ASSOCIATION DES CHERCHEURS EN ACTIVITÉS PHYSIQUES ET SPORTIVES

ACAPS 2021

19ÈME CONGRÈS INTERNATIONAL

LE NUMÉRIQUE DANS L'ACTIVITÉ PHYSIQUE ET SPORTIVE

BOOK OF ABSTRACTS

MONTPELLIER
LE CORUM

du 27 au 29 octobre 2021

Dear Delegate,

On behalf of the members of the Organizing and Scientific Committees, it is our pleasure to welcome you to the 19th International ACAPS Conference. Welcome to Montpellier! By attending this meeting, you join scientists, clinicians, students, trainers, .., around France and other 14 countries around the world who share the fieds of Physical Activity, Sport, Human Movement. Our meeting strives for a cross-fertilized multidisciplinary view, advancing deep knowledge on Movement, Physical activity and Sport. The theme of this meeting, Digital for Physical Activity and Sport should be the coming together of knowledge from different academic disciplines. The scientic program committee members have organized world-class plenary lectures in some topic areas with renowed speakers. The guest speakers will address, from an interdisciplinary perspective, current and promising research topics linking physical activity and the vast field of digital technology, which is now all-over in our dailylife. In addition to these invited lectures, we received plenty of abstracts. We accepted 10 symposia involving 51 talks, 240 oral presentations and 140 poster presentations. The organizers are grateful to the authors for their enthusiasm and to the reviewers for their work and time given to evaluate the volunteered submissions. Because of the overwhelming amount of investigator proposed content, we have set 5 parallel sessions and one symposium at times so that we could include as many of the excellent communication proposals as possible. The program for this 19th edition displays several varied themes among the sessions to satisfy all delegate. Poster presentation have been organized in 3 sessions, distributing the 140 posters by large topic area. Posters will be available for viewing during coffe breaks and lunches. Finally, we are grateful for the industry support of this meeting. The topic of this meeting requires close interaction with companies, as new technologies and digital tools are constantly emerging and being modified, often with the input of scientists, engineers and clinicians. The exhibitions should provide you with up-to-date information on the latest basic research and clinical/sport equipment. The exhibits will be avalaible during the sessions, lunches and breaks. In addition to a very rich scientific program, two evenings are proposed aiming to open our gathering to the socio-economic world (networking evening, bringing together academic and entrepreneurship players) and the general public (conference / debate on the promotion of soft mobility on a daily basis). We also want these few days spent together to be an opportunity for you to discover Montpellier. So, please discuss, learn, debate, practice, ask questions and have fun.

Kind regards,

Conference Co-Organizers

Program Overview

	Mercredi 27 octobre	Jeudi 28 octobre	Vendredi 29 octobre
8:00		Communications Orales 3 Symposium	Communications Orales 6 Symposium
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9:30		Pause Café Visite Stands partenaires	Pause Café Visite Stands partenaires
9:45	Accueil		
10:00		Conférence Plénière *Juleen Zierath*	Conférence Plénière *Krasimira Tsaneva-Atanasova*
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10:30	Workshop		
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11:00		AG ACAPS	Forum Jeunes Chercheurs
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13:15	Discours d'ouverture	Déjeuner	Déjeuner
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14:00	Conférence inaugurale *Brian Castellani*	Conférence Plénière *Nadia Bianchi-Berthouze*	Conférence Plénière *Emig Thorsten*
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15:00	Communications Orales 1 Symposium	Communications Orales 4 Symposium	Communications Orales 7 Symposia
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16:30	**Session POSTER 1** Pause Café Visite Stands partenaires	**Session POSTER 2** Pause Café Visite Stands partenaires	**Session POSTER 3** Pause Café Visite Stands partenaires
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17:30	Communications Orales 2 Symposium	Communications Orales 5 Symposia	Communications Orales 8 Symposium
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Plenary sessions

Wednesday, October 27th 2021
Plenary session 1

Big Data Mining and Complexity: Addressing the digital challenges of human movement, physical activities, and sport

Brian Castellani, PhD, FAcSS
Professor Director of the Durham Research Methods Centre and Co-Director of the Wolfson Research Institute of Health and Wellbeing at Durham University (UK). Adjunct Professor of Psychiatry (Northeastern Ohio Medical University), Editor of the Routledge Complexity in Social Science series, CO-I for the Centre for the Evaluation of Complexity Across the Nexus, and a Fellow of the National Academy of Social Sciences.
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From wearable sensors and physical activity apps to the datafication of sport and the vast information collected on human movement by research clinics, healthcare organisations and employers, we live in a digital world of big data. How these data are collected, stored, analysed, managed, and used is of significant concern – ranging from ethical and public health issues, which we've seen with COVID-19, to issues of discrimination, exploitation, and social inequality. The other concern is methodological: most professionals variously involved in human movement, physical activities and sport are not trained in big data mining analytics – from machine intelligence and simulation models to search algorithms and computational modelling platforms. There is also the issue of the digital twin, a virtual representation that serves as the real-time digital counterpart of a physical object or process. To what extent and in what ways (or not) are digital data valid and reliable representations of the physical world? These are the sorts of concerns this plenary will address. For my talk, I will survey the world of big data and its major areas of study, focusing on their potential for addressing the digital concerns of research in human movement, physical activities, and sport. These areas include data science, digital social science, visual complexity, e-science, and computational science. I also will highlight the wider movement of which these areas are a part, namely the complexity sciences. Whilst certainly no panacea, a complex systems approach is proving useful for making key advances in the analysis of big data and its related concerns.

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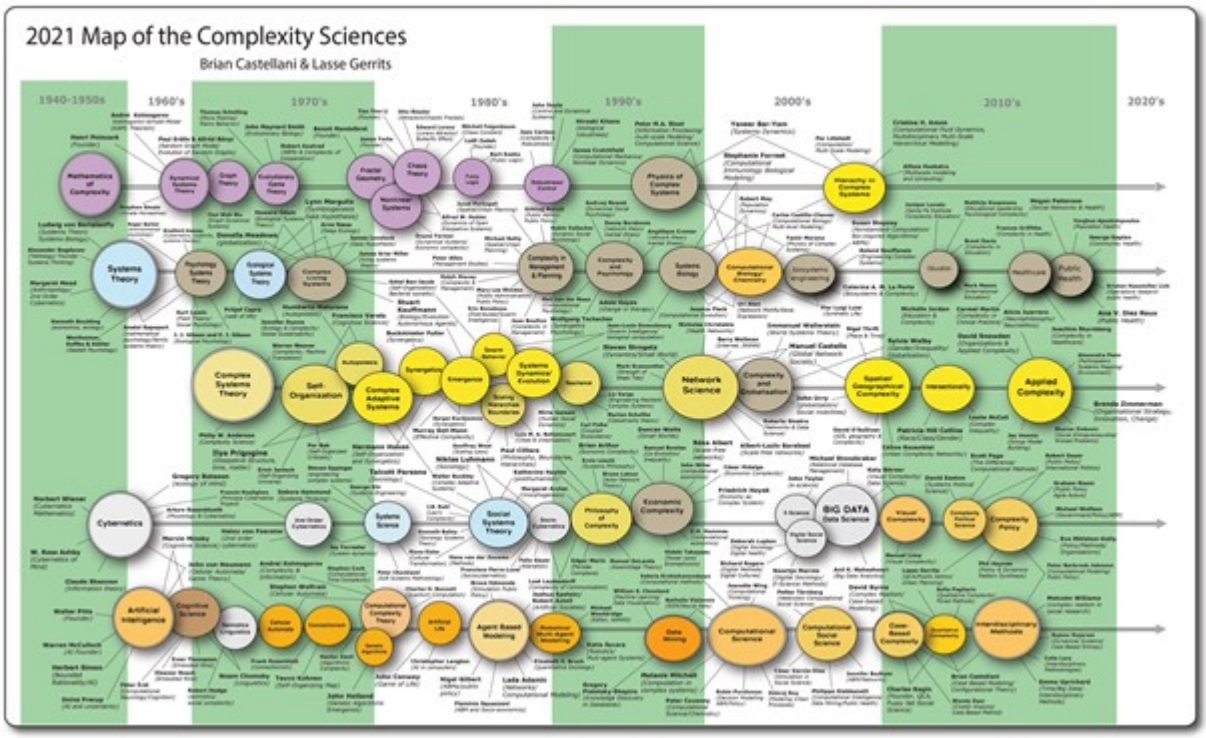

Thursday, October 28th 2021
Plenary session 2

Exercise, Inactivity, and Circadian Rhythms
Re-setting the clock in Metabolic Disease

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Type 2 diabetes is a life-threatening metabolic disease reaching epidemic proportions, with disease risk scaling linearly due to obesity and inactivity. Disturbed circadian rhythms can cause metabolic dysfunction, highlighting a role of this circuit in type 2 diabetes pathogenesis. Nevertheless, mechanisms underlying disrupted circadian rhythmicity of the intrinsic molecular-clock in type 2 diabetes are unknown. In this lecture, I will cover some of my latest work related to mechanisms by which the timing of food intake or exercise (energetic stressors) interact with peripheral clocks to control metabolic homeostasis. My overarching hypothesis is that synchronizing energetic stressors such as diet and exercise to the molecular circadian clock may maximize the health promoting benefits on glucose and energy metabolism. The goal of my current work is to elucidate the mechanisms by which physiological processes are modulated by the clock machinery in a diurnal manner including, glucose control, systemic metabolism, and mitochondrial respiration, and how dysregulation of these processes contribute to type 2 diabetes. Molecular mechanisms underpinning the link between peripheral circadian clocks, energy-sensing pathways, and the control of glucose homeostasis may one day form the basis of a new class of therapies to prevent insulin resistance.

Thursday, October 28th 2021
Plenary session 3

Affective technology and opportunities in selfdirected ubiquitous physical rehabilitation

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With the emergence of full-body sensing technology and advances in artificial intelligence come new opportunities to support people's affective experiences and needs during self-directed ubiquitous physical rehabilitation. In my talk, I will present our work on technology for chronic pain management and discuss how such technology could lead to more effective physical rehabilitation by integrating it in everyday activities and support people at both physical and affective levels. In particular, I will present how technology can be embedded with the ability to perceive people affective states through their body movement. I will also discuss how this sensing technology enables us to go beyond simply measuring one's behaviour by exploiting embodied bottom-up mechanisms that enhance the perception of one's body and its capabilities.

Key-references

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Friday, October 29th 2021
Plenary session 4

Identifying and Quantifying Movement Signatures

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Human movement has been studied for decades, and dynamic laws of motion that are common to all humans have been derived. Yet, every individual moves differently from everyone else (faster/slower, harder/smoother, etc.). We propose a measure of such variability, namely an individual motor signature (IMS) able to capture the subtle differences in the way each of us moves. We show that the IMS of a person is time-invariant and that it significantly differs from those of other individuals [1]. We then used IMS to measure objectively the level of the person's motor deficits, relative to their normal counterparts in several case studies. In an effort to establish reliable indicators of schizophrenia we developed a method that could detect deficits in movement and social interactions, both characteristics of the disorder. We asked people to perform movements alone, and to mirror the movements of a computer avatar or a humanoid robot. Using statistical learning we were able to distinguish people with schizophrenia from healthy participants with accuracy and specificity slightly better than clinical interviews and comparable to tests based on much more expensive neuroimaging methods [2]. Children with developmental coordination disorder (DCD) struggle with the acquisition of coordinated motor skills. We assessed how individual coordination solutions might emerge following an intervention that trained accurate gaze control in a throw and catch task. Kinematic data were collected from six upper body sensors from twenty-one children with DCD, using a 3D motion analysis system, before and after a 4-week training intervention. The gaze trained group revealed significantly higher total coordination following training than a technique-trained control group. Additionally, the gaze trained group revealed individual coordination patterns for successful catch attempts that were different from all the coordination patterns before training, whereas the control group did not [3]. Finally, I will present some unpublished results related to movement 'signatures' of the eye, arms, and hands which might underpin DCD.

Key-references

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Friday, October 29th 2021
Plenary session 5

Taking the exercise lab to the real world: What can we learn from big data in endurance sports?

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Laboratory performance tests provide the gold standard for running performance but often do not reflect real world conditions. In our latest work, we use a large dataset obtained from wearable exercise trackers to inform a validated model for running performance, and obtain a better understanding of the complex interplay between training and performance. The data set contains running activities of ≈ 14,000 individuals, ≈ 1.6 million exercise sessions containing duration and distance, and a total collaborative distance of ≈ 20 million km ran. The inclusion of endurance as a model parameter offers novel insights into performance: a highly accurate race time prediction and the identification of key parameters such as the lactate threshold, commonly used in exercise physiology. Correlations between performance indices and training volume and intensity are quantified, pointing to an optimal training. Our findings hint at new methods to quantify and predict athletic performance under real-world conditions, detection of doping, and the assessment of new running shoe technologies.

Key-references

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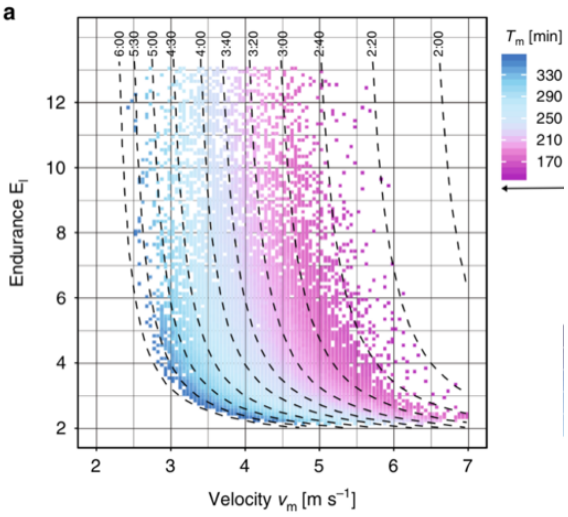

Wednesday, October 27th 2021

Digital Sciences and Technologies

From data collection to rapid feedback on the pitch
A hands-on demonstration based on a multidisciplinary project on resilience in sports

Rens Meerhoff * [1], Ruud Den Hartigh * † [2]

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[2] Department of Psychology, University of Groningen – Netherlands

Introduction
The world of sports has witnessed an incredible progress in the technologies and data science techniques that can be employed. In this workshop, we will demonstrate how these technologies can be used to aid the data-driven guidance of athletes, based on our funded multidisciplinary project on resilience in sports (project-ris.nl/english).

Resilient athletes
Athletes encounter all kinds of stressors, which can be physiological (e.g., high training load) as well as psychological (e.g., losing a match). To deal with such stressors, athletes must be resilient. When an athlete's resilience is reduced, it is pertinent to take effective measures on time (e.g., adjusting training schedule). In our approach, we use multi-modal data and knowledge from the field of psychology, human movement science, and data science to model the individual physiological and psychological processes. The model is employed to detect periods in which the athletes are at risk to loose resilience. These insights are shared with the coaches and other staff members who can take appropriate action.
In our project, we collaborate with different professional (Eredivisie) football clubs in The Netherlands. We developed a web-app in which different parts of our pipeline (from data collection to concrete feedback) come together. More specifically, the app is used to collect questionnaire data about stressors (such as setbacks and subjective physiological load), and psychological states (such as confidence and motivation). The second step is to provide on-the-spot analyses and insights. Our app contains a set of tools that provide immediate descriptive visualizations of the data of the athletes. Is anyone scoring below their normal score? Is anyone deviating from the patterns of the group?

Workshop demonstrations
In the workshop we will demonstrate our measurement infrastructure to map the physiological and psychological processes of athletes on a daily basis, by means of sensors that players wear on the field and our web-app. We will also show how our data scientists create algorithms within our online data platform to make visualizations and personalized models of resilience.
Apart from demonstrating how our pipeline has come about, we will provide some hands on experiences with working on such a pipeline. After this workshop, you will have insights into

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using an advanced system focused on data-driven guidance of athletes. It is relevant for both scientists and practitioners who aim to better understand the complex dynamics of the physiological and psychological states of athletes.

* Under the aegis of: **Chaire de psychologie du sport**, *Fondation de l'Université de Montpellier*
(https://fondation.edu.umontpellier.fr/programmes-dactivites/chaire-de-psychologie-du-sport)

Keywords: stressors, load and recovery, data science, personalized feedback, time series

Measuring Emotions from Motion: a markerless motion capture case study

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Introduction
Motion capture technologies are now widely implemented in movement sciences. However, they require the use of physical markers that need to be positioned on the major joints of the participants. The placement of these markers proves to be time-consuming. Body movements might result in marker loss, while the methods of marker-fixation can lead to slight marker shifts, hindering the quality of 3D measurements. Furthermore, marker-based systems limit the use of motion capture technologies in ecological situations. Recently, with the advents of computer vision, new marker less systems have been promoted with the promise of recording motion capture data without the hassle of placing markers on a physical body. Participants can move freely through space while the software automatically detects limb joints, movements and records kinematics. In the present work, we report a validation study demonstrating the ability to study emotional motor behaviors using a markerless 3D motion capture system.

Method
Four participants will be recruited to investigate the changes in their kinematics during an emotional induction procedure. Two emotional conditions (sadness and happiness) plus a neutral condition will be tested. Participants will be asked to walk for five meters and come back to their starting point. Prior to walking, they will listen to a recorded scenario (e.g., "imagine that you have been accepted to your dream university"). In addition, they will listen to musical excerpts specifically developed to induce emotions (Vieillard et al., 2008). Video will be recorded using 8 Miqus cameras (Qualisys AB, Göteborg, SE) sampled at 120 Hz. Theia3D software (Kingston, Ontario) will be used to compute 3D data of major joints. In order to validate their usability, markerless data will be ran through DeeREKt, a deep emotional classifier, to predict the emotional state of the participant (Brossard et al., 2021).

Results
We expect the measurement accuracy of the markerless system to be sufficient in capturing changes in posture induced by the emotions (e.g., chin and shoulder down in sadness). Furthermore, we expect DeeREKt to be able to correctly classify the emotional state of the participant in more than 50 % of the cases.

Discussion
Although markerless technology might seem to remove all hassle of marker-based technology, camera positioning and computing power necessary to run markerless software need to be taken

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into consideration. Once these requirements have been taken into consideration, markerless motion capture data can be used in a variety of applications.

Conclusion
The results obtained in this work offer a promising look toward the use of markerless motion capture technology to study emotional behavior in ecological situations. In future work, data will be gathered in natural environments implemented with sensorial nudges (odors) to test the usability of markerless motion capture technology in creating interactive environments to offer citizens with the pleasure of physical activity.

Keywords: emotions, markerless, motion, capture, deep, learning

Deep Learning for Underwater Gesture Identification From Airbone Training

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Introduction
To be able to communicate with an underwater robotic system intuitively, we propose to develop a solution based on visual gesture recognition. This work introduces a new robust data-driven method to identify and classify divers' gestures. Whereas most of the work in the literature track fingers independently [1][2][3], this work relies only on the arm and forearm motion with regards to the trunk. The aim is to show that the proposed classification is robust enough to be transferable from airborne to underwater recordings which makes it easy to train and easy to use.

Methods
First, A motion capture system is used to track 7 standard diver gestures in air (stabilize, down, up, cold, regroup, ok, not well). 5 subjects (2 males, 3 females) were required to perform the 7 divers' gestures with 5 repetitions. 11 optical markers were placed on points of interest on test subjects (forehead, chin, shoulder, elbow, hand, pelvis). The same experiment is then repeated underwater in an indoor 3x3x8m pool with an underwater 3D motion capture. To classify the different gestures, we will be comparing two different classification techniques: SVM and LSTM. Support Vector Machine (SVM) is a standard Machine Learning technique. Long Short-Term Memory (LSTM) is a neural network architecture that takes temporality into account. The architecture we used is similar to [4]. It consists of 2 layers of bilinear LSTM with a dropout layer between them. A dense layer is added to obtain the class of the gesture. In both cases, the data fed into the models are flexion/extension elbow angles and the angle defined by wrist, shoulders, and hip [5]. The angle evolution will be normalized with regards to motion duration. To evaluate the classifiers, they will be trained 10 times with 90% of the data and tested on the remaining 10%. Then the most efficient classifier will be kept and tested on underwater.

Expected Results
We expect that the classifiers will identify airbone gesture across the subjects and that the LSTM will be complementary to the standard SVM method and we expect to even reach better classification by fusing them. It can be done using ensemble learning which, consists of training

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multiple models on the same data with some sort of statistical method (weighted average for example) to obtain a general classifier. We also expect that the proposed classification is robust enough to be transferable from airborne to underwater recording with high identification rate.

Perspectives
A next step is to transfer the proposed framework to standard light RGB cameras [6]. Then the same gestures will be acquired, in an underwater environment, at different depth levels and environmental conditions related to known stress levels (water turbidity, temperature, lake/sea). This would allow us to extend the transferability of the methods, as well as to quantify the difference in the performed gestures between the different environments, and to deduce qualitative and quantitative criteria from such an assessment. For instance, this allows estimating the variation of the speed of the gesture, as well as it is quality.

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Keywords: deep learning, gesture recognition, diving, human machine interface, underwater motion capture

Reconstructing locomotor trajectories at home from a sensing floor

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Analyzing how we walk in our home can provide valuable information about locomotor efficiency and general well-being. Through the shape of our trajectories, basic walking metrics such as distance, time, and speed, and space occupancy characteristics, human locomotor behaviours at home, and the way they convey markers of wellness, can be investigated. The objective of this study was to detect, reconstruct and identify locomotor trajectories during walking at home with a capacitive sensing device, the SensFloor, recently installed in an apartment located in the centre of Montpellier, in the South of France. Data were collected both in controlled scenarios - linear and curvilinear trajectories repetitively performed by three experimental participants - and during a full day of real occupancy by one inhabitant. The algorithmic approach followed (i) identification of static graph, spatial and temporal neighbourhood from floor activation, (ii) data filtering, (iii) trajectory reconstruction through chains of dynamical nodes, and (iv) identification of walking metrics, such as locomotor distance, time, and velocity. Results revealed the efficacy of the algorithm to successfully capture human trajectories inside the apartment under different conditions, including when curvilinear trajectories are performed simultaneously by two participants in different rooms. Applied to a full random day of occupancy by a single inhabitant, our algorithm also revealed the existence of 47 individual locomotor trajectories, calculated out of 129 thousand recorded floor contacts, yielding an average walking velocity μ = 1.1 m/s with σ = 0.3 m/s, an average walking distance μ = 9.4 m and an average walking duration of μ = 8.8 s. The success of our algorithm to detect locomotor trajectories now allow the exploration of walking patterns at home and their correspondence to well-being. Acknowledgments: This research has been conducted as part of the Human at home projecT (*HUT*) co-financed by the European Regional Development Fund (ERDF) and the Occitanie Region. This acknowledgment extends to the support given by Montpellier Méditerranée Métropole.

Keywords: Locomotor trajectories, walking at home, sensitive floor, capacitive sensor, Sensfloor

*Speaker

A Big Data Approach for Studying Muscular Tuning for Pointing Directions

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Introduction
The aim of this study was to obtain insights into key muscular adaptations for arm pointing in different directions. One of the main problems in motor studies remains the huge amount of data which is generated and more importantly, our capacity to view and analyse collective differences as the muscles undergo simultaneous modifications. Here we used a machine learning approach to tackle this problem. The rationale was to focus on differences between muscles and conditions by letting them freely emerge from the machine learning classification.

Method
An experiment was done with participants seated with their hand held horizontally in front of them as a starting position. Participants then pointed their arm in different directions. Kinematic markers placed on the body-limbs recorded spatial displacements while surface EMG electrodes recorded muscular activity from nine muscles – the deltoids (anterior, middle and posterior heads), triceps brachii (long and lateral heads), biceps brachii (short head), pectoralis major (upper head), trapezius and latissimus dorsi muscles (Gaveau et al, 2016). Machine learning was used to obtain a multivariate understanding of the muscular adaptations in each direction. This was done by probing which muscle *combinations* provided the best predictions/discrimination when attempting to distinguish pointing at 90∘ (referent direction as gravity neutral) versus all other directions (0, 30, 60, 90, 120, 150 and 180 degrees). The classification algorithm used was linear discriminant analysis (LDA).

Results
Classification accuracies with test data was at 80% or higher. Following the classification, we were able to access representations of the different muscles for each direction. We then subtracted the muscle representations between directions to highlight muscle modifications. The muscle combination that provided the best discrimination accuracies were the deltoid (anterior, posterior and medial) and trapezius muscles, hence indicating that these muscles were the most altered between pointing directions. In contrast, the biceps brachii, triceps brachii, pectoralis major and latissimus dorsi provided poorer predictions of pointing direction hence indicating less consistent changes as a function of pointing direction.

Discussion and Conclusion
Even though newer algorithms might have provided higher classification accuracies, LDA was picked for ease of use and most of all, for simpler identification of the features which permitted

*Speaker

classification. An examination of the representations created by the ML algorithm allowed for an identification of the muscle combinations which are most altered by pointing direction. This may represent a fruitful complementary method to classical statistics and ensemble techniques like principal component analysis that focus on correlations rather than differences between motor control variables. Future studies will involve the investigation of how similar principles of feature selection could be applied to classification algorithms which are more efficient.

Reference

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Keywords: Machine Learning, EMG, Motor Control, Pointing, Gravity

Looking for optimal biomechanical configurations in weightlifting and powerlifting

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Introduction

More than sports, weightlifting and powerlifting are widely used in resistance training for sport performance. As they both consist of lifting additional weights they must be well executed to avoid injuries and enhance fitness and performance.

To date, pieces of advice from experienced or graduated or self - proclaimed coaches, swarm in gyms and on the web, but very little or none of these tips are based on scientific knowledge. The same technical instructions are often given to men and women with different anthropometry and training history. As they are not individualized, these instructions could be at best suboptimal for most athletes, not enabling them to express their full potential and, at worst, dangerous and causing injuries.

The central objective of our project is the development of an optimised personalized virtual human model. The goal is the optimization of performance with an assessment of injury risks at the limits of performance.

Methods

On the one hand, a virtual mechanical/skeleton model of an athlete squatting was numerically designed and set in motion according to the IPF rules. Anthropometrical determinants measured by bi-planar radio (EOS) of one of the top French elite lifters were used in the model to make it as realistic as possible. According to the literature, criteria for optimization were chosen and implemented to measure the efficiency of the movement simulated. Artificial intelligence was then added to optimize the motion.

On the other hand, an evaluation protocol of some key determinants was written. This was done after an analysis of the existing tools and the ones available at the lab and easily implementable in training. The capacity to measure in training permitted analyses on heavy loads. Which couldn't be safely possible in the lab as some lifters can squat up to 300kg and need a special environment to do so.

Finally, the different movement, modelized and measured, were compared to validate some choices on the model.

Results

Currently, it seems that the strategies used by the elite lifters are different from the model ones. These differences mainly sit in the centre of gravity displacement along the lift.

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Discussion
These differences could be explained by the fact that no muscle was present on the model. Even if elite athletes may not have optimal movement, the fact that the centre of gravity moved according to the same pattern for all of them suggests that the model must be completed.

Conclusion
We conclude that our current model is not sufficient at this stage of development to analyse the movement of the squat. It is then necessary to complete it, by adding muscles, to make it more realistic and applicable to the training of top-level athletes.

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Keywords: biomechanic, optimization, artificial intelligence, performance, mechanic

Integration of video tools in training programs: the case of collective performance in football

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Introduction
The integration of video tools into their training methods by sports coaches is quintessentially diverse (Brümmer, 2019) and loosely connected, and coaches are seldom guided in this endeavour by a coherent conceptualization of training (Isserte, Gaudin & Chaliès, under review). This is particularly true when it comes to performance improvement in football. This study addresses that issue by assessing the impact on football coaches of a learning course based on a training theory, in order to help them make an articulate and multifaceted use of video tools aimed at improving collective performance.

Methods
This study was divided into two stages. First and foremost, four unexperienced coaches following the "UEFA A-grade Football Coaching" course were introduced to the use of video tools applied to the improvement of collective performance. They were taught three main drills requiring the use of video tools and inspired by a theory of training derived from cultural anthropology (Chaliès, Gaudin & Tribet, 2015) : (i) how to conceive an animation based on computer generated imagery in order to show explicitly to players a specific collective move they have to perform, and what is expected from each of them, (ii) how to help players perform the move under predetermined conditions by giving them the necessary explanations with the support of slightly-delayed video recordings of their actions (iii) how to monitor the acquisition of the collective move in real-time match conditions thanks to video recordings that allow coaches to show the gaps between what was expected from the players and what they actually achieved. In the second stage of our study, the four coaches were invited to integrate the drills they had just been taught in their own training programs. Afterwards, we confronted them with the video recordings of their own training sessions and asked them to comment. All the data collected was submitted to a qualitative approach aimed at identifying the different uses football coaches can make of video tools and similar technologies.

Results
Our analysis showed that an articulate and multifaceted use of video tools and related technologies paves the way for the conception of "augmented" training programs aimed at the development of collective performance.

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Discussion
The results gathered allowed us to open the debate about the importance given to video tools in all kinds of training programs. More precisely, we now have elements to discuss how to make an adequate use of these tools in order to upgrade training programs and conceive training sessions that are streamlined according to the goals pursued.

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Keywords: video technology, coaching, collective performance, football

Neuroscience - motor control

Can Exergames be improved to better enhance behavioral adaptability in older adults? An ecological dynamics perspective

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Finding effective training solutions to attenuate the alterations of behavior and cognition in the growing number of older adults is an important challenge for Science and Society. By offering 3D computer-simulated environments to combine perceptual-motor and cognitive exercise, Exergames are promising in this respect. However, a careful analysis of meta-analytic reviews suggests that they failed to be more effective than conventional motor-cognitive training. We analyzed the reasons for this situation, and we proposed new directions to design new, conceptually grounded, exergames. Consistent with the evolutionary neuroscience approach, we contend that new solutions should better combine high level of metabolic activity with (neuro)muscular, physical, perceptual-motor and cognitive stimulations. According to the Ecological Dynamics rationale, we assume that new exergames should act at the agent-environment scale to allow individuals exploring, discovering and adapting to immersive and informationally rich environments, that should include cognitively challenging tasks, while being representative of daily living situations.

Keywords: Vieillissement, exergames, activité physique, cognition

*Speaker

Comparison of gait adaptability behavior between real and virtual environments

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Introduction

Falls in older adults is a major societal issue. One third of adults over the age of 65 fall at least once each year, and half of these have repeated falls. Gait and balance disorders have been identified in multiple studies as among the strongest fall risk factor (Ambrose et al., 2013). Most falls occur during tasks requiring a locomotor displacement in cluttered environments and thus, during situations that require the production of adaptive gait and when the displacement adjustments required to deal with environmental constraints are imperfectly performed. During the past years, new technologies have been used as a rehabilitation tool to prevent falls in elderly. Virtual Reality (VR) technology has been used exponentially in rehabilitation over recent years and appears as a relevant tool in rehabilitation and motor learning in elderly (Cano Porras et al., 2018). Our long-term ambition is to develop training program with an immersive VR technology to train gait adaptability in order to prevent fall in elderly. Before developing our gait training program, we must (i) check the similarity of gait adaptability behavior between real-world and virtual environment and to (ii) ensure that older adults accept our fully immersive VR technology used in our future gait training program.

Method

Young and old adults take part in the experiment (40 participants expected). Participants perform locomotor pointing tasks consisting of an approaching phase and a target pointing (i.e., place the right foot's tip as close as possible to a target). They perform this task in three experimental conditions: one real-world condition and two virtual conditions. For the real-world condition, participants walk in the experimental room. For the virtual reality conditions, participants wear the virtual reality headset HTC Vive® and walk in two different VE. From participants' feet positions, several gait parameters are computed (van Andel et al., 2018). A pointing accuracy analysis is performed to quantify the pointing performance. In the inter-trial analyses, the inter-trial standard deviations of both the toe-target distances and the step lengths over the target approach are computed. In the trial-by-trial analysis, an inter-step number analysis to determine the onset of regulation and the total amount of adjustments and an intra-step number analysis to compute the amount of adjustments needed and the amount of adjustments produced for each footfall are computed. Through the " Technology Acceptance Model " (Davis & Venkatesh, 1996), the acceptance of the virtual reality headset a priori and after use are

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assessed using self-reported measures. Cybersickness and the sense of presence are also assessed by questionnaires.

Results
Results are not yet available. We expect that participants adopt the same gait adaptability behavior whatever the condition (real-world and virtual) and that old adults adopt a more secure strategy than the young. Acceptance of the virtual reality headset should be greater for the younger a priori but it should be the same between young and old adults after use.

Discussion & Conclusion
In the case the present study allows us to ensure that gait adaptability behavior is the same in real-world and virtual environment and that older adults accept VR technology, we could develop our training program to prevent fall in elderly.

Keywords: Gait adaptability, virtual reality, locomotor pointing, acceptance

Improving cognitive functions in healthy older adults: a comparison of three combined training programs

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Introduction

Physical (i.e., aerobic and muscular resistance exercises) and complex motor skills (i.e., interlimb coordination, balance control, gait...) training have a positive impact on the aging neuro-musculo-behavioral system, not only, on physical and motor capacities, but also brain and cognitive functions. Therefore, it has been hypothesized that the combination of them might lead to larger (additive or interactive) effects on cognition (1). This can be done under three different forms of physical, motor, and cognitive combinations. First of all, through activities where a moderate level of aerobic effort is achieved while performing complex coordinated movements, such as during Nordic Walking (2). Secondly, during circuit training where complex motor skills are performed in dual-task situations (i.e., Thinking while Moving) (3), while maintaining a moderate level of aerobic effort through the sequence of the different tasks. Thirdly, by creating training situations where cognitive processes are incorporated into the motor tasks (i.e., Moving while Thinking) (3), still maintaining a moderate level of aerobic effort (2). On the basis of the Adaptive Capacity Model (4), it can be hypothesized that the Moving while Thinking training situations should be more effective than the two others. However, to our knowledge, this hypothesis has not been yet empirically demonstrated. The present study addresses this issue by comparing a Nordic walking (NW) and two cognitive-motor circuit training programs (CT-c and CT-fit). CT-c and CT- fit will presumably stimulate cognition differently: i) through conventional complex coordination training performed in single and dual-task conditions (CT-c), and ii) by incorporating decision making, inhibition, and cognitive flexibility into complex goal-directed actions (CT-fit), thanks to the use of a fitness gaming technology (Fitlight™).

Methods

Forty-five healthy independent living community dwellers participants (65–80 years) will be included after a general medical examination. The main exclusion criteria are signs of cognitive impairments (Mini-Mental State Examination $<$ 26/30) and physical impairments. Pre and post-tests will be performed to assess: cognitive functions (Montreal Cognitive Assessment; Trail Making Test; Stroop task, working memory test, Rey Complex Figure copy task, Oral Trail Making Test, and dual-task); motor fitness (Bipedal and unipedal balance test, gait assessments,

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Time Up and Go, chair sit and reach test and four-square stepping test); and physical fitness (10 m incremental shuttle walking test, maximal handgrip force, Timed-Stands test).

Expected results
CT-fit is expected to be more effective than the two other programs to improve behavioral outcomes and cognition.

Conclusion
Incorporating cognitive demands into complex, goal-directed actions using fitness gaming technology is expected to be the best solution to optimize training benefits. The consistency of such findings with the existing theoretical models will be discussed. Additionally, if the hypothesis is verified one can also conclude that technologies, and exergames, facilitating the combination of cognitive, motor, and/or physical training, keep their promise of being more efficient than conventional training to improve brain and cognition in older adults.

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Keywords: aging, cognition, cognitive, motor training, Nordic walking, exergames

Perceptual-motor adjustments allowing elderly people to drive across an intersection

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Introduction
This study is part of a project whose main objective is the design of driving assistance systems (ADAS) for elderly people (> 65 years old) in order to make their movements safer when approaching an intersection. Indeed, as the figures reported by the ONISR show, crossing an intersection is an accident-prone maneuver responsible for 20% of road deaths in France. The first step of this project was to characterize the behavior of elderly people when crossing intersections in reference to that produced by young subjects.

Method
Twenty young drivers (23 years ±3 years) and twenty elderly drivers (73 years ±5 years) performed an intersection crossing task on a driving simulator. They had to cross an intersection by modulating their speed if necessary. To do this, the subjects were placed unknowingly at varying distances from the intersection location. Five initial distances were proposed requiring distinct speed adjustments in order for the crossing to be performed. The analysis carried out in this study focused on the kinematics of the trajectories produced under different experimental conditions, as well as on the associated visual information taking strategies (oculometric analysis).

Results
The results obtained indicate similarities in the behaviors produced by the two subject populations. Functional speed regulations appear early and persist until the intersection is crossed. These regulations allow drivers to cross the intersection safely in the first half of the inter-vehicular interval. The visual strategies deployed by the seniors are also relatively close to those deployed by the control population, with the main areas of interest located on the vehicles located upstream of the inter-vehicular space. The results also reveal differences between the two subject populations. The elderly population initiates speed regulation later and compensates for this delay by changing speed more sharply as they approach the crossing. Ongoing analyses of the information gathering strategies (heat map and scan path) help clarifying the origin of these differences.

*Speaker

Discussion & Conclusion

These results confirm previous findings that reveal the ability of young drivers to produce adaptive behavior based on a close perceptual-motor dialogue (e.g., Louveton et al., 2012; Mathieu et al., 201)). They also offer some explanations as to the difficulties encountered by older people when performing accident-prone maneuvers. The new generation of driver assistance systems will have to take these particularities into account, so as to be adapted to the specificities of the users.

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Keywords: Elderly people, driving assistance systems, driving simulator, intersection.

Physical activity via a mobile telepresence robot in older adults: Perception, effectiveness, and acceptance

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Introduction

With the increase in life expectancy, the number of older adults suffering from declines in brain, cognitive, physical, and perceptual-motor functions also increases. Thus, an important challenge is to identify effective and acceptable solutions for attenuating the deleterious effects of aging. It is now well demonstrated that practice of physical activity (PA) contributes to healthy aging and well-being. However, most older adults aged over 65 years remain physically inactive (i.e., 67%; Harvey et al., 2013). Among the reasons that may explain this situation, an important one lies the difficulty of organizing the presence of a coach, which is reinforced by the sanitary situation. In this context, the organization of remote physical activity sessions, thanks to the use of video, is increasing. However, in this case, the fixed position of the camera does not make it possible to reproduce a situation comparable to that of the real presence of the coach. One solution to overcome this problem is to use a mobile telepresence robot, the movements of which are controlled remotely by the coach. The question remains however of whether interventions mediated by the robot are effective and acceptable, relative to face-to-face interventions. The present study addresses these issues, with two objectives: (1) to compare the effectiveness and perception of the coach in two conditions: face-to-face coach *vs.* telepresence coach, and (2) to analyze the acceptance of the robot *Ubbo* by older adults during a PA session conducted by a telepresence coach.

Method

Forty older adults will be randomly assigned to two different groups. Participants will be faced with a single individual session (similar for all of them) either conducted face-to-face with the coach or with the coach in telepresence, via the mobile robot *Ubbo*. Participants will have to learn a complex stepping task: the Square Stepping Exercise (SSE, Shigematsu et al., 2008). The objective of this SSE task is to walk lengthwise by reproducing a sequence of precise steps, carried out on a mat measuring 2.50 meters long by 1 meter and squared into 40 squares of 25 centimeters on each side. Three types of SSE tasks will be practiced: i) a familiarization task (4 trials), ii) a task of low level of difficulty with forward steps only (16 trials), and iii) a task of intermediate level of difficulty with forward, backward, lateral, and oblique steps (16 trials). Performance will be measured by the time to complete each SSE task and number of errors.

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Acceptance of the mobile telepresence robot will be measured using a self-reported questionnaire (Venkatesh et al., 2012). Moreover, coach's perception will be measured using four questionnaires: i) perceived competence and perceived warmth (Čaić et al., 2020), and ii) perceived sociability and perceived adaptability (Heerink et al., 2010). Comprehensive qualitative methodology embedded in the "enactive phenomenological" research program (Theureau, 2015) will be also conducted to identify the typical lived experience of the participants during the two sessions, using videos and self-confrontation interviews.

Results
Results are not yet available.

Discussion
The present study will allow to determine whether the mobile telepresence robot is as effective as the face-to-face intervention, how it is perceived, and whether it is accepted by older adults. To our knowledge, it is the first experimental study addressing these issues.

Keywords: Older adults, physical activity, mobile telepresence robot, acceptance

Symposium : Aspects psychophysiologiques de la performance

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- Introduction (Romuald Lepers)

- Mental fatigue: how to avoid its negative effects? (Thomas Jacquet)

- Boredom, a possible confounding factor in protocol aiming to examine cognitive fatigue effects on physical performance. (Michel Audiffren)

- How to manage Exercise-Induced-Pain during a high intensity task? Psychological strategies used by expert crossfitters.(Marjorie Bernier)

- Measuring sensory responses to physical exercise: Why and how? (Mathieu Gruet)

Keywords: Mental Fatigue, Pain, Boredom, Perceived effort

*Speaker

Mental fatigue: how to avoid its negative effects?

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Mental fatigue, which is defined as a psychobiological state caused by prolonged and/or intense periods of cognitively demanding activity and characterized by subjective feelings of "tiredness" and "lack of energy", could lead to an alteration in both cognitive performances (e.g., attention, planning) and physical performances (e.g., endurance performance, motor control). These alterations can have negative repercussions on daily life activities and induce, for example, a decrease in productivity in companies, an increase in the risk of medical errors or road accidents. Several models have been proposed to explain the effects of mental fatigue (the model of the motivational control theory, of costs and benefits, or the dual regulation of mental fatigue), all suggested that the decrease in performance in presence of mental fatigue is the result of a decrease in resources allocated to perform the required task. Among the brain areas involved in the allocation of resources, the anterior cingulate cortex seems particularly impacted by mental fatigue. In the presence of mental fatigue, a reduction in the anterior cingulate cortex activity, due to a failure of the dopaminergic networks is observed. Thus, several studies have proposed compensation strategies, known to have beneficial effects on dopaminergic production, to counteract the effects of mental fatigue and limit its deleterious effects.

First strategies used to compensate for the effects of mental fatigue employed bioactive substances (a compound interacting with the living tissue) such as creatine, chicken extract, or caffeine. The intake of these bioactive substances before, during, or after a mentally fatiguing task appears efficient to counteract mental fatigue and limit its deleterious effects on performance. However, these bioactive substances can also have side-effects such as anxiety, restlessness, or headaches. For this reason, other strategies using non-bioactive substances such as meditation, music listening, and monetary reward have been proposed. The use of these strategies during or after a mentally fatiguing task has also been shown to be efficient in counteracting mental fatigue. While almost all studies have focused on limiting mental fatigue effects with acute strategies, recently, a study evidenced that a 4-week endurance training program improves tolerance to mental fatigue. This observation is not surprising given the many beneficial effects of regular physical activity on cognition. Future studies should investigate the effectiveness of prevention strategies of mental fatigue.

To summarize, the limitation of mental fatigue and its deleterious effects is a field of investigation in full expansion due to its possible repercussions on daily life. The studies carried out until now attributed the effectiveness of these compensation strategies to an increase in

*Speaker

dopamine production; however, no study has directly tested this hypothesis. Finally, most studies on mental fatigue compensation have been conducted in the laboratory, and it would be interesting to test these strategies in more ecological conditions.

Keywords: Mental fatigue, Cognitive fatigue, Compensation, Performance

Boredom, a possible confounding factor in protocol aiming to examine cognitive fatigue effects on physical performance

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The reason that lead individuals to stop exerting effortful control during a mental or physical task is currently a subject of passionate debates in the community of psychologists and neuroscientists. Four main approaches propose mechanisms explaining this disengagement of effort. The resource approach assumes that a mental resource progressively decreases throughout an effortful task up to a conservation threshold where individuals decide to stop exerting effortful control (Baumeister et al., 2018). The short-term neuroplasticity approach claims that the capacity to generate synchronized theta rhythmic oscillations (i.e., effortful control) is weakened by the production of adenosine when a brain region has a high consumption of glucose (André et al., 2019). The cost-benefit approach proposes that individuals stop to exert effortful control when costs become higher than benefits (Kurzban et al., 2013; Shenhav et al., 2017). Finally, the motivational approach assumes that because individuals perceive effortful control as costly and aversive, they generally prefer to shift towards more pleasant activity after a first strenuous effortful task and drop out more easily in a subsequent effortful task (Inzlicht et al., 2014). These different approaches generally use the sequential protocol, in which participants have to perform two consecutive tasks: a first highly or weakly effortful task (i.e., depleting vs. control task) followed by a highly effortful task (i.e., the dependent task). According to the three first approaches, the earlier dropout or decline in performance generally observed in the dependent task when it is carried out after the depleting task can be interpreted as an effect of cognitive fatigue if specific patterns of results are observed. For instance, it can be expected a feeling of fatigue accompanied by a decrease of performance in the dependent task and a decrease in connectivity between the salience and the central executive networks recorded with EEG and fMRI. By contrast, the last approach denies the existence of a cognitive fatigue effect and explains the disengagement in effort exclusively with motivational mechanisms. The purpose of the present series of three experiments was to replicate the effect of disengagement of effortful control induced by a first task tapping executive functions by using an appropriate protocol. In the first experiment, we failed to observe the earlier disengagement of effort in the dependent task (i.e., an endurance handgrip task) and boredom induced by the control task seems to explain this lack of significant results. The second experiment, confirmed that the control task used in the first experiment is a highly boring task. In the last experiment, participants performed

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a 30-min cognitive task (modified Stroop task or emotionally neutral video task) followed by the endurance handgrip task. As expected, participants squeezed the handgrip during a shorter time after the Stroop task than after the control task. These results support the view that exerting a long effortful task leads to a decrement of performance in a subsequent effortful task. However, this series of experiments shows that motivational variables involving boredom play a considerable role in the occurrence of this phenomenon and suggests that boredom induced by the depleting task as well as the control task need to be controlled in such protocols. Further studies disentangling cognitive fatigue from boredom are required in the future.

Keywords: Mental effort, Executive functions, Boredom, Ego depletion, Sequential tasks

How to manage Exercise-Induced-Pain during a high intensity task? Psychological strategies used by expert crossfitters

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Introduction
Strategies used by athletes to manage injury pain or chronic pain such as distraction from pain, praying, reinterpreting pain sensations, ignoring pain (Deroche et al., 2011; Meyers, 1992) are well known. However, the psychological strategies that athletes use in order to manage Exercise-Induced Pain (EIP) are not yet familiar. EIP occurs naturally when athletes are engaged in an intense and prolonged exercise without causing lasting damage and will usually diminish or completely disappear shortly after exercise is ceased or intensity is reduced (Mauger, 2019). Strategies to manage EIP will be explored during a crossfit challenge corresponding to a high intensity performance task.

Method
Ten expert crossfit athletes will be recruited. To collect data during the health crisis, the experiment takes place remotely. First, each participant performs a WOD (Work Of the Day) including three series of three exercises to induce pain. After the WOD, a video stimulated recall interview is conducted: the participant watches his/her own performance and after each exercise he/she is asked a) to rate their perception of effort and pain with the Borg CR10 scale and, b) to describe the type of pain felt, the thoughts and emotions induced by this pain, the strategies used to manage pain and their function. Qualitative data are analysed inductively and deductively to identify categories of strategies. The links between pain and effort perceptions and strategies are also examined.

Preliminary results
To date, five participants completed the protocol. Coping strategies such as acceptance or planification and cognitive strategies such as intermediate goal setting, or motivational self-talk have been highlighted.

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Discussion
Results will be discussed in the light of publications on coping strategies identified in other sport pain research. They will also be compared to the scarce previous work on EIP management (Kress & Statler, 2007; Lasnier, 2020).

Conclusion
Future research will be proposed to established links between the identified strategies and performance. A better understanding of strategies used by expert athletes to manage EIP would make it possible to set up interventions.

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Keywords: Exercice Induced Pain, psychological strategies, high intensity task, crossfitters

Measuring sensory responses to physical exercise: Why and how?

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Introduction

Most exercise tests (e.g. cardiopulmonary exercise testing) are primarily interpreted from changes in physiological outcomes, with often poor examination of the associated sensory responses. However, some psychological responses to exercise might be relevant to shed light on the factors limiting exercise performance but also to understand exercise intentions and behaviors in various settings and populations. While most studies in the fields of sport sciences and clinical exercise physiology focused on overall rating of perceived effort (RPE), it is also possible to report differentiated RPE scores (e.g. peripheral muscle vs. respiratory effort), but also different sensations like fatigue, pain or affect. Some sensory responses (e.g. respiratory sensations) may also be reported using a quantitative approach (e.g. dyspnea intensity) as well as a qualitative approach (e.g. selection of different dyspnea descriptors). While all these sensations may provide complementary informations they are not always easy to discriminate. The aim of this presentation is to provide an overview of the different sensations which can be measured during and after different exercise modalities and discuss the importance as well as the difficulty in dissociating these sensations, with selected examples from various healthy and pathological conditions.

Results and discussion

While humans are able to dissociate fatigue from effort, effort from discomfort or respiratory effort from breathlessness in specific experimental conditions, we will see that it is not always possible, notably during whole body exercise. It is important to keep in mind that measuring several sensations at a given time point during physical exercise implies incorporating several single-item scales and thus reporting several scores within a short time frame. While this is necessary to provide a comprehensive assessment of the sensory responses associated with a given exercise modality and intensity, this also increases the risk of cognitive overload and response conflation which may contribute to inaccurate reports. Moreover, dissociating sensations (e.g. effort, discomfort and fatigue reported in isolation instead of all these sensations grouped under an undifferentiated RPE score reported within a *gestalt* framework) may imply using less words to describe complex concepts. These issues are particularly relevant in people unaccustomed to these sensations (e.g. long-term sedentary individuals) and lacking experience in reporting them during specific exercise modalities, but also in diseases and conditions associated with cognitive decline.

*Speaker

In practice, the choice in the type and number of sensory responses reported during exercise should be guided according to:
- the desired objective (with the importance of assessing only the sensations which are *a priori* required to answer the main question)
- the investigated population (keeping in mind that the ability young athletic adults have to discriminate specific sensations may not be transferable to other populations)
- the time that can be devoted to the familiarization required to understand and report these sensations in a valid manner

Keywords: exercise, sensations, effort, performance, rehabilitation

The effect of overlearning on the consolidation of a motor skill.

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Introduction

Learning of a new motor skill passes through several stages before it becomes resistant to the passage of time. During learning, the evolution of performance over time describes a curve. A fundamental notion regarding this learning curve is that of asymptote (Edwards, 2010). It illustrates the idea that the learning capacity is infinite over time but with an increasingly slow progression. One of the most widely used methods in education is overlearning (Hagman & Rose, 1983). It characterizes classically by two criteria: continuing to practice after achieving a given performance or after completion of a given quantity of practice (Rohrer *et al.*, 2005). A third criterion but not studied to our knowledge would be to individualize training concerning the reaching of an asymptotic performance (Schmidt et *al.*, 2019). In this study, we compared the effect of several learning methods based on this third criterion on the long-term consolidation of a motor skill.

Methods

Thirty subjects (n = 31) were assigned randomly in three different groups to perform a classic sequential finger task with the left non-dominant hand. Subject was instructed to "do the sequence as quickly and accurately as possible". Performance was a function of accuracy over time. Asymptotic performance (AP) was reached when the performance's variance of the last five trials was less than 0.5. The "Learning" group (LR) stopped their training when they reached the AP (n = 10). The "Overlearning" group (OLR) performed directly following the initial training the same number of trials as necessary to reach the AP (n = 11). The "Spaced" group (SP), carried out the same protocol as the Overlearning group with a rest period of 24 hours between the initial learning session and the additional session (n = 10). Performance was measured during the first and last three trials before reaching the AP (PRE-L and POST-L), the first three and final three additional practice trials for OLR and SP groups (PRE-SL and POST-SL, respectively). A recall was carried out seven days after the previous training session (D8).

Results & Discussion

The number of trials carried out to reach the AP was equivalent between each group. Compared to PRE-L, performance was significantly better for all three groups at POST-L ($p < 0.01$).

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Performance was equivalent between the groups at these two times ($p > 0.68$). The additional practice did not improve the OLR group's performance ($p = 0.98$). The SP group that returned the next day to complete their additional practice continued to progress from the level reached the day before at the end of training ($p < 0.05$). The performance of the SP group following this additional practice was significantly better than that of the OLR group at the same time (i.e., POST-SL; $p < 0.01$). After 7 days of retention, the LR and SP groups' performance was significantly lower compared to their performance obtained before stopping training (POST-L and POST-SL respectively for each group; $p < 0.05$). The performance of the LR group was significantly lower on recall compared to the other two groups ($p < 0.01$).

Conclusion
The use of variance to predict the reaching of asymptotic performance seems to be appropriate. The results tell us that stopping learning when performance becomes asymptotic is insufficient to guarantee powerful retention of a new motor skill. Practice on the asymptotic performance, despite the lack of progression, appears to be necessary to optimize the retention of a motor skill.

Keywords: Motor learning, Overlearning, Consolidation

Visual feedback Reliability influences learning of continuous motor task

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Introduction

During motor learning, the individual mobilizes his/her sensory systems (*e.g.*, visual, tactile) to know the gap between what he/she had to produce and what he/she actually did (Schmidt, 1993). This information, called intrinsic feedback, makes it possible to plan, regulate and adapt the movement or to detect and correct errors after the movement. Therefore, they are essential, underpin sensorimotor learning and can be manipulated to improve this learning (Blandin *et al.*, 2008). Recent work suggests that learning a discrete movement depends on the reliability of sensory information (Hewitson *et al.*, 2018 ; Körding & Wolpert, 2004 ; Robin *et al.*, 2004). Here we assessed this hypothesis of a motor learning based on sensory inputs reliability to a continuous task, *i.e.*, composed of several sub-actions (*i.e*, motor sequences).

Methods

The task consisted of an arm pointing movement toward targets which were presented in an ordered sequence of 12 elements. Participants (n=28) were required to point as fast as possible the presented targets without knowing they could have a repeated order (sequence). This sequence was repeated 200 times (20 blocks of 10 repetitions) in the acquisition phase. The pointing movement was performed with a visual cursor which was more or less reliable, depending on the group's condition. In the zero uncertainty condition ($\sigma 0$), the cursor was a single point (= 1 mm) defining a reliable visual cursor. In the uncertainty condition (σ), the cursor was formed by 25 points (= 1 mm) distributed as a two-dimensional gaussian with a standard deviation of 20 mm which form a points' cloud. In this later condition, only one point of the cloud allowed to validate the target and this reference point changed randomly every 12 elements (a sequence). After 24 hours, participants of the two groups returned to perform the retention phase to judge the persistence of learning, one block with the control cursor ($\sigma 0$), and one block with the group's cursor presented during the all previous acquisition phase ($\sigma 0$ or σ). Finally, participants run inter-manual transfers (visuo-spatial and motor) to judge the generalization of learning.

Results

Preliminary results showed a learning effect in both groups, i.e., the movement time of the retention test decreased over repetitions until the retention test. However, the group σ showed a reduced learning of the motor sequence compared to the group $\sigma 0$: their movement time during

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the retention test performed with the reliable cursor ($\sigma 0$) was higher. In addition, we observed a better performance in motor and visuospatial transfer of the group $\sigma 0$ versus the group σ.

Discussion

Our first results tended to show that the visual information reliability impacted the learning of a motor sequence: the higher the visual cursor reliability, the better the motor learning. The next step will be to complete our samples and to include an intermediate group (medium uncertainty). Further kinematics analyses will be conducted to precisely determine how visual uncertainty modifies the sequence learning.

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Keywords: motor sequence, sensorimotor learning, feedback

Motor learning and sleep-related memory consolidation following action observation, motor imagery and physical practice

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Introduction
Learning a new motor skill generally requires physical practice (PP) of the task. Other ways to acquire new motor skill exist such as action observation (AO) which consists in observing others performing the skill, and motor imagery (MI) which involves to mentally rehearse the movement. Newly acquired memories by PP or MI undergo further modifications during a period of consolidation, which benefit from sleep (daytime nap or night) (1,2), but lack of evidence prevails for AO (3). Motor memory consolidation (MMC) is behaviorally expressed by offline skill improvements, and suggested to be mediated by thalamo-cortical sleep spindle activity (4). Sleep spindles are brief oscillatory patterns (11-16 Hz) reflecting reactivation of task-related neural circuits during light stage 2 sleep (NREM2). Importantly, following PP, the amount of sleep spindles and their clustering in "trains" relate to memory consolidation (4). However, the role of sleep spindles in MMC following AO and MI remains unknown. Hence, the objective of this study is to determine the mechanisms underpinning sleep-related MMC following PP, AO and MI.

Method
EEG sleep recordings of 45 young adults were acquired during a 90 min daytime nap following either PP, MI or AO of a 5-element motor sequence task performed with the non-dominant left hand. Skill consolidation was assessed by computing the gains in sequence task performance between pre-nap and post-nap tests. A post-nap inter-manual transfer test was also carried out to evaluate motor learning generalization to the contralateral hand. At the brain level, spindle clustering and rhythmic metrics were extracted during NREM2 sleep, and EEG time-frequency (TF) analyses were conducted to reveal the temporal organization of spindle-band oscillations.

Results
All groups showed gains in performance following the nap. Significant positive correlations were observed between the number of spindles and performance gains for the PP and MI groups, but not for the AO group. However, the transfer gains correlated positively with the amount of spindles following AO only. Finally, TF analyses revealed a predominant cluster-based organization of NREM2 sleep spindles for all groups, with a mean recurrence of spindles every 3-4 seconds.

*Speaker

Discussion
Our results confirm that both MI and AO are effective methods to improve motor learning, albeit to a lesser extent than PP. Moreover, we showed that a 90 min daytime nap benefited MMC following PP, MI and AO, thus revealing the critical role of sleep in the consolidation process for each practice mode. Interestingly, TF analyses reveal that the rhythmic 3-4s occurrence of spindles in trains is essential for efficient memory reprocessing during sleep consolidation, and irrespective of the practice mode. Finally, transfer test performance indicated that sleep favored an effector-independent representation (i.e., generalisation to the unpracticed hand) of the consolidated motor sequence following AO, while an effector-specific representation is consolidated following PP and MI.

Conclusion
This study provides new insights regarding the role of sleep, and NREM2 spindles in particular, in the consolidation and long-term representation of motor skills following PP, MI and AO.

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Keywords: sleep, memory consolidation, motor sequence learning, spindles, physical practice, motor imagery, action observation

Learning an arm movement on a mechatronic device: influence of visual feedbacks occurrence

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Motor learning is the acquisition and consolidation of a motor skill over time (Schmidt, 1975). The learning process is established by a step of spatial appropriation of the task, to evolve towards the development of a motor command. To this aim, visual and proprioceptive feedbacks (Fb) together with extrinsic Fb play a crucial role in the learning process (Blandin et al., 2008). However, for many tasks, vision is always available and creates a dependency detrimental to learning (Proteau et al. 1992). Indeed, proprioceptive Fb is neglected, not allowing to build the dynamics of the movement. Therefore, the first objective of this study was to reduce the dependence on visual Fb during learning with a fading procedure (progressive removal of Fb). A second objective was to investigated whether fading of Fb during learning on the mechatronic device improved the transfer to real practice condition.
The movement to be learned used a mechatronic device named Hybrid Innovative Learning Validation System and required arm rotation. Working by admittance, this dispositive is composed of two parts. The free part is the real condition, the subject manipulates a mechanical arm connected to a mass linked by a cable and pulleys. The reference movement was established on this part, by an expert subject. This part was also used to evaluate transfer. On the robotic part, the participants learned the movement. When the participant produced the proper torque of force, the device accompanied the motion. Conversely, if the torque produced was not correct, the robot will slow down until stop the movement.

Twenty-three young adults learned a forearm movement during the acquisition phase (6 blocks of 15 trials). A control group had visual Fb (cursor) on the torque they produced during the acquisition phase. For the Fading group, visual Fb was progressively removed until its complete removal for the last block. The next day, both groups performed the retention (no Fb on the robotic part) and transfer tests (no robotic assistance on free part and robotic assistance without Fb on the robotic part, counterbalanced order). The Root Mean Square Error of the torque produced during the different trials was computed to assess the learning of the movement.

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Preliminary results show a difference between the control group and the fading group during the robotic transfer. It confirms that with continuous visual feedback, the learner develops a visual dependency. The presence of this feedback seems to block the treatment of other sensory information. By contrast, for the fading group, the cursor diminution would allow learning by the proprioceptive information. Results of the transfer tests displayed limited transferability of robotic learning towards non-assisted movement, maybe because of duration of learning is too short. Data collection and further analyses will be conducted before presentation.

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Keywords: dependency, motor learning, transfert, biomechanical interaction, cognition

Postural control interacts with spatial learning in older adults navigating in an ecological environment

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Introduction
Cognitive demands for postural control increase with aging and cognitive-motor interference (CMI) arises during many situations while walking, especially with visuo-spatial cognitive tasks (Menant et al., 2014). Spatial navigation tasks therefore constitute cases where CMI may occur given the cognitive and multisensory nature of spatial navigation, while also being heavily impacted by aging (Gazova et al., 2012). We posited that visually and physically exploring an unknown environment may be subject to CMI for older adults and investigated potential indicators of postural control interfering with spatial learning. Given known associations between age-related alterations in gait and brain structure, we also examined potential neuroanatomical correlates of this interference.

Methods
14 young and 14 older adults had to find an invisible goal in an open-field ecological environment while their body and eye movements were recorded. Participants were disoriented at the beginning of each trial, performing 8 trials in total. We calculated walking speed, trajectory efficiency and goal fixations. We analyzed the change in walking speed on the first, compared to the last trial and adaptation indices (similar to the slope of a learning curve) for all three variables to quantify their modulation across learning trials. All participants were screened with a battery of visuo-cognitive tests. Eighteen of our participants (10 young, 8 older) also underwent a magnetic resonance imaging voxel-based morphometry evaluation. A correlation analysis was performed between the change in walking speed and grey matter volume, adjusting for total intra-cranial volume (TICV) and sex.

Results
Older adults reduced their walking speed considerably on the first, compared to the last trial ($t=2.16$, $p< 0.05$). The adaptation index of walking speed correlated positively with those of trajectory efficiency and goal fixations ($0.699> r> 0.643$, $p< 0.001$), likely indicating that learning alleviated the cognitive resource sharing between walking and visually sampling and encoding the environment. The change in walking speed correlated negatively with grey matter volume in superior parietal and occipital regions and the precuneus ($p< 0.05$ FWE).

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Discussion
We interpret older adults' change in walking speed as indicative of CMI, similar to dual task costs. Our findings support existing literature on the sensitivity of walking speed as a marker of age-related structural brain changes, extending these to a task of greater ecological validity. This interpretation is supported by the correlations between the adaptation indices and, importantly, between the change in walking speed and grey matter volume in brain regions that are important for navigation, given that they are involved in visual attention, sensory integration, motor coordination and encoding of space (Committeri et al., 2004).

Conclusion
Our findings under ecological conditions in a natural spatial learning task question what constitutes dual tasking in older adults and can lead future research to reconsider the actual cognitive burden of postural control in aging navigation research.

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Keywords: Aging, Cognitive, motor Interference, Spatial Learning, Navigation, Walking Speed, Postural Control, Brain Atrophy

Time of day effects on motor learning processes

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Introduction

It is well-known that the time of day modulates physical performances (Teo et al., 2011). However, its influence on motor learning remains unclear. Here, we investigated the time of day effects on two different processes of motor learning: the acquisition (i.e., the immediate training effect) and the consolidation (i.e., the motor memory formation after the passage of time or/and the night of sleep).

Methods

We divided 36 adults into three groups, which trained on a finger-tapping task, either at 10 a.m. (G10am), 3 p.m. (G3pm) or 8 p.m. (G8pm). We recorded the skill performance (i.e., the ratio between task duration and accuracy) before and immediately after the training to evaluate acquisition. To measure consolidation, all participants re-performed the task 24 hours later. We applied repeated measures ANOVA between groups on skill performances and one-way ANOVA on performance gains (i.e., the difference between tests) between groups.

Note that, the chronotype of each group was similar (G10am: 50 ± 11; G3pm: 50 ± 9; G8pm: 50 ± 11; one-way ANOVA $F_{2,33} = 0.06$, $p = 0.95$) without any correlation with performance gains.

Results and Discussion

The time of day does not influence the acquisition process, as all groups presented the same amount of skill performance improvement after the training. However, the skill performance 24 hours later showed different consolidation levels for the three groups: a deterioration for G10am, a stabilization for G3pm, and an enhancement for G8pm.

To understand these contrasting results on the consolidation process, we further investigated the performance deterioration of the G10am during the day. We designed two groups, one trained at 10 a.m. (n = 13) and the other at 3 p.m. (n = 13), both were tested 5 hours later, to compare the passage of time effect on different training schedules. We found a performance deterioration for the 10 a.m. group 5 hours after the training, while the 3 p.m. group stabilized its performance. This result suggests that the passage of time deteriorates the performance when the training takes place in the morning.

In another control experiment, we included two similar groups (training at 10 a.m. vs 3 p.m.) that experienced an interference task to investigate the robustness of motor memory after the

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training. The morning group showed a greater performance deterioration 5 hours after the training than the afternoon group. This result reveals a more labile memory after morning training, thereby supporting previous findings. We hypothesize that this time-of-day effect on consolidation is the result of human physiological circadian rhythms and/or behavioral factors such as the amount of physical activity that is performed before the training session (Gueugneau et al., 2015).

Conclusion

Overall, it seems important to take into consideration the time of day, in the sport or clinical domain, to schedule efficient training or rehabilitation protocols.

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Keywords: motor learning, acquisition, consolidation, time of day

The combination of deep breathing and mental imagery promotes cardiovascular recovery in firefighters

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Introduction
At each intervention, firefighters may be confronted with hostile environments that can lead to severe injuries or even death (Perroni et al. 2014). There rescue operations involve intense physical activity associated with a high level of cardiovascular stress. Consequently and as underlined by Marcel-Millet and colleagues (2018), it is absolutely crucial that each firefighter benefits from optimal and rapid recovery between each operation during his 24-hour shift in order to maintain his performance level, as well as the health of his heart. In this way, the present study investigates the effects of a 30-min recovery protocol combining deep breathing and mental imagery on the cardiac adaptations and performance of French firefighters during the repetition of two Cooper tests.

Methods
Forty firefighters were divided into two experimental groups which undertook two maximum fitness tests separated by either the control recovery protocol (30 min reading time; n=20) or the experimental recovery protocol (30 min of deep breathing and mental imagery; n=20). Measurements of the performance at the maximum fitness tests and of the heart rate (HR) and between two R-waves of the cardiac electrical activity for the heart rate variability (HRV) were performed with an HR monitor (S810i, Polar, Aulnay-sous-Bois, France) throughout the experiment. For all the measurements, when normal distribution and equality of variances were respected, data were analyzed with a 2'2 mixed ANOVA. Sessions (pre, post) were within-participant factors while recovery protocol group (EXP, CTRL) was a between-participant factor. Then, Tukey HSD post hoc tests were carried out, where appropriate. When non-normal distributions were verified (all the HRV parameters, Shapiro-Wilk tests, all $p < 0.01$), between-participant group effects were investigated with Mann-Whitney U-tests, and within-participant session effects were investigated with Wilcoxon tests for paired samples.

*Speaker

Results
When compared to the pre-tests, the percentage evolution ratios in the post-tests for the Cooper performance (-2.4% in the control condition compared to the experimental recovery protocol), the heart rate recovery (+3.5%), the HRV analyses and more particularly the high frequency power band (HF; [0.15:0.40] Hz) that is thought to show the parasympathetic dominance were promoted by the experimental protocol, compared to simple reading.

Discussion
In light of these results, the tested recovery protocol combining deep breathing and mental imagery when compare to a simple reading rest allows a better maintenance of physical fitness performance, promotes heart rate recovery and parasympathetic reactivation. Consequently, we propose in a first time the use of practices of deep-breathing combined with mental imagery to improve firefighters' recovery. In a second time, future studies will investigate the replicability of the present results in even more ecological conditions for the firemen, i.e. between real rescue interventions and within 24-hour shift guards. Finally, the impact of such protocols on the risks of mortality in firefighters should be investigated.

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Keywords: Firefighter physical performance, Heart rate variability, Autonomic nervous system, Cardiovascular recovery, Cooper test

RV-REEDUC project: Using a virtual reality protocol for the rehabilitation of upper limb functions in children with cerebral palsy

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Introduction

The rehabilitation of upper limb motor functions in children with cerebral palsy aims at improving functional autonomy in daily activities (Sakzewski *et al.*, 2014). However, conventional rehabilitation programs encounter some limitations such as the repetitiveness and the lack of attractivity of the proposed protocols and the poor transfer in activities of daily life (Yalcinkaya *et al.*, 2014). In this context, virtual reality appears as a promising tool to provide more attractive and playful protocols with a better control and a better progressivity in the stages of rehabilitation (Chen *et al.,* 2015). However, scientific evidence in this area is still insufficient to define and validate specific and safe rehabilitation programs. The RV-REEDUC project aims at developing and testing a motor rehabilitation protocol of the upper limb using playful and attractive perceptual-motor tasks in virtual reality, dedicated to children with cerebral palsy. The main task will consist in tracking a virtual target moving with an effector manipulated by a remote controller. It will be specifically designed to significantly involve arm and elbow mobilization, which are generally underused in children with cerebral palsy. Indeed, these children often present spasticity of the arm resulting in excessive elbow flexion and forearm pronation. The eye-hand coordination and functional abilities of these children will be evaluated in order to analyze the effectiveness of a virtual reality intervention.

Method

This study will include twenty children with cerebral palsy who will be randomly divided into two groups: one group receiving three weekly virtual reality rehabilitation sessions for four weeks, and a control group which will only follow its usual care in the same period. The effectiveness of the rehabilitation protocol will be evaluated through several tests assessing motor functions of the upper limb. Thus, the eye-hand coordination, manual dexterity, evolution of joint amplitudes, kinematics of movements and functional use of the affected upper limb in daily tasks will be examined.

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Results
We expect to observe a more significant improvement in the motor functions of the upper limb for the group following the virtual reality protocol, as compared to the control group. We also hypothesize that the gains obtained at the end of the virtual reality rehabilitation program will be transferable to activities of daily living. A first feasibility study using a visuomotor tracking task will be conducted in healthy adults to examine if the arm and the elbow are sufficiently mobilized in the task according to the space of interaction and the speed of the target. This preliminary study will be used to characterize the involvement of the arm and the elbow in the visuo-manual pursuit task. The virtual reality rehabilitation protocol and the preliminary results will be presented during the congress.

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Keywords: Rehabilitation, virtual reality, children, cerebral palsy, upper limb function

Motor modularity to effectively applied force during pedaling

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Introduction
It has been proposed that the central nervous system modulates the activation of muscle groups, also called motor modules, to coordinate multiple muscles in the building of complex motor behaviors [1]. We tested this hypothesis in comparing changes in the muscle synergies during a pedaling task under different mechanical constraints.

Methods
Eleven experienced male cyclists (height: 179 cm ± 5, mass: 72.8 kg ± 5). randomly performed two trials at 90 rpm, lasting 1 minute each. One trial consisted of a bilateral pedalling task at 250 W (BIL) while the second one was a unilateral task with the right leg at 125 W (UNI). Effective pedal forces (FE, Powerforce, 500 Hz) and the surface electromyographic (EMG, Delsys, 2000 Hz) activity of 11 muscles of the right side were recorded: *tibialis anterior* (TA), *soleus* (SOL), *gastrocnemius lateralis* (LG) and *medialis* (MG), *vastus lateralis* (VL) and *medialis* (VM), *rectus femoris* (RF), *tensor fascia latae* (TFL), *biceps femoris* (BF), *semitendinosus* (ST) and *gluteus maximus* (Gmax). Mean FE and EMG amplitude (RMS) were averaged over 15 cycles and split into four 90∘ sectors (315∘-45∘, 45∘-135∘, 135∘-225∘ and 225∘-315∘). The EMG linear envelops (low-pass filtered at 6 Hz) were decomposed by the non-negative matrix factorization to obtain muscle synergies composition (motor modules) and activation (motor primitives). The EMG RMS values were weighted by the motor modules to estimate the level of activity of each muscle synergy according to the four sectors. The duration of motor primitive was approximated by the full width at half maximum. The effect of pedaling tasks was assessed by means of one-dimensional statistical parametric mapping on motor modules and primitives. Two-way ANOVA for repeated measures were used to assess changes in FE and in level of activity of muscle synergies according to the pedaling tasks and sectors.

Results
FE was lower during the downstroke phase of the UNI task phase than during the BIL task ($p < 0.001$), but higher during the upstroke phase ($p < 0.001$). For both tasks, three muscle synergies were extracted. The first one implied SOL, VL, VM and Gmax and was mainly activated during the downstroke. The second one was composed by SOL, LG, MG, BF and ST and was activated around the bottom dead centre. The third muscle synergy was activated during the

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upstroke phase and composed by TA, RF and TFL muscles. Neither the motor modules, nor the shapes of motor primitives differed between both pedaling tasks. However, the UNI task widened the third motor primitive (p=0.026). Estimate of muscle synergies level of activity changed according to the pedaling tasks ($p \leq 0.001$) and to the sectors ($p < 0.001$), while solely the second and third synergies presented an interaction effect ($p < 0.001$ and p=0.012, respectively). For these two synergies, the pull up action in UNI task implied an increase in the level of activity in sectors 3 and 4 (0.01¡p¡0.001), and in sector 1 for the third synergy only (p=0.037).

Discussion

Our results agreed with the literature relative to the robustness of the motor modules among different mechanical constraints during pedaling [2] and extend those about the pulling up effect on muscle coordination and activation [3]. According to the principle of motor modularity, we showed that the central nervous system widened and increased the activation of robust motor modules in order to adjust the amount of effective force to produce on the pedal.

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Keywords: Muscle synergies, Non negative matrix factorization, Motor control, Surface electromyography

Does motor exploration in new walkers originate from a low-dimensional modular control or from a high-dimensional command?

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Introduction
The motor command underlying walking in adults has been hypothetized to involve a small number of modules (also called muscle synergies or motor primitives) allowing to reduce the number of degrees of freedom (DOFs) effectively regulated by the central nervous system (CNS) (Bizzi et al. 2008). While this motor command is stable and optimized in adults, the muscle activity of toddlers is known to be highly variable across steps, supposedly for the purpose of motor exploration (Chang et al. 2006). Here we investigated the extent to which motor exploration could coexist with modularity in new walkers: is this variability allowed by a variable activation of a small number of modules or by a non-modular organization?

Method
We recorded the electromyographic (EMG) activity of 10 bilateral lower-limbs muscles in adults (n=12) and toddlers (n=12) during 8 gait cycles. In each individual, we used non-negative matrix factorization to identify the underlying modular command (Delis et al. 2014). We compared the variability of EMG signals in toddlers and adults. We computed the VAF (Variance Accounted For) as a quality of reconstruction index: a VAF close to 1 indicates that modules represent the original signal. We also computed indexes to analyze the variability and selectivity of activation of those modules.

Results
The EMG signal was significantly more variable in toddlers than in adults ($p< 0.001$). While the muscular activity of all strides could be modeled in adults by a consistent low-dimensional modular organization, significantly more modules were needed in toddlers to account for their greater stride-by-stride variability ($p< 0.001$). Activations of these modules varied more across strides ($p< 0.001$) and was less parsimonious ($p< 0.001$) in toddlers than in adults. Finally, the extent to which the signal could be modeled with 4 modules was correlated with walking experience (r=0.67) rather than age (r=-0.16) in toddlers.

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Discussion
The muscle activity of toddlers walking shows high stride-by-stride variability that seems to be generated by the CNS for motor exploration (Dhawale et al. 2017). This motor exploration is concomitant with a higher dimensional command in toddlers relatively to that of adults. Our findings support that the low-dimensional modular control of locomotion observed in adults builds itself as the organism develops and practices. In new walkers, motor exploration requires a larger space of possible actions, which might be allowed by non-modular inputs and/or by the existence of a higher number of modules that are yet to be screened and tuned (Valero-Cuevas 2009).

Conclusion
Our findings support that development leads to a reduction of dimensionality in the motor command, which might involve the formation of new modules and/or a screening among existing ones.

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Keywords: Modularity, walking, development, motor exploration

Longitudinal investigation of the evolution of modularity from birth to independent walking

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Introduction
Walking is believed to be controlled by the central nervous system through a small number of motor modules (i.e. muscle synergies). However, how these modules develop remains unclear. On one hand, the number of modules available at birth is low, and increases during the first year of life (Dominici et al. 2011). On the other hand, motor exploration is needed at early stages of learning and could be limited if the space of possible movements was too restricted. To understand the extent to which the large variability of infant's motor patterns can coexist with modularity, we longitudinally investigated the modular organization of different behaviors, from two locomotor precursors at birth (Sylos-labini et al. 2020) to independent walking.

Method
We followed 12 infants from birth to independent walking and recorded the electromyographic (EMG) activity of 10 bilateral muscles during 5 cycles of flexion/extension of lower-limbs throughout different behaviors. At birth (av. 4.1 days) and at 3 months (av. 98 days), we recorded stepping (N=6) and kicking (N=9). When they could walk independently (av. 14.2 mo), walking was recorded (N=10). For each individual, we used non-negative matrix factorization to identify the underlying spatial and temporal muscle modules. We computed the number of modules needed to account for the variability of EMG signals across ages, as well as various indexes to describe the evolution of different features of modularity.

Results
As expected, the variability of EMG signal decreased with age, from stepping and kicking to walking ($p < 0.05$). This decrease of variability was associated with both an increase of the number of motor modules and a decrease in the variability of their activations ($p < 0.05$). The selectivity of module activations (i.e. the extent to which a spatial module is reproducibly activated by the same temporal module), was consistent across ages but remained always much below adult's values. Finally, the number of muscles composing each spatial module decreased with age, and temporal patterns showed more refined peaks of activation ($p < 0.05$).

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Discussion
These results suggests on one hand that some of the nervous command stabilizes itself with age between birth and independent walking (as the variability of the command decreases) but on the other hand that the space of possible movements is widened (as the number of modules grows). Spatial modules are made of less and less muscles, suggesting a reduction in muscle coactivations and a more individualized muscular control (Teulier et al. 2012). Such a capacity to control less muscles at a time might be needed when performing a new behavior to explore the space of possible with less restriction (Valero-Cuevas 2009).

Conclusion
Stepping and kicking are commanded through a variable activation of a small number of modules, while walking in toddlers results from a less variable activation of more modules composed of less muscles activated more finely in time. This could indicate that new walkers control their muscles more individually rather than using precursor motor modules in order to explore different ways to walk.

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Keywords: Modularity, walking, stepping, kicking, development

The use of virtual reality exposure for the management of fear of falling and postural disorders among older adults: A preliminary study

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Falling is a serious public health problem leading to psychological consequences as Fear Of Falling (FOF), postural and motor disorders. Many studies found a link between FOF and gait disorders. A decrease in stability, a backward disequilibrium and an increase of postural oscillations is often observed when older subjects expressed FOF (Adkin et al., 2002). Experimental research into the context of the emergence of FOF and its link with posture showed that FOF could be explained by motivational, cognitive, and sensorial models (Adkin & Carpenter, 2018). The complexity of this phenomenon makes FOF interventions difficult to develop and assess. There are some evidences that physical activity program (balance and strength exercises, and yoga interventions) (for review, Kendrick et al., 2014) may reduce FOF by improving strength, gait and balance. However, none of these programs have taken into account the causal factor on FOF.
Researchers suggest that FOF occurs when the old adult felt a threat which can further disrupt postural control leading to a fall (e.g., when placed on an elevated platform) (e.g., Zaback et al., 2019). Besides, it has been shown that, when exposed repeatedly to the source of fear, FOF and postural reactions are progressively attenuated (Johnson et al., 2019). However, the experimental situation proposed here is judged to be dangerous for older with balance deficits and risk of falls (Cleworth et al., 2012). Virtual Reality (VR) may offer a solution to this limitation while simulating real situations that trigger FOF.

The aim of this study is to identify the causal context of FOF development among elderly by comparing their reactional fear, subjective perception of stability and postural performance when exposed to two types of virtual situations: on showing a forward Translation (Tr) scene and the other a forward Tilt (Ti) scene simulating a fall. We support the hypothesis that exposure to (Ti) would induce more FOF than (Tr) scene and that repeated exposure to (Ti) would progressively decrease FOF resulting in postural behavior adaptation. The objective is to provide insights for specific rehabilitation program for FOF.

*Speaker

It is a randomized cross-over study. Fifty-two older adults aged 65 and over will participate. All of them have a FOF with a score $\geq$ to 23 on the Falls Efficacy Scale International questionnaire (Yardley et al., 2005).

VR session consists of a familiarization phase with the VR and 5 trials (T1, T2, T3, T4 and T5) with a 5-minute break in between. The first trial (T1) lasts 2 minutes and the next four (T2, T3, T4 and T5) last 5 minutes each. T1 consists of two successive exposures of one minute each: one exposure showing a forward Tilting environment (Ti) and another one showing a forward translational environment (Tr). The 4 other trials (T2, T3, T4 and T5) include 5 successive exposures of (Tr) or (Ti) scene. The alternation of (Tr) and (Ti) is carried out to obtain two conditions. The participants will be randomized to visualize one of them.

During the 5 trials, the subject will wear a VR HTC VIVE headset while standing on a Wii Balance Board in order to record Centre of Pressure (COP) position. After each exposure, the effect of each type of scene on FOF and subjective perception of stability will be evaluated through a scale ranging from 0 to 10 for FOF (Zaback et al., 2015) and another for stability perception (Schieppati et al., 1999).
The committee for the protection of individuals approved this experimental procedure which will be implemented during June.

Keywords: Fear Of Falling, Virtual Reality, Postural Control, Elderly

Life Sciences - Physiology, Biomechanics

Muscles synergies during upper limbs cycling

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Cycling, realized with lower limbs or upper limbs, is extensively used for improving health, training status or for diagnosis purposes. It has been shown that an improvement in lower limbs function can be accomplished by using upper limbs rehabilitation (Kaupp et al. 2018), showing that both limbs shared common neuromuscular control processes. While lower limbs muscle coordination has been extensively studied, upper limbs pedaling task hasn't been investigated in detail. The aim of study thus is to investigate the lower and upper limbs muscle coordinations during cycling using the synergy decomposition framework. As upper limbs pedaling is not usual for most people, a larger interindividual variability is expected in comparison with the lower limbs. We hypothesize that despite higher interindividual variability, a robust modular control exists on upper limbs as well as lower limbs, resulting in a fixed number and low interindividual variability of synergies (De Marchis et al. 2013).
6 young healthy adults non experts, performed 2 minutes submaximal cycling exercise in both upper (ARMS) and lower (LEGS) conditions at their preferential cadence. The intensity was set at 30% of the maximal power output. Torque, joint kinematics, and the activity of 11 muscles for each limb was recorded. Muscle synergies were extracted using Non-negative Matrix Factorization. Interindividual variability was addressed by computing Variance Ratio, r-Pearson coefficient and the time shifting of each synergy activation vectors.

Cycling with ARMS involved more propulsive torque than LEGS (90% vs 50% of the total cycle duration). A slightly higher number of synergies was obtained for ARMS (4 synergies for every participants) than for LEGS (ranging from 2 to 4). Torque, joint kinematics and EMG activity showed higher interindividual variability for upper than lower limbs, resulting in higher interindividual variability in the synergy vectors for ARMS. Larger inter-participants discrepancies were apparent for the upper limbs when the r-Pearson coefficient or the synergy time-shift was analyzed by pairs of participants.

Even if cycling is a highly constrained movement (circular and "guided"), our study showed that the limbs are coordinated differently to perform this exercise: the kinematics and dynamics indeed differed between ARMS and LEGS. While LEGS pedaling consisted in pushing the pedal, ARMS pedaling resulted in more complex torque application, involving both pushing and

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pulling. The corresponding muscle activity could be described by 4 muscles synergies, robust between participants. Indeed, the interindividual differences arise from a temporal shifting of the synergies between the participants, rather than a fully different profile. Contrary to lower limbs where low interindividual variability was observed, our results showed that upper limbs muscle coordination follow a robust modular organization, like the one at the lower limbs, but with a more flexible temporal implementation.
This work brought important information for rehabilitation and diagnosis based on upper limbs cycling. Indeed, our results suggest that, using muscles synergies framework, interindividual variability could reflect individual strategy rather than lack in muscle coordination which could be important to consider for clinicians or pathology.

Keywords: Arm cranking, Electromyography, Coordination, Inter, individual variability, Modular control of movement

Effect of gait speed on fiber dynamics of plantarflexor and dorsiflexor and the metabolic cost

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Introduction
The metabolic cost of walking (Cw) is an important parameter to explain decreased functional capacity and is influenced by the gait speed and the muscle-tendon dynamics [1]. Arnold et al. [2] have shown that the muscle force ability is decreased as speed gait increases for the plantarflexors but the relationship with Cw was not studied. The aim of this study was to investigate the fiber dynamics of plantarflexor and dorsiflexor muscles and their association with the metabolic cost.

Methods
Metabolic (K5 Cosmed), kinematic (Optitrack), kinetic (Bertec) and electromyography (*gastrocnemius medialis*, *soleus* and *tibialis anterior*) measurements were made on ten young subjects (3 males and 7 females ; 171.6 ± 5.8 cm, 67.2 ± 7.9 kg, 24.4 ± 1.5 years). Subjects walked on a force-plate instrumented treadmill at 1.00, 1.20, 1.40, 1.60 and 1.8 m/s during 1min30. Net cost of walking *NCw* (J O2/kg/m) was computed by the gross metabolic rate minus the net metabolic rate divided by walking speed (m/s). A one degree-of freedom (ankle) EMG-driven approach was used to extract the normalized force according to the force-length (fAL) and force-velocity (fv) relationships [3]. We computed the force generation ability of a muscle as Fability = fAL * fv * cos(α) [2] where α is the pennation angle. At the maximal Fability during each gait cycle, the fAL, fv and Fability were estimated. A one-way (speeds) repeated measures ANOVA was performed for each muscle and a multiple linear regression model was used to explain the *NCw*.

Results and Discussion
The lower *NCw* was found at 1.2 m/s corresponding to the preferred walking speed (PWS) for 7 subjects. For the *SOL*, the Fability, fAL and fv significantly decreased with increasing speed

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above 1.2 m/s speed. For the *gastrocnemii,* only fv decreased when gait speed is above 1.2 m/s. The peak force produced by the muscle significantly increased at all gait speed for the *SOL*, and was significantly lower at 1 and 1.2 m/s compared to 1.6 and 1.8 m/s for the *TibAnt*. The Fability of the SOL and the *Tibant* accounts for 48.3% of the variance in *NCw* with a moderate effect. The increase of *NCw* with the increase of gait speed could be mainly attributed by the decrease in muscle force ability of the *SOL* due to the force-velocity muscle property.

Conclusion

The U-shape of *NCw* with gait speed can be partially explained by the decreasing capacity of *SOL* muscle to produce muscle force and more specially by the force-velocity relationship whereas the *gastrocnemii* were less influenced by the gait speed.

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Keywords: neuromusculoskeletal modelling, gait, metabolic cost, Hill, type muscle model

Does different activation between the medial and the lateral gastrocnemius during walking translate into different fascicle behavior?

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Introduction
The functional difference between the medial gastrocnemius (MG) and lateral gastrocnemius (LG) during walking has not yet been fully established. Although evidence highlights that the MG is activated more than the LG [1], the link with potential differences in mechanical behavior between these muscles remains unknown. The aim of this study was to determine whether the differences in activation between the MG and the LG during walking translate into different mechanical behavior.

Methods
Fifteen healthy participants walked on a treadmill at their preferred walking speed under two randomized conditions : (1) level walking (0% grade) and (2) incline walking (10% grade). Participants performed both conditions twice, to first record MG and LG activations using surface electromyography (EMG) (Trigno Delsys Inc., USA; 10 mm interelectrode distance) and second to measure MG and LG fascicle behavior using B-mode ultrasound imaging (120 Hz, 5-8 MHz, 60mm field-of-view, LV8-5L60N-2, ArtUS, Telemed, Lithuania). All measurments are recorded during a single session.
Raw EMG signals of thirty strides were filtered, rectified and normalized to the maximal activation level previously determined during maximal voluntary contractions. We used a semi-automated tracking algorithm to determine fascicle length and pennation angle during ten strides of walking. We normalized fascicle length and fascicle velocity to the fascicle length at heel-strike during level walking. The change in pennation angle was expressed as the absolute difference of the pennation angle at heel-strike during level walking
To assess the muscle effect, the condition effect and the muscle x condition interaction, we conducted a two-way repeated measures ANOVA on the EMG and ultrasound parameters. Then, we used correlations to determine the relationship between the MG-LG differences in EMG and the MG-LG differences in ultrasound parameter.

Results and discussion
Average EMG amplitude during stance was higher in MG than LG ($p< 0.01$), regardless the condition, with no interaction effect ($p=0.74$).

*Speaker

During early stance, the MG fascicle lengthened less (p=0.02) and rotated less ($p<$ 0.01), compared to the LG. However, we found no differences in the amount of fascicle shortening following this lengthening (p=0.31) or in peak shortening velocity during this shortening (p=0.93) between the MG and LG. During the fascicle shortening period, the MG underwent greater increases in pennation angle compared to the LG (p=0.04). We did not find any significant interaction effects (All $p>$ 0.19).
Finally, out of the eight correlations, only one significant correlation between MG-LG differences in average EMG amplitude during the lengthening period and MG-LG differences in the amount of pennation angle change during the lengthening period for level walking was observed (R=0.65; $p<$ 0.01).

Conclusions
In this study, we found that, during walking, the higher activation of the MG, consistent with previous reports, was associated with less fascicle lengthening compared to the LG. This may enhance the catapult-like muscle-tendon interaction in the MG. At the individual level, the lack of relationship between the MG-LG differences in activation and the between-muscle differences in fascicle behavior may be linked to potential inter-individual variability in muscle and tendon properties. Our results highlight that the MG and LG may provide slightly different mechanical functions and thus we cannot derive information from experimental measurements on MG to infer the behavior or the function of the LG and vice versa.

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Keywords: B mode ultrasound, fascicle length, electromyography, locomotion, muscle function

Kinematics analysis of upper limbs during a hand sewing task: comparison between Experts, Intermediates and Novices.

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Introduction
To be efficient, the hand sewing task requires a very high accuracy and consistency of the whole upper limb. Expert's skills are difficult to learn and evaluate [6]. The aim of the present study was to compare the kinematic of the hand sewing task between novices, intermediates and experts in order to better understand the characteristics of expertise and contribute to the task back-up and training.

Methods
Thirty participants were divided in three groups: ten novices (NOV), ten students (INT) and ten experts (EXP). The upper-limb kinematic was captured with twelve cameras and fifty-two anatomical markers placed on trunk, arms and hands [1][2][4] during ten sewing stitch movements. Joint angles were extracted by inverse kinematic and were averaged among interpolated sewing cycles from 1 to 100%. Twenty 1d two-way SPM, then ANOVAs between groups and intra/inter-individual CMC were performed for each degrees of freedom (DoF)[3][5].

Results
EXP maintained a more neutral position with shoulder than NOV: angles of Abduction maintain along cycle (SPM : P=0.006) and range of motion Flexion/Extension (F/E) were smaller (EXP: 6.2±4.3○, INT: 8.1±3.8○, NOV: 12.6±7.8○; P=0.05). Ranges of motion were larger for wrists and fingers of EXP: wrist Pronation/Supination (P/S) (EXP: 59.8±20.7○, INT: 52.4±16.9○, NOV: 40.0±14.5○; P=0.05), wrist Abduction/Adduction (A/A) (EXP: 13.4±4.8, INT: 12.8±3.8, NOV: 6.8±2.4○; P=0.002) and Middle Finger Metacarpophalangeal F/E (EXP: 25.8±5.1○, INT: 20.6±9.5○, NOV: 14.0±4.7○; P=0.002). EXP Fingers F/E range of motion differ from NOV for First and Middle Fingers joints during part of the sewing cycle (SPM : P=0.001). The intra-individual reproducibility between the cycles was higher for EXP than NOV (EXP: CMC=0.65, NOV: CMC=0.49, P=0,016). Movement of EXP were quite similar between each individual, coefficient of multiple correlation (CMC) were over 0.4 for : P/S (CMC=0.4) or A/A (CMC=0.6) of Wrist and First finger F/E (CMC:0.4-0.5). None of the CMC were higher than 0.4 for Novices.

*Speaker

Conclusion
EXP participants use less their proximal joint and more their distal joints than NOV and INT allowing higher precision and efficiency. EXP used less their shoulder, which stayed closer to the body, but used more their wrist and their fingers. This ability enabled to avoid to lift the arm, which was resting on the table. It reduces energy cost and muscle work. We can observe a high reproducibility of the movement pattern for EXP, while it is more random in NOV. It highlights an efficient movement, allowing performance for EXP. The tools developed in the present study will be used in the training process of dressmakers.

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Keywords: accurate task, kinematic analysis, expertises, hand sewing

Passive-induced hyperthermia decreases soft tissues stiffness

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Introduction

It is well established that hyperthermia influences force production and improves muscle contraction velocity [1]. Yet, the underlying mechanisms of these adaptations are poorly understood. Recently, our group demonstrated a reduction in electromechanical delay of plantar flexor muscles following passive heat exposure [2]. Our findings suggested a major putative effect of hyperthermia on the properties of the contractile component of *gastrocnemius medialis* (GM) muscle, with faster electrochemical processes, without fully excluding an opposite effect on the elastic properties of the muscle-tendon unit. Previous works showed that shear modulus (*i.e.*, index of muscle stiffness) measured in passive conditions, increased after the application of cold pulsed air in humans [3], questioning about a possible opposite effect in hot environment. The aim of this study was to investigate the effect of passive-induced hyperthermia on muscle-tendon unit of GM and Achille tendon stiffness properties.

Materials and methods

Nine men and seven women, recreationally active, voluntarily participated in this study. Participants performed two testing sessions in control (CON, 26 ∘C) and hot environments (HOT, 46-50 ∘C) following a passive heat exposure inducing hyperthermia. Participants laid prone with their knee fully extended and their ankle flexed at 90∘ (0∘ = neutral position) on a customized ergometer. Resting shear modulus of GM was assessed using shear wave elastography and isometric ramp contraction were assessed. The ultrasound probe was firmly attached to the GM muscle belly in a place where fascicles and aponeuroses were clearly visible. For active tendon stiffness, participants performed ramp isometric contractions following a linear increase in isometric plantar flexor force from 0 to 90 % of maximal voluntary contraction peak force, previously determined during two maximal voluntary contraction trials.

Results and discussion

Mean core and muscle temperatures were higher in HOT than CON: 38.4 ± 0.3 ∘C *vs.* 37.0 ± 0.3 ∘C and 37.0 ± 0.6 ∘C *vs.* 34.0 ± 0.8 ∘C (both $P < 0.001$), respectively. Shear modulus values obtained in resting condition were significantly lower in HOT than CON: 13.7 ± 4.9 kPa *vs.* 15.7 ± 4.7 kPa ($P = 0.03$). Active Achilles tendon stiffness was significantly lower in HOT than CON: 27.8 ± 8.5 *vs.* 32.3 ± 8.2 N.mm-1 ($P = 0.023$). This outcome is in agreement with a

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recent study conducted in humans. Specifically, Gimeno et al. [4] reported a decrease in active *biceps femoris* stiffness, by measuring muscle displacement using tensiomyography, following 20-min of warm water immersion. Theses muscle and tendon mechanical properties may increase the amount of stretch that the muscle tissue is able to sustain. Such effect could be useful in the context of prevention of muscle injury.

Conclusion

Passive-induced hyperthermia decreases the passive muscle stiffness and active tendon stiffness. As such, the muscle-tendon unit properties should be considered when using passive exposure, training, or competing in hot environment.

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Keywords: heat, muscle temperature, core temperature, shear wave elastography, active tendon stiffness

Influence of maturation status and gender on the force-velocity profile

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Introduction

Increases in age lead to greater sprinting speeds with gender differences said to occur after 15 years of age [1]. To understand the underlying mechanisms of performance, a more detailed evaluation of sprint performance is required from the assessment of an individual's force-velocity (F-V) profile. F-V profiles have only recently been studied in children and adolescents, however youth have often been grouped by chronological age [2] or limited to male subjects [3]. It is well established that children mature at different rates, thus it is essential that this should be accounted for by grouping subjects according to their maturity status. Moreover, during the years surrounding peak height velocity (PHV), rapid changes in body dimensions can have a confounding effect on the differences between youth of varying maturity. Concerning F-V profiling, no studies seem to have attempted the use of allometric models to compare mechanical parameters between youth of different anthropometric parameters. The aim of the study is to analyse the gender and the maturation effects on sprint acceleration mechanics and on the F-V profile.

Methods

Approximately 100 children and adolescents (girls and boys, age: 8 to 18 years) will be recruited from local athletics clubs for this study. Body mass (BM), height, and sitting height will be measured in order to estimate age from PHV according to the method proposed by Mirwald et al. [4]. Subject data will subsequently be grouped by maturation status (pre-, mid-, post-PHV). Whole-body fat free mass (FFM) and FFM of the lower limbs (FFMLL) will also be calculated from skinfold thickness and the truncated cone method. After a standardised 15-min warm up, participants will perform two maximal 30-m sprints separated by at least 3-min rest. To avoid premature deceleration the finish line will be set at 35-m. Raw velocity-time data will be measured at a sampling rate of 46.875 Hz using a radar device (Stalker ATS II, Texas, USA) positioned 5-m behind the start line. Processed speed-time data will be used to derive the mechanical parameters of the F-V profile [5]. The technical ability to apply force in the horizontal direction and at increasing velocities will also be examined. Allometric models will be applied by scaling theoretical maximal force and velocity, and the associated maximal power output (F0, V0, Pmax) to BM, FFM and FFMLL. If data normality and equality of variances are obtained, a two-way ANOVA will be performed on all the dependent variables.

*Speaker

Results
Experiments started in February 2021 and are scheduled to finish at the end of May 2021. We hypothesise that prior to puberty the allometric models will attenuate maturity and gender-based differences due to quantitative factors. However, in post-pubertal subjects differences are likely to remain regardless of the scaling method indicating differences of a qualitative nature.

Discussion
Accounting for differences due to maturation status and gender when assessing physical qualities in youth is of great importance and should not be overlooked. This analysis is particularly useful for coaches and practitioners as it provides information to adapt and improve training programs.

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Keywords: Force, velocity, sprint, maturation, gender

Link between airway damage and dehydration of the airways computationally determined by an original model.

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Introduction
At high VE, during prolonged exercise, dehydration of the bronchial mucosa and epithelial damage have been observed. Therefore, a ventilation threshold may exist, above which bronchial water losses exceed the epithelium capacity for water replenishment, that we believe match with epithelial damage.

Aim
Our aim was to verify this assumption by comparing the epithelial integrity after a 30-min exercise between healthy young subjects who sustained a sufficient ventilation to provok airway dehydration and those who did not. The originality of our study is the theoretical threshold of dehydration was individually-determined using a previously-established computational model, adapted to the experimental conditions.

Method
In our study, epithelial damage has been evaluated by measuring the variation of serum club cell protein (cc16/cr) of 16 healthy young adults. Measurements were performed pre- and post-30-min continuous cycling exercise at 70% of maximal work rate. VE was measured continuously during the effort. Airway water and heat loss was assessed for each participant using a recently published computational model adapted to the experimental conditions and compared to the theoretical threshold of dehydration. Two ways ANOVAs with repeated measures was

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carried out to identify significant difference in cc16/cr over time (warm-up *vs* post-exercise) and between groups (group A *vs* group B). The previously-established computational tool used several input parameters which characterize the ventilation dynamics and the inspired air conditions (Karamaoun *et al.* 2018), by using experimental data from Haverkamp *et al.* (2005). These parameters, representing the external conditions of ventilation, were integrated in the pulmonary model using a correlation between the room temperature (Troom) and the tracheal air temperature (TT) (McFadden *et al.* 1985). In parallel, the relative humidity at the entrance of trachea (RHT) was derived using an original phenomenological model specifically developed. The computational tool was run up for various functional residual capacity (FRC).We entered into the model the experimental data of temperature and humidity of the room (19∘C an 55% RH), as well as the individual lung volume values for each subject (Combes *et al.* 2019). Subjects' s etimated FRC(Quanjer et al. 1993) has been used to determine the bronchial geometry. Both the diameters and lengths of the bronchial generations were modified accordingly in our morphometric model. Finally, this modified morphometry was used as a new geometry in which the temperature and water content equations of our computational tool were solved.

Results

Eleven participants exceeded the theoretical threshold for bronchial dehydration during exercise (group A) and 5 did not (group B). There was a significant interaction time $\times$ group for cc16/cr ($F=12.80$, $p=0.003$) and the increase in cc16/cr was of 0.50 ± 0.25 ng.l-1 in group A vs 0.10 ± 0.10 ng.l-1 in group B ($p=0.007$, $d=1.40$). This increase was significant ($101 \pm 100\%$, $p < 0.001$) in group A but not in group B (13 ± 13 %, $p = 0.28$) ($d=0.95$).

Conclusion

Our results show a good correspondence between the exceeding of the threshold of bronchial dehydration computationally calculated, and the appearance of epithelial damage. This study is the first step towards the development of innovative training programs, based on the level of ventilation, for both athletes and people with respiratory pathologies.

Keywords: Mathematical modelling, epithelial damage, airway dehydration

Recovery of neuromuscular and cardiorespiratory functions in COVID-19 survivors after an ICU stay

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Introduction

Coronavirus disease 2019 (COVID-19) has caused almost three million deaths worldwide and infected 130 million people. Although most patients recover well following infection, those who are admitted to intensive care unit (ICU) can experience severe dysfunction during and following their ICU stay. To the best of our knowledge, no study has presented objective follow-up

*Speaker

measurement of cardio-respiratory and neuromuscular function of these patients in the year following ICU stays. The purpose of this study was to assess patients having stayed in ICU due to COVID-19 infection within the first two months following their discharge, and six months afterwards.

Methods
The study involved across 6 ICUs of University hospitals and private clinics. Forty-eight patients (65 ± 10 yr) who had been hospitalized in ICU for COVID-19 infection for 36 days [11-80] and mechanically ventilated for at least 3 days were recruited. Participants visited the laboratory three times at two time point each: at 4 to 8 weeks (T1) as well as 6 months (T2) after ICU discharge. The 1st and 4th visits consisted of questionnaires, blood test, spirometry testing and cardiopulmonary exercise testing on cyclergometer to assess VO2peak. (i.e. maximal oxygen uptake). The 2nd and 5th visits consisted in neuromuscular function testing i.e. maximum voluntary contraction (MVC) of the knee extensors (KE) and a fatigability test entailing KE contractions of progressive intensity until task failure (i.e. QIF test). The 3rd and 6th visits were an MRI measurement with quadriceps volume and metabolic fatigue (data not presented).

Results and Discussion
Using FACIT-F questionnaire, 54% of patients were classified as fatigued at T1 vs 24% at T2. At T1, fatigue, depression and sleeping questionnaires as well as the main spirometry indices showed significant differences between the fatigued and non-fatigued group ($p< 0.05$). These variables were the only discriminating data between fatigued and non-fatigued patients. On average, VO2peak, relative to body weight, increased significantly ($p< 0.001$) by 15% ± 19% between T1 and T2 (i.e. 17.7 to 20.5 ml/min/kg). Maximal aerobic power reached on bicycle during an incremental test increased significantly (+42%, $p< 0.001$) between T1 and T2 from 93 to 130 W. Forced vital capacity, maximum voluntary ventilation and the forced expiratory volume in one second increased significantly ($p< 0.05$) by 9.4%, 1.2% and 4.5% between T1 and T2 to reach 90.1%, 98.8% and 92.5% of normal values at T2, respectively. KE MVC and the number of contractions during the QIF test also increased between T1 and T2 (+41% and +42%, respectively both $p< 0.001$).

Conclusion
At T1, outcomes of the spirometry tests were the only objective differences between patients self-declared as fatigued vs non-fatigued. At T2, despite an improvement in all tested parameters and a reduction of the self-declared fatigued, COVID-19 survivors remained below normal values for the spirometry tests (e.g. 83% of predicted values for forced vital capacity) and VO2peak (i.e. 53% of predicted values). These outcomes show the importance to offer treatment and care (i.e. exercise, physiotherapy) to counteract the persisting cardiorespiratory impairment like long-term COVID-19 syndrome for instance. This study will be continued on ICU survivors unrelated to COVID-19 to better understand the relative influence of the virus vs the ICU stay.

Keywords: COVID, 19, recovery, ICU, VO2peak, neuromuscular function

Effects of the COVID-19 national lockdown on dietary habits in active vs. non-active French adults

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Introduction

In response to the COVID-19 pandemic many countries have implemented periods of national lockdown that have substantially changed the daily life of people worldwide. In France, a national quarantine requiring people to stay at home and the closure of all but essential public places were implemented for the first time on March 17, 2020 for 8 weeks. Using questionnaires and interviews, recent studies reported relationships between life disruptions associated with COVID-19 quarantine [1], and alterations in dietary patterns [2] and inversely, maintenance of dietary patterns [1,3] and lifestyle habits. Thus, the aim was to determine (using food diary analysis at several time points) the impact of the COVID-19 lockdown on the dietary patterns in active and non-active French adults.

Methods

A total of 220 participants, age $>$ 18 years, who had never been positive for COVID-19 took part in an online survey including sociodemographic, eating behavior, weight change, sedentary behavior (SED) and physical activity (PA) questions at different times during (3rd week of lockdown: P1; and 7th and 8th week of lockdown: P2) and post lockdown (1-month post: P3). Participants completed food diaries every 4 days over these periods. Participants who did not complete at least 1 food diary in each period were excluded from the final analysis. Energy Intake (EI), nutrient breakdown and fluids consumed in P1, P2, and P3 were obtained from the food diary analyses. Linear mixed effects models were fitted to analyze the differences in dependent variables between the three lockdown time periods.

*Speaker

Results
Thirty-five females and 15 males (age, 45±15 yrs; BMI, 22.6±3kg/m2; 94% with an outdoor space) completed questionnaires and food diaries. Sixty percent had a professional activity during the lockdown, 80% of them working as executives, employees, and retired, and 58% had at least a master's degree. 54% declared themselves to be active (comply with the PA recommendations [4]) and 72% to be non-sedentary (> 7h/d SED) at the time they entered the lockdown. EI (kcal/d) and nutrient consumption did not differ between active (1661.9 ± 458.1) and non-active (1789.1 ± 606.4), or sedentary (1714.6 ± 523.1) and non-sedentary individuals (1742.6 ± 539.0) nor between lockdown time points. Alcohol consumption and EI were consistently higher in males than in females but did not differ between periods. Sedentary participants consumed significantly (p=0.02) more alcohol than non-sedentary participants in P1, P2 and P3. More than 60% of participants reported no change in the number of meals and snacks between periods. Almost half of the participants reported a variation of body weight in P2 vs P1 (44% loss and 56% gain, median change: 1.0 kg) and 40% reported a variation of weight in P3 vs P2 (55% loss and 45% gain, median change: 0.0 kg).

Conclusion
For the first time, using a food diary analyses revealed that the lockdown period had minimal impact on the dietary intake and eating behaviors in active and non-active French adults. Apart from methodological considerations, the maintenance of dietary patterns could be partly explained by the environmental conditions of the population studied.

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Keywords: Coronavirus, lockdown, online study, food records, eating behavior, BMI

Effect of the COVID-19 national lockdown on physical fitness in active vs inactive French adults

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Introduction
People with reduced physical fitness (PF) are at greater risks of reduced health-related outcomes [1]. In response to COVID-19 global pandemic, French government has imposed lockdown on March 2020 for 8 weeks. A decreased physical activity (PA) levels in several countries and different populations were observed [2-3], which could in turn reduce both PF and health-related outcomes. Increases in the body mass index (BMI) and decreases in several PF outcomes were observed in adolescents after COVID-19 lockdown, compared to the pre-pandemic period [4]. However, less data are available in the adult population. The aim of this study was to assess PF in adults during the first French lockdown.

Methods
Adults (age $>$ 18 years) never been tested positive for COVID-19 took part in an online survey including sociodemographic outcomes (sex, age, BMI, socio-professional categories (SPC), education status, daily physical activity, sedentary behaviors, familial environment and four self-administered PF tests (one-minute sit-to stand test: STS; unipodal tests: UP left & right; chair test: CT). Measures were carried out at three weeks in lockdown (P1), at the end of lockdown (P2) and one-month after lockdown (P3). Participants were grouped based on their previous (before lockdown) lifestyles (four profiles regarding sedentary behaviour (SB) and PA levels : sedentary is $\geq$ 7h/d of sedentary behaviors and active is $\geq$ 150 min/d of at least moderate physical activity [5]). Linear mixed effects models were fitted to analyze the differences in PF tests at the three lockdown times periods and the influence of the sociodemographic parameters.

Results
A total of 104 participants (32 men and 72 women) completed tests of PF (age, 44.3±15.8 years; BMI, 22.8±3.3 kg/m^2; 12% lived alone, 34% had children; 28% were active and 56% were sedentary; 17% were retired). Sixty percent had a professional activity during lockdown, 80% of

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them working as executives, employees or retired, and 56% had at least a master's degree. No differences were observed at P1 between the SB and PA subgroups for the four tests. However, the non-sedentary sub-groups present higher PF performances. PF performances for the non-sedentary subgroups increased from P1 to P2 and from P1 to P3 ($p< 0.05$). The sedentary – non active subgroup increased UP test performance ($p< 0.02$). PF did not change throughout the time periods for the sedentary – active subgroup. SPC (STS, CT, UP), BMI (CT), age (STS, CT, UP) and SB (STS) were the variables exerting the greater influence on PF outcomes.

Discussion
The great lockdown did not negatively affected PF outcomes in our population. However, the participants presented high levels of education that also contributed to explain the results of sedentary – active subgroup. Age, SB, high SPC and obesity are the parameters explaining most of the variance in PF outcomes. Lockdown and reduction of practicable activities may have led participants to train for and with the tests. The older participants were more affected and should receive more specifics recommendations.

Conclusion
Lockdown did not lead to a decrease in PF but rather tended to increase some of its components.

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Keywords: Coronavirus, lockdown, physical fitness, online survey

Is Afghan walking sessions integration of interest for COPD patients rehabilitation?

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Context
Chronic Obstructive Pulmonary Disease (COPD) is characterized by progressive and non-reversible airflow limitation. Recommendations for exercise training in patients with COPD consist of combining endurance, strength and inspiratory muscle training programs. Pulmonary rehabilitation improves exercise tolerance, reduces respiratory symptoms and increases patient's quality of life (QoL) (Gloeckl, Marinov & Pitta, 2013). Meditation and breathing control activities have also shown benefits (Yudhawati & Rasjid Hs, 2019).
The Afghan walk (Stiegler, 2004) is a physical activity that combines an aerobic effort, a meditative state and a rhythmic breathing technique based on the subject's footstep. The main respiratory pattern consist of an inspiratory phase during 3 footsteps, keeping inflated lungs during a fourth and then an expiratory phase during 3 footsteps, ending with keeping deflated lungs during a last footstep, before starting a new cycle. Despite of the many supposed benefits associated with this activity, to our knowledge, there is no scientific evidence supporting the interest of conducting this activity in COPD patients.
The aim of this study was to assess the effects of implementing Afghan walking sessions in a respiratory rehabilitation program on functional capacity, ventilatory parameters and QoL in COPD patients.

Methods
Thirty patients with COPD (GOLD score: 2.7±1) gave their written informed consent to participate in the study. After having completed an evaluation of anthropometric characteristics, respiratory function, functional capacity (6-MWT) and QoL (SF-36) examinations, participants were randomly allocated to either a control group or an experimental group. For all participants, the 4-weeks respiratory rehabilitation program was composed of daily cycloergometer sessions, strength-training and stretching sessions. In addition, each week, 5 treadmill walking sessions were added to the control group (CTRL) while the experimental group (EXP) completed 3 Afghan walking sessions, completed by 2 treadmill walking sessions. Ventilatory, functional and QoL assessments were repeated at the end of the program in both groups. Descriptive analysis and a Linear Mixed Model (LMM) were used to assess the impact of each rehabilitation program.

Results
Compared to CTRL, EXP had higher improvements in vital capacity (VC: -0.3% vs. +7.5%) forced vital capacity (FVC: 0% vs. +13.7%), forced expiratory volume in 1 second (FEV1: -4% vs. +14.9%) and inspiratory and expiratory capacities (-0.8% vs. +11% and +4.1% vs. +8.7%).

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The LMM tended to show significant effects of Afghan walking sessions on VC, FVC and FEV1. Both groups improved 6-MWT distance (+13.9% vs. +11.9%). The lower benefit observed for EXP could be explained by lower walking speed and travelled distance during Afghan walking sessions compared to treadmill sessions. Finally, QoL was not improved in CTRL and EXP. This surprising result could be related to biased responses linked to pre-program quarantine week.

Conclusion

Afghan walking could be a usefull activity in COPD patient's rehabilitation. Further analyzes are required to confirm this assumption.

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Keywords: Afghan Walk, COPD, pulmonary disease, rehabilitation

A comparison of two grouping methods in classification of young rugby players

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Introduction
In rugby union, serious attention is being paid to minimize and control the risk of injury in youth categories. Thus, classifying young rugby players by age is a matter of debate in some rugby federations with a growing awareness to evolve the age-grading model [1]. The aim of this study was to compare variance in the body size and body composition of schoolboy rugby players, aged 9 to 14 years, across a weight- and age-grading models.

Methods
Assessments of skinfold thickness were used to assess body fat mass (BF), fat-free mass (FFM), body fat mass index (BFMI) and fat-free mass index (FFMI). Standardized measure of height and weight were taken for all participants. Data were grouped according to the age categories of the French Rugby Federation (U11: Under 11 years, U13: Under 13 years, U15: Under 15 years), to the weight categories (W30-44.9; W45-59.9; W60-79.9) carried out from 25th and 75th weight percentile in each age category. BMI status (NW: normal-weight versus OW/OB: overweight/obese) were considered. Extreme morphotypes are characterised from BFMI and FFMI in the weight-grading model on the Hattori's body composition chart.

Results
The dispersion of anthropometric characteristics decreased significantly for the weight model, except for height in all groups and BFMI for U13. Among NW, 3%, 1.8%, 0% up-graded; 18.2%, 68.7% and 45.5% down-graded; among OW, 50%, 21.5%, 12.5% and among OB, 91.3%, 83.3%, 74.6% up-graded, respectively in U11, U13, U15. FFMI/BFMI were correlated in U11 ($r= 0.80$, $p< 0.001$), U13 ($r= 0.66$, $p< 0.001$), U15 ($r= 0.77$, $p< 0.001$). There was no significant

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correlation in W45-59.9 and low correlations in W30-44.9 (r=0.25, p< 0.001) and W60-79.9 (r=0.29, p< 0,001). Significant grading difference between the centroids (p < 0.020) and the distribution deviates from centroids of BFMI and FFMI (p < 0.0001) were noted between the two models. Thirteen players were located in adipo-slender, twenty-three in adipo-solid, twenty-two in lean-slender, two located in the lean-solid morphotype in weight model.

Discussion

Our results pointed out a decrease of the dispersion in most of anthropometric characteristics for the weight-grading model compared to the age-grading model. Young players of different age categories were mixed, and consequently taking into account the level of growth by weight and height. Knowing that more than half young American football players classified in advanced maturity were obese [2], it could be reasonable to think that obese players of a young age category will find themselves with players with similar maturation level in a high weight category.

Conclusions

This weight-grading model allowed to reduce the dispersion of FFMI/BFMI between young players while preserving the identity of age category. The Hattori's body composition chart allowed more detailed examination of morphological atypicalities among schoolboy rugby players and to design individual intervention for fat loss or muscle gain.

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Keywords: health, rugby union, adolescents, obesity, body composition

Anticipated DHEA response to competition in elite college soccer players

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Introduction
It is not yet clear whether a competition-related stressor alone would be able to alter hormonal responses, particularly for DHEA and testosterone. Therefore, this study measured the impact of the same acute exercise, associated or not with competition-related stress (official college soccer game played at the opponent's home versus practice game) in elite soccer players on both saliva DHEA and testosterone concentrations and rhythms.

Method
All procedures were approved by the local Ethics Committee and were carried out in accordance of the declaration of Helsinki. Twelve healthy, trained male volunteers (age: 21.2 ± 1.8 yr; weight: 77.9 ± 3.5 kg, height: 177.3 ± 4.0 cm), performing at the top national soccer student level, agreed to participate in the study after being informed of the nature of the experiments and gave written informed consent. The two experimental days: competition day ("match", i.e., away national university tournament soccer match) and training day ("train", i.e, simulated match in an out-of-competition day) were randomized and separated by one week, with samples taken: a) immediately after awakening between 07:00/07:30 h; b) 09:00 h; c) 12:00 h; d) between 14:00/15:00 h, just before the real or the simulated match; e) between 16:00/17:00 h, just after the real or the simulated match; f) at 20:00 h. All samples were analysed in a blinded way for DHEA and testosterone determination.

Results
Wake-up DHEA concentrations were decreased at 12:00, 14:00/15:00, and 20:00 on the "official game" day and at 09:00, 12:00, 14:00/15:00, and 20:00 on the "training game" day, respectively. Salivary DHEA values at 09:00 were higher on the "official game" day compared to the "training game". Post-exercise DHEA values at 16:00/17:00 were higher on both the "official game" day and the "training game" day compared to pre-exercise values at 14:00/15:00, whereas wake-up testosterone concentrations were from 09:00 onwards on both experimental days.

Discussion and Conclusion
An anticipated DHEA response to competition stress was found in the present study. However, on both experimental days, comparable increase in post-exercise DHEA concentrations were obtained without change in post-exercise testosterone or in their diurnal patterns [1-5].

*Speaker

In conclusion, our data demonstrate for the first time an anticipated increase in DHEA during competition, but there is no impact of a competition-related stressor on DHEA and testosterone exercise responses and a diurnal steroidal pattern was maintained.

Keywords: saliva – steroid hormonal pattern – soccer players – circadian rhythm

Athletic pubalgia impairs static postural balance in soccer players

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Introduction
Several mechanisms such as altered agonist-antagonist muscle co-contraction (Cattagni et al., 2014), and pain (Litwin et al., 2011) have been proved to impair postural balance in different populations. It remains unclear whether these mechanisms, involved in athletic pubalgia (AP), may impair postural balance in soccer players with AP. Considering that postural balance impairment is associated with sport-related injuries and athletic performance declines (Zemková, 2014), it seems important to investigate the effect of AP on postural balance. Such investigation could provide clinicians with additional elements when designing rehabilitation programs and consequently preventing players with AP from potential injuries associated with postural impairment. Therefore, the aim of this study was to compare postural balance outcomes between soccer players with and without AP.

Methods
Fifty-four soccer players, 27 with AP (AP group: APG) and 27 healthy ones (control group: CG) participated in this study. Static postural balance was assessed by recording the mean centre of pressure (CoP) oscillations on firm and foam surfaces and in eyes opened (EO) and closed (EC) conditions. Besides, Copenhagen Hip and Groin Outcome Score (HAGOS) subscales were evaluated.

Results and discussion
The APG exhibited significant worse postural balance (higher CoP displacements) on the foam surface (EO: $p< 0.01$, EC: $p< 0.05$) compared to the CG. They also had significantly ($p< 0.001$) worse self-reported outcomes in all HAGOS subscales (pain: d=2.43, symptoms: d=2.68, activities in daily living: d=1.86, physical function in sport and recreation: d=3.23, participation in physical activity: d=2.21 and hip and/or groin-related quality of life: d=2.83) compared to their counterparts. Soccer players with AP revealed static postural balance impairment compared to the controls that could be due to their worse HAGOS pain score.

Conclusions
As soccer players with AP could play through pain, it seems important to work on balance

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rehabilitation programs not only to prevent potential injuries, which could result from postural impairment, but also to restore their worse HAGOS sport function and physical activity scores.

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Keywords: postural performance, groin, pain, soccer

Determination of Lower Limbs Explosive Muscular Power of High Level Basketball and Volleyball Players

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In North Africa, few studies have evaluated the physical capacities or biological profiles of professional volleyball (VB) or basketball (BB) players. The aim of our study was: i) to elaborate the impact of training and competition of two professional teams (BB and VB) on a physical level, specifically the muscular power of the lower limbs; ii) to evaluate the influence of the morphotype on game position in each sports game.

Material and methods
Subjects - 28 male BB and VB International players were invited to participate in this study (N=28; 14 BB players and 14 VB). The mean age, height and weight are respectively 28.14 ±5.17 years, 194±9 cm, and 91.29±10.12 kg for the BB group and 28.14 ± 4.15 years, 193 ± 5 cm and *87.61 ± 7.65 kg for the VB group.* Already injured players as well as players who were injured during the study were taken off the protocol.All the sessions were conducted at the same time during the training session from October 2019 to January 2020.
Study protocol - The tests' order was counterbalanced during the measurement sessions for all the subjects. All subjects underwent two types of measurements:
-Anthropometric measurements of weight, sitting height, standing height, lower limbs length, intercondylar diameter of the femur, circumferences in the lower limbs, intercondylar diameter of the humerus, brachial circumference, skin folds.
-Muscular power tests: five-jump-test (FJT) and Sargent test as vertcial jump (VJ).
We have used Harman formula to calculate peak and mean (average) of power values. Indeed, Harman et al. (1991) established the following equations: Peak Power (PP [W]) = 61.9 x VJ (cm) + 36.0 x mass (kg) + 1822, and the Mean Power (MP [W]) = 21.2 x VJ (cm) + 23.0 x mass (kg) – 1393.
Statistical analysis - The results were obtained by applying repeated measures analysis of variance (ANOVA). A post-hoc Newman-Keuls test was applied to compare experimental data two by two. When comparing two independent groups, we have used the Mann-Whitney U test.

Results
A significant difference was recognized between BB and VB group in the FJT (respectively, 11.76 ± 0.83 m, 13.07 ± 0.91 m; p=0.0007) and VJ measurements (respectively, 0.49 ± 0.06 cm, 0.61 ± 0.04 cm and p=0.00004). There was a significant correlation between the PP (W)

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and the muscular power tests (FJT and VJ) in the BB group (Respectively, r=0.85, p=0.007 and r=0.59, p=0.02).

Discussion

No statistically significant differences between the anthropometric results were found in comparison of both teams. However, our results showed a significant difference in the power parameters test (FJT and VJ) in VB team. This suggests that VB team had stronger players with more developed explosive power of the lower limbs. This finding was confirmed by a significant difference in the peak of power in favor of the VB team. We related the difference in the VJ results to the differences in the jumping sport skills, as the VB sport requires more jumping skills than BB.

BB players were mesomorphic and VB players were ectomorphic-endomorphic. In the VB team, the liberos were endomorphic while the Middle blocker were mesomorphic. The results we found in each team separately and through a comparison of their game position could enable coaches to individualise and determine suitable training methods, depending on the morph type of an athlete.

Keywords: Physiology – Power – Lower Limbs – Basketball, Volleyball

Do athletes with unilateral patellar tendinopathy have postural balance inter-limb asymmetry?

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Introduction
Patellar tendinopathy (PT) is one of the most common causes of anterior knee pain in athletes (Lian et al., 2005) that decreases proprioception (Torres et al., 2017). Interestingly, proprioception impairment (Horlings et al., 2008) and pain (Hirata et al., 2012) induce postural balance alterations. Therefore, athletes with unilateral PT (UPT) may have postural balance inter-limb asymmetry, which may increase subsequent lower extremity injury occurrence (Paterno et al., 2010). Therefore, we aimed to evaluate static and dynamic postural balance inter-limb asymmetries in athletes with UPT.

Methods
Twenty-eight athletes with UPT and 28 healthy athletes participated in this study. Static postural balance inter-limb asymmetry (symmetry index: SI) was assessed based on differences in the mean center of pressure (CoP) velocity (CoPv) values between the two legs. Dynamic postural balance was assessed with inter-limb asymmetry using the Y Balance Test (YBT).

Results and discussion
In static balance, SI values were significantly ($P < 0.001$) higher in the UPT group compared to controls. In dynamic balance, inter-limb asymmetry values were also significantly ($P < 0.01$) higher in athletes with UPT compared to controls.
There are many potential mechanisms that may contribute to the asymmetrical postural balance such as pain and proprioception alteration.

Conclusion
Athletes with UPT had higher postural balance inter-limb asymmetries compared to controls. As most athletes with UPT continue to train and compete, adequate training and rehabilitation programs should be ensured to prevent potential subsequent injury occurrence.

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Keywords: patellar tendinopathy, postural balance asymmetry

Effect of 5 weeks of HIT in hypoxia on physiological profiles measured in situ by GPS with elite soccer players.

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Introduction

Hight intermittent sprint in hypoxia has been demonstrated benefits on performance for team sports (Brocherie et al. 2015). Technological improvement from last decades permit to simulated altitude using inflatable mobile solution close to the practice and integrate more easily this typology of training in real situation. Even if many studies report benefit of this one, few studies were performed during real season with professional players. The aim of this study is to investigate the effect of 5 weeks of high intermittent training (HIT) under hypoxia comparing Metabolic Power Profile (MPP) (Cassirame et al. 2017) and Acceleration Speed Profile (ASP) (Morin et al. 2020) based on GPS data collected during all training and games session.

Methodology

During football season, men professional team added supplement training under hypoxia for 12 volunteers' players during 5 weeks with 2 supplements sessions per week with hypoxia set between 3000 and 3200m with Cloud 9 machine (Sporting Edge, UK). At 1st week, players performed a moderate exercise on bike (Wattbaike, UK) set at 30% off their maximal power output during 2 phases of 5 min, and a second one 2 days later with 2 sets of 8 reps of 15 s all-out exercise followed by 20 s recovery. For 2nd to 5th weeks, players performed 2 sessions per weeks, 2 and 4 days after games day with 3 sets of intermittent training as follow 15s-20s / 15s-20s / 8s/15s with 3 min recovery between sets. During same period, other players from the team performed similar exercise bout in normoxia conditions.

All players were equipped with GPS during all trainings and games sessions (Exelio, Italy). Data collected permitted to generate MPP and ASP on periods of 2 weeks before and after training intervention. For each volunteer player (HG), a player of same role was randomly integrated in control group (CG). Difference of evolution between group were analysed using magnitude

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based inference using 0.2 SD for small effect, 0.6 SD for moderate and 1.2 SD for large (Hopkins et al. 2009).

Results
After training intervention, we can observe that both groups significantly increased their performance for MPP and ASP. No difference was found in ASP evolution between HG and CG. Performance increase was similar for both. Regarding MPP, Small differences were observed between group evolution for rolling average 1, 10, 15 and 30s and moderate differences for 3 and 5s. No difference was observed in duration over 30s.

Conclusion
In professional football season, adding high intermittent exercise under hypoxia can permit to increase metabolic power on short duration exercise only whereas maximal acceleration and speed capabilities remain unchanged.

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Keywords: Football, hypoxia, HIT, GPS, profile

Effect of a sleep education program in a professional ice hockey team

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Introduction
Chronic sleep deprivation can lead to various physiological and/or psychological disorders in the general population (Banks et al., 2007, Hurdiel et al., 2014). In high performance athletes, sleep is an integral part of recovery and performance. Several studies have shown that the sleep of players in team sports is often degraded, due to late matches, and frequent travel (Walsh et al., 2021), The objective of our work, was to propose a sleep education program to professional ice hockey players and observe the longitudinal effect on subjective sleep quality and sleepiness.

Methods
Twenty-one professional hockey players, aged 19 to 38 years (25 ± 5.5 years), participated in this study. During the season, we have initiated several actions to improve players' sleep. First of all, we hosted a sleep conference at the beginning of the season. This conference explained the main principles of sleep and made players aware of the importance of sleep-in recovery and performance. Second, after an initial individual assessment, each week, we were able to give players personalized advice and strategies to meet their specific needs.
From January 4 to April 21, players completed a monthly self-reported sleep and sleepiness questionnaire, the Pittsburgh Sleep Quality Index (PSQI) and the EPWORTH, respectively. This allowed us to assess their subjective sleep quality and sleepiness throughout the season. Repeated measures analysis of variance (ANOVA) and post hoc tests were performed to observe the individual evolution of the PSQI score and the Epworth scale. The components of the PSQI were also included in the analysis.

Preliminary results
The statistical analysis reveals a significant intra-individual difference for the Epworth ($p < 0.001$). The Post hoc tests showed all comparisons of the first assessment with the others are statistically significant ($p < 0.05$). There was a trend in improved observed for the overall PSQI Score ($p = 0.061$). Only the component "Daytime dysfunction" was significant ($p < 0.001$). The Post hoc tests showed a significant difference between the first and the second assessment ($p < 0.001$), the first and the third ($p = 0.025$), the first and the fourth ($p = 0.005$)

Conclusion
Among professional ice hockey players, a fifteen-week sleep education program may reduce sleepiness and improve players' perceived fitness. The subjective sleep quality, as assessed by the

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overall PSQI global score, was not significantly improved, the results are encouraging. As the season is not yet over, a fifth evaluation could confirm our first results. Finally, it would be interesting, to measure in a more objective way, the sleep of the players with for example actimetry.

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Keywords: Sleep, sleepiness, health, performance, hockey, recovery

Effect of an intermittent exercise training program including short apneas on the aerobic and anaerobic power

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The performance of short and repeated apneas during intense intermittent exercise is sufficient to induce an arterial desaturation (Thesis, Guimard A). A training program using such a dynamic apnea could therefore lead to similar adaptations to those observed after an intermittent hypoxic training program. The aim of the present study was to evaluate the effect of a dynamic apnea training program on the aerobic and anaerobic power in young men.

Twenty four men untrained in apnea and in endurance (20.4 ± 2.1 years) followed a two months exercise training program which consisted in: 16 sessions of training with 3 bouts of 10 repetitions of 10 sec at 90% of the power reached at maximal oxygen uptake (PVO2max) separated by 20 sec at 50% of PVO2max. Thirteen volunteers performed the periods of 10 sec at 90% of PVO2max in apnea (apnea group) and 11 volunteers breathed normally during these periods (control group). Before and after the training program, participants performed a maximal progressive exercise test and a Wingate test on a cycle ergometer.

Training increased PVO2max during the progressive exercise test ($p< 0{,}001$) and did not alter VO2max ($p=0{,}42$). The peak power during the Wingate test was increased by training ($p=0{,}009$) and the mean power did not change ($p=0{,}11$). No effect of the training group was found for each variable.

These results indicate that repeated short apneas included in an intermittent exercise training has no specific effect on the aerobic and anaerobic power. The physiological effects induced by these dynamic apneas were likely too transient to induce similar adaptations to those observed during intermittent hypoxic training.

Keywords: dynamic apnea, maximal progressive exercise, Wingate test

*Speaker

Effects of different preseason training protocols on physical performance, hematological parameters and plasma volume variations, in professional soccer players

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Introduction

During the soccer match, players performs a variety of movement skills with high intensity intermittent efforts such as jump, speed, agility, muscle strength, kicking, overhead play for header (Stolen et al. 2005). In fact, researchers in the field of sport performance have proven that repeated sprint ability (RSA) and resistance training (RT) constitutes as important components to improve fitness performance among soccer players (Meylan et al. 2014). However, to our knowledge, the effect of combined RSA-RT, on physical and physiological markers has not been determined yet. The aim of this study was to examine the effect of 8 weeks combined program, with RT and RSA exercises, on anthropometric measurement, jumps speed, endurance, repeated sprint and hematological parameters.

Methods

Sixty-two (62) male professional soccer players (age: 24.8±2.6 years; weight: 67.51±7.4 kg; height: 179.63±7.78 cm; BMI: 21.52± 2.48 kg/m^2) from the same Tunisian football team (J.S. Omran) were enrolled in this study. Players were randomly assigned to four groups depending on the training programs :((a) Resistance training group (RTG; n= 15), (b): Repeated sprint training group (RSTG: n= 15); (c) Combined training group (CTG; n= 15); and (d) Control group (CG; n=15)). The study was carried out eight 8 weeks of the pre-season period. Players from different groups were evaluated two times during the study plasma volume, hematological parameters, and physical fitness was evaluated over three days.

With the usual training, players added a specifics exercises three times a week, with nonconsecutive days (48h rest), using repeated sprint only (for RSTG) or back-squat training only (RTG) or back-squat and repeated sprint trainings, during separate sessions, alternate during combined training (CTG).

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Results and Discussion
The results of this study showed that CT improved significantly sprint 30-m, RSS performance indices, while RST showed an improvement only in sprint 30-m and best time index of RSS. However, no significant change was observed on RSS indices and sprint 30-m with RT group. Our results are similar with Torrelo et al. (2018).

Keywords: Alternate training, body composition, sprint, countermovement jump test

Effects of eastward flight with a synchronization strategy at destination, on sleep-wake and core body temperature rhythms in professional road cyclists

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Introduction

In professional athletes, travel across several time zones is an inevitable features of participation in international competitions or training camps. Rapid airline travel across several times zones induces jet-lag, caused by conflict between the internal pacemaker and external cues (Duffield and Fowler 2018). Although the sleep-wake rhythm synchronizes within a few days after transmeridian flight, circadian rhythms such as melatonin or core body temperature (CBT) rhythms take longer to resynchronize (Lee and Galvez 2012). To the best of our knowledge, limited field studies have investigated circadian rhythms during a real Eastward flight in professional athletes. Thus, the objective of this study was to assess the effects on sleep-wake and core body temperature rhythms, of long-haul travel to the east (France-Japan), using an active strategy of synchronization at destination with melatonin and bright light, in professional cyclists.

Methods

Four male professional road cyclists (age: 26.0±1.4 yrs; height: 175.8±1.5 cm; weight: 62.8±5.7 kg) of the French national team took part in this study. The day before travel, athletes maintained their usual sleep-wake rhythm at home. Athletes traveled overnight from Paris to Tokyo on a direct flight in economy class. At destination, athletes synchronized their sleep-wake rhythm as quickly as possible, with use of melatonin pills in the evening for 5 days (3.0 mg on the 1st night, 2.0 mg on the 2nd , 3rd, and 4th nights and 1.0 mg on the 5th night) and light therapy upon awaking (20 min at 1500 lux). Sleep-wake rhythm was evaluated by a sleep diary and CBT was monitored continuously by electronic capsules (e-Celsius®, Bodycap, France) from the day before travel to the 5th day at destination. CBT data was analyzed using the Cosinor model.

*Speaker

Results and discussion

The week before travel, bedtime was 22:45±02:00 h:min and wake-up time was 07:50±02:09 h:min for a total sleep time (TST) of 08:44±02:02 h:min. TST decreased to 07:33±00:53 h:min on the 3rd night in Japan causing a sleep dept, which was restored on the 4th and 5th nights (08:51±02:11 h:min and 09:10±01:40 h:min respectively). Preliminary CBT results showed that batyphase appeared at 05:00±01:05, with a nadir at 36.2∘C, the day before travel. It shifted at 07:56±02:50 h:min, with a nadir at 36.3∘C, the first night at destination, *i.e.* a phase advance about 4 hours on the 7 time zones crossed. This phase advance was then slower than the first days, since batyphase appeared only at 07:00±03:36 h:min with a nadir at 36.0∘C, on the 5th night (Table I).

Although chronobiological rhythms of these athletes were not completely synchronized, sleep-wake rhythm and TST were restored after 3 days at destination. We can hypothesize that professional athletes, due to their frequent experiences of jet lag, adapt well to a new schedule. Furthermore, melatonin administration and bright light exposure like sunrise, in addition to the sunset summer in Japan might have been favorable to a relatively rapid synchronization.

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Keywords: Cycling, jet lag, core body temperature, eastward flight

Effects of melatonin ingestion on cellular damage and physical performance following maximal running exercise in soccer players

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Introduction
Antioxidant supplementation has become a common practice among athletes to boost sport achievement (Ammar et al., 2018). Likewise, melatonin (MEL) has been ingested as an ergogenic aid to improve physical performance (Cheikh et al., 2018). Nevertheless, the effect of acute MEL ingestion on aerobic performance in a continuous exercise until exhaustion has been previously investigated only during indoor exercises which are not specific to running activities (i.e., swimming, cycling) (Beck et al., 2015, 2016, 2018). Therefore, the present study aimed to evaluate the effect of MEL ingestion on physical performance and biochemical responses during exhaustive running exercise.

Methods
In a double-blind randomized study, thirteen professional soccer players [age: 17.54 ± 0.78 years, body mass: 70.31 ± 3.86 kg, body height: 1.80 ± 0.08 m; maximal aerobic speed (MAS): 16.85 ± 0.63 km/h; mean ± standard deviation], members of a first league squad, performed a running exercise until exhaustion at 100% of MAS, after either MEL or placebo ingestion. Physical performance was assessed, and blood samples were obtained at rest and following the exercise.

Results
Compared to placebo, MEL intake prevented the increase in oxidative stress markers (*i.e., malondialdehyde*) and alleviated the alteration of antioxidant status (*i.e.,* glutathione peroxidase).

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In addition, MEL intake decreased post exercise biomarker of muscle damage (*i.e.,* creatine kinase). However, physical performance was not affected by MEL ingestion.

Discussion

The main findings of this study proved that MEL does not affect physical performance. Some previous studies concluded also that MEL ingestion had no effect on endurance performance (Brandenberger et al., 2018). However, a more recent study (Cheikh et al., 2018) demonstrated that MEL ingestion after strenuous late-evening exercise improved aerobic performance on the following day. These findings have been attributed to the improvement in sleep quality and quantity after MEL ingestion. Moreover, Beck et al. (2018) found that MEL ameliorated aerobic performance during a cycling exercise until exhaustion. The difference between the present study and that of Beck et al. (2018) may be due to the difference in the exercise type used, since it has been shown that physical performance during a limited time test is superior during a cycling exercise than a running one (Derman et al., 1996).

Otherwise, MEL ingestion before the running exercise test prevented the increase of cellular damage. Accordingly, our previous study showed similar trends for muscle damage and oxidative stress parameters after MEL ingestion during an intensive training camp (Farjallah et al., 2020).

Conclusion

Acute MEL intake before a maximal running exercise protected athletes from oxidative stress and cellular damage but without an effect on physical performance.

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Keywords: melatonin, oxidative stress, cellular damage, physical performance

Effects of post-exercise whole-body cryotherapy/cryostimulation and hyperbaric oxygenation on sleep quality in cyclists

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Introduction
Intense physical exercise induces residual fatigue that may affect sleep quality. Sleep constitutes an essential component of recovery and performance. Whole body cryotherapy (WBC) is a recovery method commonly used by athletes. It has been shown that WBC might enhance sleep quality (Bouzigon et al., 2014). Hyperbaric oxygenation (HBO) is an innovative recovery process in the field of sport. However, investigations on the effect of HBO on post-exercise recovery and sleep are lacking. The aim of this study is to assess and compare the effect of HBO and WBC on nocturnal heart rate variability (HRV) and sleep quality following an intense exercise performed in the afternoon. It is hypothesized that a single exposure of these recovery methods will stimulate the vagal tone during sleeping.

Method
Well-trained cyclists will perform an incremental maximal effort test (+ 25 W per minute) on a mechanical cycle ergometer in order to determine their peak power output (PPO). During experimental sessions, participants will perform a noon intermittent training consisting of eight bouts of 20s cycling interspersed by 10s of rest (Tabata pattern) at 130% PPO (50 W load, cadence between 90 and 100 rpm). Then, they will complete in randomized order the following recovery modalities: HBO (15-min at 97% O2 - increasing pressure from 1 to 1.3 ATA, 40-min at 97% O2 - 1.3 ATA, 5-min at 97% O2 - decreasing pressure from 1.3 to 1 ATA), WBC (3-min at -60∘C) or passive recovery (Control). During each night following training session, HRV (mean R-R interval, RMSSD, LF, HF, LF/HF power ratio) and sleep endpoints (sleep onset latency, wake after sleep onset, total sleep time, sleep efficiency, rapid and non-rapid eye movement proportion) will be recorded using Hexoskin shirts ©.

Results and Discussion
We hypothesize that the use of 3-min WBC after training will enhance HRV activity, suggesting benefits on sleep quality compared to Control condition. Indeed, Douzi et al., (2019) shown an improvement of parasympathetic nervous activity during the slow-wave sleep period after a similarly WBC post-exercise exposure. Furthermore, although autonomic nervous activity has not been yet investigated during sleep following HBO exposure, we also expect an improvement of parasympathetic nervous activity. Indeed, Lund et al. (2003) shown that HBO (60 min at 2.5 ATA) used at rest increased cardiac vagal tone, suggesting a stimulation of the activity of the cardiac parasympathetic system.

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Conclusion
The aim of this research is to assess the effect of HBO and WBC on HRV and sleep quality after performing an intense physical exercise.

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Keywords: Cryotherapy, hyperbaric oxygen therapy, sleep quality, heart rate variability, parasympathetic system

Effects of repeated cryostimulation on sleep parameters in healthy subjects

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Sleep is a primordial component of physical performance and health. Optimal sleep quality and quantity is such a major issue, since we know that more than 20% of the population is suffering from sleep disorders. Cold therapy lead to numerous beneficials effects particularly on wellness feelings, anti-inflammatory process and autonomous nervous system activation. Thus, cryostimulation exposure may be considered as a potential strategy to improve sleep.Previous studies using acute cryotherapy session already demonstrated benefits on perceived sleep quality and reduced movements number in the night. However, little is known about the effects of repeated cryotherapy exposures on sleep.The aim of this study was to evaluate the effects of 5 consecutive days of cryostimulation sessions on sleep parameters.
Twelve healthy subjects (5 female ; 7 male aged 22.8 ± 2.2) participated in this randomized protocol, with 5 consecutive days with/without cryotherapy exposure. Sleep was analyzed over the 5 nights of each condition (control/cryo). Sleep quality and quantity were assessed by questionnaire (Spiegel), actigraphy (movements number) and headband (cerebral activity).

Preliminary results showed that subjective sleep quality was higher in the cryotherapy condition compared with the control week. This difference was observed in female as well as in male participants. These results are promising considering cryostimulation as a potential strategy to improve sleep but more parameters need to be analyzed to strengthen the positive impact of cryostimulation. Thus, further analysis will focus on objective indices such as sleep duration, sleep onset, duration of REM and non-REM sleep cycle phases, number and duration of awakenings, sleep efficiency and position changes.
The overall of the oncoming results will give us new findings about how repeated cold exposure influence sleep patterns.

Keywords: cryostimulation, sleep

*Speaker

Effet de l'entraînement à des intensités autour de la vitesse critique sur la performance du 400 mètres crawl chez les jeunes nageurs.

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Contexte
Bien que les nageurs soient impliqués dans l'entraînement et la compétition à un âge relativement jeune, les différences dans les réponses physiologiques à l'exercice, par rapport aux adultes, ne sont généralement pas respectées. Les jeunes nageurs sont rarement impliqués dans le contrôle de l'entraînement, ce qui conduit à une prescription inadéquate des intensités et du volume d'entraînement. Cette étude visait à examiner l'effet de la prescription et du contrôle des intensités d'entraînement autour de la vitesse critique (CV) sur les performances du 400 m crawl pendant une période de 8 semaines.

Méthodes
Vingt jeunes nageurs de sexe masculin (13,4±1,0 ans) ont été répartis au hasard en deux groupes. Le groupe expérimental (EG) avec lequel on a utilisé un suivi de l'entraînement basé sur des intensités autour de la CV (95, 100, 105 et 110% de la CV), tandis que pour le groupe de contrôle (CG), différentes zones de fréquence cardiaque (FC) (EN1+, EN2, EN2+ et EN3) ont été utilisées comme critère d'intensité. Le volume d'entraînement était le même pour les deux groupes. Un test maximal de 400 m crawl (T400) a été effectué avant et après la période de 8 semaines afin de déterminer les intensités de CV et d'évaluer les variations de performance. Le taux d'effort perçu (RPE) et les valeurs de la FC ont également été évalués.

Résultats
Des effets principaux significatifs du temps ont été observés pour T400, CV, FC et RPE. Une interaction significative groupe x temps a été trouvée pour le T400 (p=0,035, taille de l'effet=1,07, modérée). Les résultats ont révélé des améliorations significatives avant-après pour EG (de 328,46±26,25 s à 305,88±20,09 s) et CG (de 329,07±25,24 s à 314,75±19,87 s). Une interaction significative groupe x temps a également été trouvée pour CV (p=0,005, taille de

*Speaker

l'effet=1,51, grande). Les résultats ont révélé des améliorations significatives avant-après pour EG (de 1,126±0,08 m/s à 1,207±0,07 m/s) et CG (de 1,124±0,08 m/s à 1,173±0,07 m/s).

Conclusions
La CV calculée à partir d'une seule course de 400 m peut être appliquée chez les jeunes nageurs compétitifs pour prescrire et suivre des séries d'entraînement en endurance. Dans cette étude, 8 semaines de prescription et de suivi d'un programme d'entraînement en endurance utilisant des temps imposés correspondant à des intensités allant de 95% à 110% de la CV a permis de mieux améliorer les performances du 400 m crawl par rapport à la méthode de suivi "traditionnelle" basée sur les zones de FC. Ainsi, les entraîneurs de natation sont encouragés à concevoir des programmes d'entraînement basés sur un contenu et des intensités liés à la CV pour le suivi et la prescription de l'entrainement chez les jeunes nageurs compétitifs.

Keywords: natation, endurance, suivi de l'entraînement, zones d'entraînement, vitesse critique

Effets de la privation partielle de sommeil, de la sieste et de la caféine sur la somnolence subjective et le temps de réaction

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Objectif
tester les effets de la privation partielle de sommeil (PPS), une courte sieste, une dose modérée de caféine, et leur combinaison sur la somnolence subjective et le temps de réaction chez des sportifs.

Méthodes
Neufs judokas de haut niveau ont volontairement complété une session après une nuit de sommeil normal (NSN) et quatre sessions après une nuit de PPS (temps au lit de 22h30 à 02h30). Dans un ordre contrebalancé, les participants ont complété cinq sessions expérimentales; NSN, PPS avec ingestion de placebo (PLA), une opportunité de sieste de 20 min (N20, de 14h10 à 14h30), une dose modérée de caféine (CAF : 5mg·kg-1) et la combinaison d'une dose modérée de caféine et d'une sieste (CAF+N). Le temps de réaction simple (SRT) et à choix multiples (TCRT) et le questionnaire de somnolence d'Epworth (ESS) ont été évalués avant (12h45) et 30 min après la sieste (15h00).

Résultats
la PPS a augmenté le SRT comparé au NSN ($p< 0.01$; d=1.02) mais pas le TCRT. Seulement l'ingestion de CAF a amélioré la performance de SRT ($p< 0.001$; d =2.07) comparé à PLA. TCRT a été meilleure après N20 ($p< 0.001$; d=2.89) et CAF+N ($p< 0.001$; d=2.17) comparé à PLA. Les scores de ESS ont augmenté après la PPS par rapport au NSN ($p< 0.001$, d=0.86) et ont diminué après N20 ($p< 0.001$; d=2.18) CAF ($p< 0.001$; d =3.14) et CAF+N ($p< 0.05$; d=0.69) comparé à PLA.

Conclusion
la courte sieste et l'ingestion d'une dose modérée de caféine peuvent contrecarrer l'augmentation de la somnolence induite par la PPS chez les sportifs. La caféine est plus recommandée avant des taches simples. Toutefois, une courte sieste est mieux recommandée quand les athlètes doivent réaliser des taches qui nécessitent une réflexion (e.g., sports à habileté ouverte).

Keywords: sieste, psychostimulants, privation de sommeil

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Force-Velocity Profile: gender effect

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Introduction

The ability to produce high mechanical power during sprint acceleration is one of the major determinants of physical performance. Horizontal "profiling" provides information on the specific sprint acceleration movement and the underlying physical or technical characteristics that limit the performance of each individual. This Power-Force-Velocity profiling approach is based on Force-Velocity (F-V) and Power-Velocity (P-V) relationships [1]. The slope of the F-V relationship determines the F-V mechanical profile (Sfv). The comparison of these mechanical parameters of the F-V profile and sprint performance between men and women has, however, attracted little attention. Most studies of gender differences have failed to apply a scaling ratio when reporting data. The confounding effect of body dimensions between men and women is therefore not considered. For the mechanical variables of the F-V profile in sprinting, allometric models have often been applied to body mass (BM) and not to fat-free mass (FFM) or FFM of the lower limb (FFMLL) [2]. This study aimed to investigate the effect of gender on the F-V mechanical profile in sprinting in males and females using allometric models applied to mechanical parameters.

Methods

Fourteen men (72.14 ± 7.8 kg ; 180 ± 6.3 cm) and fourteen women (62.09 ± 6.4 kg ; 167.1 ± 6.7 cm) sports science students participated in this study. Raw speed-time data for 3 maximal 35m sprints (standing start) were measured with a radar (Stalker ATS II) at 46,875 Hz. Sprint performance and mechanical parameters of the F-V relationship were calculated from the simple modelling of the velocity-time curve [3]. The technical ability of force application (DRF) was determined over the entire acceleration phase via the linear relationship between the effective mechanical force (RF) and displacement speed. FFM and FFMLL were also calculated using skinfold thickness and the truncated cone method. To analyse the gender effect, a Mann-Whitney test was used. Allometric models were applied by scaling mechanical parameters (Pmax, F0 et V0) to BM, FFM and FFMLL.

Results

Sprint performance was significantly better for men than for women (5.28 ± 0.28 s *vs* 6.29 ± 0.56 s , $P < 0.001$). Absolute Pmax, F0 and V0 were significantly higher for men than for women (1336.25 ± 239.16 W *vs* 838.27 ± 154.41 W ; 641.75 ± 88.64 N *vs* 499.73 ± 67.88 N ; 8.29 ± 0.51 m/s *vs* 6.70 ± 0.74 m/s respectively ; $P < 0.001$). When scaling to BM, FFM and FFMLL,

*Speaker

significant differences between men and women disappeared for F0. For Pmax and V0, there were no further differences when the values were scaled to FFM and FFMLL, using allometric models. For the parameters of force application and direction, maximal RF value (RFmax) was significantly higher and *DRF* significantly lower for men (53.90 ± 2.37 % *vs* 48.56 ± 3.44 % ; -9.66 ± 0.98 %.s/m *vs* -11.23 ± 1.06 %.s/m respectively ; P< 0.001).

Discussion

After applying allometric models, the differences in the F-V profile between men and women were explained by body dimensions. As sprint performance was better in men, other qualitative and technical parameters may explain sprint performance. Men were able to direct more force in the horizontal direction (higher RFmax) and their decrease in RFmax with increasing speed was considerably lower (less negative *DRF*) [4].

Conclusion

There were no significant differences for Pmax, F0 and V0 once the allometric model was applied by scaling mechanical parameters to FFM and FFMLL. Nevertheless, men performed better due to greater technical abilities.

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Keywords: Force, Velocity, Sprint, Gender, Allometric model

Gender effect on energy expenditure and substrate metabolism during sub-maximal running

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Introduction
Some studies have shown that females derive a relatively larger contribution from lipids to oxidative metabolism than males during exercise [3]. Perhaps, the higher fat mass in women may allow them to preferentially use this energy source as a fuel while exercising [4]. Outdoor track running (tarmac, grass) demands greater energy expenditure compared with a motorized treadmill at a same level [1]. The aim of the study was to use an allometric model to evaluate the impact of anthropometric data on the energy expenditure (EE) substrate oxidation during submaximal running in women and men.

Methods
Twelve men (age, 24±2 years; Body Mass Index (BMI), 23±2 kg.m-2) and ten women (age, 22±2 years; BMI, 22±2 kg.m-2) volunteered to participate in this study. EE, carbohydrates (CHO), and fat oxidation were calculated during an incremental running test. Field running speeds were 6, 7, 8, and 9 km.h-1 (commonly used speeds in regular populations). The duration of each speed level was 5 min. The running field was a square field of 80 m perimeter (20 m side). A sound signal was produced to allow subjects to adjust their speed to reach a corner every time they heard a sound signal. Data of oxygen consumption (VO2), carbon dioxide production (VCO2) were measured by indirect calorimetry (Metamax 3B-R2 metabolic measurement system, Germany) for each speed. Subject heart rate was monitored during all running stages with Polar H10. The allometric model was applied for EE, VO2, VCO2 and maximal fat oxidation (MFO) rate to BM, fat free mass (FFM) and fat free mass of the lower limb (FFMLL). To analyze the gender effect, a Mann-Whitney test was used.

Results
EE was higher in men than in women significantly at the speed of 6, 7 and 8 km.h-1 in absolute values and in scaled values to FFM and FFMLL. Speed at the MFO was significantly ($p < 0.05$) higher in men (7.8±0.9) than in women (7.2±0.6). Absolute and relative MFO were significantly higher in women than in men, but the significant differences disappeared when the allometric model was applied. There were no significative differences between women and men in fat oxidation (mg.min-1 and %) in absolute, relative and scaled values. In men, CHO oxidation was significantly greater for the three first speeds.

*Speaker

Discussion and Conclusion
Such as previous studies [2], the results of this study demonstrated significant gender differences in EE and substrate oxidation during sub-maximal running exercise. When an allometric model was used, the gender differences remained. Physiology such as hormonal profile could explain the gender differences in responses to exercise. The higher MFO speed in men than in women must be taken into account to maximize fat use during physical activity.

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Keywords: Energy expenditure, Substrate oxidation, Gender, Allometric model

Influence of repeated sprint ability on the in-game activity profiles of semi-professional rugby union players according to position

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Introduction
Rugby union is an intermittent sport with high-intensity effort (running or collision) and short random recovery periods between efforts. Activity profiles are highly dependent on the player's position. Forwards are more implicated in combat actions and backs complete more high-intensity runs [4]. Repeated sprint ability (RSA) is defined as the ability to reproduce maximum intensity short efforts (< 10 s), interspersed with short and incomplete recovery periods. In rugby, the ability to repeat sprints is an essential performance factor [1, 3]. Today in rugby union we still do not know how the level of RSA affects the performance of movement characteristics and repetition of combat tasks in game and if there are differences according to the position. Thus, this study investigated the relationship between RSA and *in-situ* game performance according to position and to consider the key performance indicators specific to each position.

Methods
This study was based on a retrospective analysis of 18 consecutive game's GPS and technical data and of physical tests results monitored around game 9. For 33 highly trained rugby players we tested the RSA in a 12×20m sprint test over a 20s cycle. During the study the regularity of RSA values were monitored. All players that have participated in, at least, 10 games were included. Physical test performances were correlated with GPS and technical data according to position, with, i) a classification within two groups: forwards and backs, ii) a classification into four groups: five forwards, back row, inside backs, and outside backs.

Results and discussion
In forwards, players with the best RSA produced significantly more accelerations and more fighting actions. In backs, RSA was correlated with the production of high intensity running. As previously shown, winning teams performed significantly more RHIE which attests to the importance for all players to repeat high-intensity efforts. Our results thus confirm that RSA could be a key physical ability to perform during match games in back as well as in forward players.

*Speaker

In five forward, RSA was associated with the number of accelerations and fighting actions which suggests that RSA performance could be related with the ability to reproduce the high intensity efforts five forwards are confronted with [2].

In back row, RSA was correlated with distance and the frequency of fighting actions. In inside backs, RSA was related with distance, number of accelerations and high speed running which attests that RSA is a determining physical ability for the mixed performance of back row (oriented toward fight) and inside backs (oriented toward running) since it improves both their participations in combat and high intensity running phases.

In outside backs, RSA was associated with sprint frequency and the maximal velocity reached in game which shows that better RSA would allow this group to improve their amount of sprint and high speed activity.

Conclusion
These results demonstrate that RSA is associated with match running and combat activity (i) in a global way, (ii) and also as specifically for each of the player's position, by improving the corresponding activity profile.

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Keywords: high intensity, key performance indicators, movement characteristics

Isometric strength database for muscle maximal voluntary endurance field tests: normative data.

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Background
Different field tests are used to evaluate muscle capacity, in particular maximal voluntary isometric endurance. However, although there are some normative values for a few muscle endurance tests, these do not consider the weight, height, gender or age of individuals, which are well-known factors that influence muscle performance.

Hypothesis/Purpose
The purpose of this study was to investigate the test–retest reproducibility of eight field tests and establish muscle endurance norms, in a healthy population, based on their anthropometric characteristics, which could allow the optimal evaluation of the entire muscle function in a quick manner.

Methods
This study was conducted in two phases. The first phase was to check the reproducibility inter- and intra-assessor for eight isometric muscle fields tests on 20 volunteer subjects aged 40.9 ± 11.6 years old (age range: 21–58 years). The eight tests were designed to assess the isometric endurance of the trunk flexors muscles [1] , trunk extensors muscles [1], right and left quadratus lumborum muscles [2], quadriceps muscles [3], hamstring muscles [4], back muscles [5] and chest muscles [6]. Postural positions of original tests were modified for reduce the discomfort of the position during the evaluation. The second part was to establish muscle norms for these eight tests, based on the anthropometric data of the subjects, on a total of 400 healthy participants grouped by age (50 males and 50 females for each age brackets: 20–29; 30–39; 40–49; 50–59 years old).

Results
The intra and inter-assessor reproducibility tests are very high for all muscle measurements (the intraclass correlation coefficients varied between 0.915 and 0.996 and the coefficient of variation between 3.6% and 11.8%). The area under the receiver operating characteristic curves demonstrates a good sensibility with values greater than 0.7 for each test. Each muscle belt presents same ratio regardless of the age and gender group. The simultaneous multiple regression analyses highlight that the anthropometric characteristics of subjects influence significantly the performance of isometric tests.

*Speaker

Conclusion
After demonstrating an excellent reproducibility of all tests , this study has permitted establishing prediction equations in a healthy population according to their anthropometric characteristics as well as agonist/antagonist ratios for eight muscle isometric field tests. These equations will make it possible to individualize muscle function training programmes by highlighting the muscle imbalances or weaknesses to be restored in the context of primary prevention, sport or rehabilitation. Following this study, the prediction equations were integrated into a computer tool in order to be able to follow the subject at a distance by means of a self-assessment allowing for a readjustment of the training programme intensities.

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Keywords: Évaluation musculaire isométrique, Normes Musculaires, Reproductibilité

Melatonin intake during Ramadan fasting reduces muscle damage but not repeated sprint performances in elite female handball players

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Introduction

A common challenge for Muslim athletes is that competitions are scheduled during or shortly after Ramadan intermittent fasting (RF). Most of the studies focused on males rather than females concerning the effect of RF on physiological responses (Memari et al. 2011, Hosseini et al. 2013). In order to reduce the adverse effect of RF on athletic performance, several strategies have been attempted which include changes in lifestyle and nutritional habits (Chaouachi et al. 2012). Nevertheless, several studies agreed on the beneficial role of oral melatonin (MEL) intake to readjust sleep cycles and jet-lag adverse effects after transcontinental flights, making athletes more prone to optimal performance (Cheikh et al. 2018). The study was designed to assess the effect of MEL intake on cognitive, physical and biochemical responses to strenuous exercises during RF.

Methods

Ten elite female handball players performed a running-based anaerobic sprint test (RAST) during two experimental periods across their luteal phase: one week before (BR) and during the last week of Ramadan (LWR). MEL (5-mg) or placebo (PLA) were ingested during each period, 30 min before starting test sessions in a double-blind randomized design. Dietary intake was assessed during the two periods. Fatigue index (FI), sprints power (SP) were calculated from the RAST. Blood samples were collected before and after the RAST.

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Results
The results showed that RF has no adverse effect on energy intake (Kcal). Moreover, the four last SP decreased significantly at LWR compared to BR accompanied with higher FI during the two conditions ($p < 0.01$). Lower SP (5th and 6th) was observed with PLA compared to MEL only BR. Muscle damage (i.e, creatine phosphokinase (CK), lactate Deshydrogenase (LDH) were higher after the RAST during LWR compared to BR ($p < 0.01$) during the two conditions. The increase of these markers was greater with PLA rather than MEL ($p < 0.05$) during the two periods test.

Discussion and Conclusion
RF decreased RAST performances and increased muscle damage and fatigue. These alterations could be attributed to disturbances of sleep and circadian rhythms. Nevertheless, MEL serves as a therapeutic solution that provides protection against exercise-induced muscle damage during RF. futures studies should focus on the effect of chronic evening ingestion of MEL in order to assess more benefit in other areas such as sleep quality, antioxidant state which lead certainly to an optimal performance during RF.

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Keywords: Ramadan fasting, melatonin, female, handball, performance, muscle damage.

Nap improved technical and tactical game-related performance during small-sided basketball games in professional players

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Physiological determinants of success in basketball revealed the importance of both aerobic and anaerobic pathways. Due to its complexity and mixed physical-technical-tactical nature, basketball requires physical demands and technical skills. However, technical demands remain poorly investigated. Furthermore, small-sided games (SSG) are widely used by coaches to simultaneously develop technical and tactical skills under high physical loads. Recently, it was suggested that napping enhances physical and cognitive performances in athletes. To date, only one study investigated the effect of sleep extension on basketball players, showing improvements in reaction time, sprint speed, shooting accuracy, free throw percentage, and three-point field goal percentage. Due to the importance of repeated-sprint ability and the aerobic-anaerobic aspect of basketball during competition, it would be of interest to investigate the effect of napping on real-situation games and technical performance during basketball SSG. We aimed to examine the effect of 40-min nap opportunity on cognitive performance and technical skills during SSG in professional basketball players.
Twelve professional basketball players accomplished randomly two conditions: 40-min nap opportunity (NAP) and control condition (CON). Subjective sleep quality was assed using a visual analog scale (VAS). Nocturnal sleep and naps were monitored by actigraphic recording and sleep diaries. The following parameters were derived and analyzed: total sleep time (TST), time in bed (TIB), sleep efficiency (SE), sleep onset latency (SOL) and wake after sleep onset (WASO). Profile of mood state (POMS) and simple reaction time (SRT) were measured before and after both conditions. Post-nap testing session started at 15:30 h by a 15 min standardized warm-up. Next, participants played a 10 min SSG. Technical and tactical performances during SSG were assessed using Team Sport Assessment Procedure. Observational variables were Volume of Play (VP), Attack with ball (AB), Efficiency index (EI) and Performance score (PS).

31.4 ± 7.1 min of sleep during nap with 62.8 ± 14.2 % of SE were observed. There was no significant difference during the night before experimental days in TIB, TST, SE and WASO between CON and NAP. Similarly, no significant difference was reported in VAS values between CON and NAP conditions. Although no significant difference was reported in VP, the values

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of AB, EI and PS were significantly higher in NAP compared to CON condition ($0.006 \leq p \leq 0.01$). POMS' fatigue, anger and tension scores were significantly lower after nap compared to values before nap. Vigor score was significantly higher after NAP compared to values after CON condition ($p = 0.01$). There was no significant effect of conditions or time on SRT.
As expected, nap improved technical and tactical performance during SSG. Subjective fatigue, tension and anger were reduced, and vigor was enhanced which may reflect better readiness and more concentration after nap to start a game-situation. This could explain improvement of performance in NAP condition, through a better mastery of technical skills and accurate decision making during SSG. The absence of significant improvement for cognitive outcomes could be due to sleep inertia's negative effect since cognitive tests started right after the nap. In summary, NAP reduces fatigue, anger, tension and enhances vigor, allowing a better technical and tactical performance during basketball SSG.

Keywords: Nap, Technical performance, Basketball, Small sided games, match analysis, fatigue, vigor

On the road of world class performance in the pole vault: changes according to ages and genders

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Introduction

Pole vault performances require large panel of capabilities from athletes such as speed, force, technical drills and mental skills to become elite athletes (Frère et al. 2010). Given that the mix of skills required to achieve a high level of performance, athlete evolution can be difficult to interpret globally. Recently, several studies described typical performance reached by athletes from both gender over a large panel of age (Ganse et al. 2018). This approach more focus on performances decline with age than performances increase and do not provide information to manage athlete's evolution. The first aim of this study was to generate performance corridor for French pole vaulters from both genders, grouped by level and proceed similarly for best world class athletes. Secondly, the study aimed to compare corridors from same gender.

Methodology

Results database from French federation were used as main database to sort all performances realized by athletes in competition over 30 years period ending in December 2019 31st. Performances realized by athletes from U16 were collected to generate personal performance history keeping best performance of each season. For national athletes, female results were sort to generate 3 corridors based on their all-time personal best (PB), from 4.2 to 4.4 m (F4.2), from 4.4 to 4.6 m (F4.4), and over 4.6 m (F4.6). World class corridor was generated using results from female over 4.8 m (FWC). For national male, corridors were created using the same methodology with range from 5.4 to 5.6 m (M5.4), 5.6 to 5.8 m (M5.6) and 5.8 to 6 m (M5.8) and over 6m for world class athletes (MWC).

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For each age categories, corridors were stated different from each other when differences between them were bigger than 20 cm as stated to generate group.

Results
Sorting of database permitted to identified 142 athletes distributed as follow: F4.2: 31, F4.4: 8, F4.6: 4, FWC:15, M5.4: 31, M5.6: 19, M5.8: 10 and MWC: 24. Regarding female, FWC and F4.6 groups get similar trajectory from U16 to U22 where FWC follow their career largely over other groups. W4.2 and W4.4 corridor are different from other groups from U16 and become closer for U21 to U23 where the difference is not significant. For all senior categories' performances became lower than FWC and F4.6. Regarding male, 4 corridors start very close at U16. M5.4 and M5.6 corridors became different than MWC after U19 and U21 respectively. M5.8 group are never different than MWC based on our criteria. We can note that MWC corridor is over M5.8 by 10 cm from Senior 4 to the end of the career.

Conclusion
According to previous studies, performance's corridor for both genders look as an inverted-U shape (Berthelot et al. 2019). Our study pointed out that this shape is different proportionally to PB with longer plateau at the top for best athletes. We also provided categories where corridors fork with world class athletes.

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Keywords: Athletics, pole vault, performance, growth

Origins of gastric disorders and optimization of nutrition during Ultra-Trail events.

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Leader of ultra endurance events, the ultra trail does not escape the popular craze for the discipline In France, since the first edition of the Ultra Trail du Mont Blanc® (UTMB), the number of "finishers" has risen from 67 in 2003 to 1685 in 2017; that of the registration request from 722 to 5575.
However, while the drop-out rate is only 4% for the Paris Marathon, it varies from 30 to 55% for trails of over 160 km.

Studies carried out by the UTMB medical commission show that more than 20% of withdrawals from long-distance races are directly linked to gastric problems or indirectly to their consequences (exhaustion, hyperthermia, hypothermia, cramps, etc.). In 2009, during the UTMB, the reasons given for withdrawals showed that one in five withdrawals was due to gastric problems (L Poletti, S Isnardon, 2009). There are two types of digestive disorders in ultra-endurance practices: lower digestive disorders (diarrhoea, bleeding, abdominal cramps) and upper digestive disorders (gastro-oesophageal reflux, vomiting, nausea). The origin of eating disorders may therefore be multifactorial: physiological or mechanical.

During races, the refreshments offered by the organisers are often rich and varied, even offering local products. To meet their energy needs, runners can help themselves to these refreshments, which can become real meals for some. It's therefore legitimate to ask whether the products proposed by the organisers are in line with the energy needs of the athletes, and whether these foods, which are culturally present in these races, do not favour the appearance of digestive disorders. Furthermore, we can ask whether the runner's sporting experience can influence food management and food intake during the race.

To test our hypotheses, 228 runners (87% men, 13% women) having run on different trail profiles (31% on - 60km, 50% on 60 to 150km, 19% on + 150km) answered a 3-part questionnaire (runner's profile, food habit during training, race management). Of all the participants, nearly 65% had already had to abandon a race, directly linked to eating disorders.

The results show that 49% of the runners have abandoned a race because of symptoms directly related to digestive disorders (nausea or diarrhoea), but also indirectly (dehydration, hyperthermia, cramps).

*Speaker

During training, 12% of runners suffer from digestive problems. Of these, 32% believe that the duration of training is the cause (46% between 1 and 5 hours of effort), whereas withdrawals from races mainly occur between 6 and 12 hours of effort. Furthermore, runners are less accustomed to eating and drinking during training than during a race (46% do not eat during training).

Runners' cravings for food and drink are often at odds with the range of food and drink offered by race organisers. For solid food, runners would like to eat more salty dishes, hot dishes, less fatty food, less industrial food and more variety, especially for fruit. For liquid food, the runners would like to have several different types of water, and of good quality (St Yorre, Vichy). As a result, and in general, we can be surprised by the type of food recurrently eaten by runners: fatty foods (meats, cheese) which can be long to digest, or laxatives (coffee).
Finally, and despite the existing links between digestive disorders and inexperience in running (Isabelle Morin, 2009), the least experienced runners, or those who are younger (24% are under 40 years old), are not more affected by digestive disorders than experienced runners.

Keywords: Ultra, endurance, Nutrition

Physiological Impact Of A Typical Training Session With Different Volumes On The Day Preceding A Soccer Match.

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Introduction
Previous studies showed that soccer weekly periodisation varies between teams (1). However, a consensus is generally observed for the day preceding the match (MD-1) with a training load decrease (1,2). Furthermore, a recent survey (unpublished observations) amongst French academies highlighted that almost all teams performed a tapering on MD-1 by implementing reactivity drills and small sided games (SSG). However, implementing SSG so close from match could be questioned as this training method was shown to elicit high neuromuscular constraints leading to fatigue (3). This study aimed to determine the physiological impact of such training strategy on match day performance (MD). Different training volumes were tested to observe if reducing the duration could annihilate the potential performance decrements generated by SSG.

Methods
Eleven elite U19 academy soccer players conducted three typical training sessions lasting 45 min (TS45), 60 min (TS60) and 75 min (TS75) on MD-1. It included a standardized warm-up, reactivity exercises and SSG. The latter was a 5 against 5 players plus goalkeeper on a 30x40m field, with 2 min work, and 2 min rest. During TS60, warm-up, reactivity and SSG were 10 min, 15 min and 24 min, respectively. Remaining time was used for coaches' instructions and water breaks. Duration was decreased and increased by 25% for TS45 and TS75, respectively. Tests were conducted three days before these training sessions for baseline values (PRE) and repeated before (POST) a training match on MD (subsequent day). Tests consisted in a counter movement jump (CMJ), 20 m sprint, Illinois agility test (IAT) and Hooper questionnaire (for the subjective fitness level).

Results and discussion
PRE values were identical over the three weeks. At POST, CMJ was greater for TS45 (42.7 ± 5.1cm) compared to TS60 (40.7 ± 5.5cm, p=0.032) and TS75 (40.9 ± 5.7cm, p=0.032). 20m time was lower for TS45 (3.07 ± 0.10s) compared to TS60 (3.13 ± 0.10s, p=0.021) and TS75 (3.20 ± 0.10s, p=0.002). 20m time (p=0.021) was also lower at POST for TS75 compared to TS60. IAT time was lower on TS45 (14.8 ± 0.5s) compared to TS60 (15.4 ± 0.3s, p=0.002) and

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TS75 (15.2 ± 0.3s, p=0.015). Furthermore, the Hooper index (p=0.015) was lower at POST (7.6 ± 1.5) compared to PRE (10.3 ± 2.8)for TS45 indicating a better overall fitness level, while no difference were highlighted for TS60 (11.0 ± 3.5 vs 11.4 ± 3.4, p=0.634) and TS75 (9.7 ± 2.4 vs 10.7 ± 2.5, p=0.272). These results suggest that this session leads to a decrease in performance on MD. Reducing the training duration to 45 minutes limits the onset of fatigue, while increasing the duration to 75 minutes leads to a decrease comparable to that of 60 minutes.

Conclusion
In its current form (TS60), the commonly used training session the day preceding a match leads to a decrease in physiological and psychological characteristics on MD.

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Keywords: Tapering, Workload, Performance, Microcycle, Youth

Predicting percentage of heart rate reserve and rating of perceived exertion during bench stepping in young adults: preliminary data

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Context

Bench stepping (BS) is a physical activity commonly implemented by fitness practitioners (Canneva, 2005) and that can be used by physical education teachers to develop in youths the ability to use digital exercise-related information to manage health, as during French high school programs (MENJS, 2019).

To prescribe and control individualized exercise intensity during BS exercises, it may be preferable, although still debated, to use the percentage of oxygen uptake (VO2) reserve or the percentage of heart rate (HR) reserve (%HRR) methods (ACSM, 2017). Because measurements of VO2 are not feasible in most exercise contexts, using %HRR is likely to be the preferred method during BS. When HR measurements are not available, using a scale for rating perceived exertion (RPE) allows a rough but easy individualized estimation of exercise intensity (ACSM, 2017).

Reaching an individualized exercise intensity target during BS is challenging due to a number of variables to take into account (e.g., bench height, music rhythm). To our knowledge, no studies have attempted to propose a model that would facilitate the prediction of the individual intensity actually reached during a BS exercise. Therefore, the aim of the present study was to develop an equation for predicting %HRR and RPE during BS.

Methods

Twelve sport sciences students (21-24 years, 8 women, novice in BS) gave their written informed consent to participate in the study. Participants completed measurements of anthropometric characteristics (height, weight, and leg length), a VAMEVAL test, a 5-min measurement of resting HR (lying), and a session with nine 5-min conditions of BS (3 music rhythms [125, 135, 145 bpm] $\times$ 3 bench heights [15, 20, 25 cm]) while performing the same choreography that consisted of different basic steps. HR was measured during the tests and sessions using a Polar® V800 HR monitor. RPE was assessed using the Borg's RPE 6-20 scale. Linear mixed-models were developed for predicting %HRR and RPE using bench height and music rhythms as fixed effects and a random effect on the intercept.

Results

Mean %HRR [95% CI] ranged from 52.2% [43.5; 60.9] to 82.9% [75.1; 90.8] and mean RPE [95% CI] ranged from 8.6 [7.2; 9.9] to 14.9 [13.5; 16.4] depending on the BS condition. %HRR

*Speaker

and RPE models were significant, with the followings fixed effects : %HRR model, intercept = -48.69 [-61.85; -35.54], bench height = 1.92 [1.77; 2.07], music rhythm = 0.58 [0.51; 0.66]; RPE model, intercept = -11.54 [-15.93; -7.16], bench height = 0.44 [0.38; 0.50], music rhythm = 0.10 [0.07; 0.13].

Conclusion
Our results support previous studies that highlighted the effect of bench height and music rhythm on the physiological response during BS. However, our sample size was small. Additional data are required to provide more accurate models and to investigate the value of using relevant covariates for predicting %HRR and RPE during BS.

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Keywords: bench stepping, percentage of reserve heart rate, height, rhythm, model

Relationships of the 5-Jump Test (5JT) Performance of Youth Players With Volleyball Specific' Laboratory Tests for Explosive Power

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Introduction
Volleyball involves movements with and/or without horizontal approaches (i.e., spike jumps, jump setting, blocking).The 5-jump test (5JT) was suggested to assess lower limb explosive power of players challenging in some disciplines (e.g., soccer, judoka, running). It appears that no previous study has investigated the 5JT performance components in volleyball players. Since the volleyball game involves jumping activities with and/or without horizontal approaches (i.e., spike jumps, jump setting, blocking; Sheppard et al., 2008), the primary aim of this study was to characterize the horizontal power and jumping performance in volleyball youth players. Consequently, the objective of this study was to test the relationships of the 5JT performance with laboratory tests for explosive power (CMJ and SJ tests).

Methods
Forty volleyball players (boys, mean age: 12.4 ± 0.8 years) were tested for 5JT, CMJ, and SJ tests. 5JT performance was expressed in absolute terms (m), and relative to leg length (5JTLL) and body mass (5JTBM). The SJ and CMJ tests were evaluated using the optojump photoelectric cells and the following data were collected: peak power (Pp) of jump (W, W.kg-0.67), peak jumping force (Fpeak, N), peak jumping velocity (Vpeak, m/s), peak heights of CMJ and SJ (CMJH and SJH, respectively, cm). Only significant ($p < .05$) Pearson product-moment correlations (r) > 0.30 were considered. 5JT performance was significantly correlated with SJ, Vpeak ($r = 0.90$), SJH ($r = 0.88$), Pp [W.kg-0.67 ($r = 0.86$), W ($r = 0.72$)], Fpeak ($r = 0.45$); and CMJ, Vpeak ($r = 0.82$), CMJH ($r = 0.80$), Pp [W.kg-0.67 ($r = 0.89$), W ($r = 0.85$)], Fpeak ($r = 0.73$). 5JTLL values were significantly related to SJ, Pp [W ($r = 0.81$), W.kg-0.67 ($r = 0.74$)], Vpeak ($r = 0.82$); and CMJ, Pp [W ($r = 0.73$), W.kg 0.67 ($r = 0.84$)], Vpeak ($r = 0.75$), Fpeak ($r = 0.67$)]. 5JTBM values were significantly related to SJ, Pp (W, $r = –0.43$).

Results
The findings of this study highlight that the 5JT may be a suitable field test for evaluating volleyball players' power. The 5JTs offer an interesting measurement of explosive power because of the limited facilities needed compared to the assessment of vertical jumping and lower

*Speaker

limbs' power, which requires sophisticated materials. Coaches who do not have direct access to laboratory equipments can use the 5JT in order to test lower limb horizontal explosive power.To conclude, in youth volleyball players, the 5JT may be viewed as an explosive strength diagnostic instrument under field circumstances.

Keywords: explosive power, vertical jump, leg strength, volleyball, youth

Serum metabolite biomarkers following a 12-week High-Intensity Interval Training combined to citrulline supplementation in obese older individuals.

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Introduction
Physical activity and nutrition play important roles in the prevention of adverse health effects that can occur with ageing. It has been shown that High-Intensity Interval Training (HIIT) combined with citrulline supplementation (CIT) can improve physical and functional capacities. Therefore, the aim of this study was to evaluate the metabolomic blood profile adaptations following a 12-week HIIT training combined or not with CIT in obese older adults, and examine if the metabolomic changes are related to clinical/blood parameters.

Methods
71 sedentary obese older men and women completed blindly a 12-week (3x/week) elliptical HIIT program combined with a 10g daily supplementation of either CIT (n=43) or equivalent placebo (PLA; n=28) during a double-blinded randomized interventional trial. Clinical/blood parameters (body composition, muscle function, functional capacity, triglycerides level) and serum metabolomic profile were assessed before and after the intervention. Extra blood samples served to estimate metabolomic parameters using mass spectrometers coupled to multiple different liquid or gas phase chromatography methods.

Results and discussion
364 metabolites and ratios of metabolites were identified. Among this number, 44 changed significantly following the 12-week intervention (Time effect), and 10 of them were more affected when

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HIIT is combined with supplementation (Time x Supp effect). Arginine significantly increased due to the intervention (Time effect). Following the correlation analysis, TG(16:1/18:1/16:0) and Aspartic acid were both significantly correlated ($p < 0.01$) to several fat parameters (arms fat mass, android fat mass, trunk fat mass, legs lean mass, leptin, triglyceridesand LDL cholesterol). Arginine induces a beneficial effect on the cardiometabolic health by providing vasoprotective andantihypertensive effects. It was also reported that arginine plays an important role in inflammation by inducing the activation of macrophages, hence on immunity.

Conclusion

The increase in arginine bioavailability could provide beneficial effects on the cardiometabolic health and on the immune response. Additionally, TG(16:1/18:1/16:0) and Aspartic acid might be specific biomarkers when fat parameters are considered, and hence for a healthy ageing. Further studies are needed to confirm the potential use of some metabolites as clinical biomarkers of non-pharmacological intervention in older adults.

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Keywords: Metabolomics, HIIT, Citrulline, Ageing

The effect of strenuous aerobic training on energy intake in adolescent swimmers: comparison with home confinement

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Introduction
In adolescent athletes, an appropriate energy intake is required to promote adequate growth in addition to meeting high energy demand during aerobic training. A negative energy balance balance due to insufficient energy intake and high energy expenditure may impair the growth, health, and physical performance of these athletes. Thus, there is a need to a better understanding of compensatory adaptations in response to regular aerobic exercise in adolescent athletes [1]. The aim of this study was to compare the effect of strenuous aerobic training to a non-exercise activity during home confinement on energy and macronutrient intake in adolescent swimmers.

Methods
Seven adolescent swimmers (13±1 years) of the Toulon Var swimming club were voluntary to participate to this study. Teens were in a sport and school section and swam 10 hours/week with 3 hours of training of land work. Daily energy intake (EI), macronutrient intake, energy expenditure (EE), physical activity level (PAL), energy balance (EB) were evaluated during one week of a strenuous aerobic training (31.5±3.5km/week; RPE score: 6.3; training load: 79,43UA±10,5), and after 8 weeks during one week of home confinement (non-exercise activity). Body fat mass and weight were assessed only during the week of strenuous aerobic training (beginning and end of the week). These measurements were not possible during the home confinement period.

Results
Daily PAL (1.84±0.13 vs 1.36±0.06), EI (10714±1636 vs 8452±1088 kj.d-1), EE (10983±1830 vs 8293±1209 kj.d-1) were significantly higher during strenuous aerobic training than during home confinement ($p < 0.01$). EB was significantly lower during strenuous aerobic training (-270 ± 331 kj.d-1) than during home confinement (+ 150 ± 298 kj.d-1). During aerobic training, daily EE was significantly higher than daily EI (p=0.037). Body fat mass (14,8 ± 2,9 vs 14,8 ± 2,7 %) and weight (50.6 ± 8.7 vs 49.8±10.2 kg) did not change significantly between the beginning of the week and the end of the week of training. During home confinement, no significant differ-

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ence was noted between daily EE and EI (p= 0.21). Distribution of macronutrients in daily EI differed between the two periods. Daily relative protein intake was significantly lower (p= 0.04) during strenuous aerobic training (14.7%) than during home confinement (20.7%). However, daily relative carbohydrate intake was significantly higher (p= 0.034) during strenuous training (54.6%) than during home confinement (49.3%). No significant difference was noted for daily relative lipid intake between the two periods.

Discussion

Our results highlight the implementation of mechanisms to regulate energy homeostasis of young swimmers. An increase of daily carbohydrate intake during the strenuous aerobic training supports a specific regulation of macronutrient availability

Conclusions

Fine regulation of energy balance was observed despite large changes in metabolic constraints in adolescent swimmers. Compensatory adaptations of energy and macronutrients intake in response to a strenuous week of aerobic training were also noted in this population.

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Keywords: energy balance, adolescents, macronutrient, body mass

The Effects of Menstrual Cycle Phase on Elite Athlete Performance: a longitudinal and prospective study

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In elite athletes, training individualization is widely recommended to optimize competitive performance.
Previous studies have evidenced the impact of hormonal fluctuations on different performance parameters among female athletes, but the parameters themselves, the magnitude and the direction of the effects are inconclusive. While consideration of menstrual cycle phases as a parameter in training individualization strategies is necessary, systematic evidence identifying such impacts in elite athletes should be evaluated. Additional longitudinal and prospective studies to systematically monitor on-field performance parameters are urgently required to enable recommendations and training individualization in female elite athletes.

The EMPOWER project proposed a longitudinal and prospective study coupled with robust statistical methods to establish and validate causal links, quantify impacts, and make reliable recommendations that can guide evidence-based future training individualizations. The follow-up started with 12 rowers and para-rowers, 8 cyclists, 1 fencer, 6 artistic gymnasts, 5 biathletes, 5 skiers and 4 cross-country skiers. During the follow-up, athletes were asked to fill in a short questionnaire every morning notably with information related to sleep, mood, training performance and feelings. On a regular basis, in each phase of the cycle, athletes had to take a saliva sample to accurately quantify five hormones (testosterone, estrogen, progesterone, DHEA and cortisol) as well as a sport-specific performance test. Every day their trainings were monitored using different connected devices (watches, power meters...) or questionnaires to quantify the training load of athletes. Before starting the protocol, we assess the necessity of such a monitoring on athlete and their need to an individualized training. First results revealed that each athlete reacts differently to issues related to their gender, and high-level athlete reacts differently from less-trained athletes. In particular, the symptoms related to menstrual cycles are different from those who practice less sport. Athletes are very sensitive to these issues, and this

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may explain the high level of compliance with the questionnaire (more than 76% of assiduity depending on the sport). Among the population of athletes monitored, we observed divergent hormonal profile. Each female athlete is different from another and does not respond similarly to training throughout the menstrual cycle. There is a variety of athlete responses to physical tests.
As highlighted in the divergent literature, responses to menstrual issues regarding performance is widely heterogeneous from one athlete to another. These findings emphasize the need for researchers and support staff to undertake menstrual cycle profiling and monitoring and continue to develop awareness, openness, knowledge and understanding of menstrual cycle.

Keywords: Female, elite athlete, women, physiology, performance, individualization, injuries, menstrual cycle, training

The Interplay Between Plasma Hormonal Concentrations, Physical Fitness, Workload and Mood State Changes to Periods of Congested Match Play in Professional Soccer Players.

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Objective
The aim of this study was to analyze hormonal, psychological, workload and physical fitness parameters in elite soccer players in relation to changes in training and match exposure during a congested period of match play.

Methods
Sixteen elite soccer players from a team playing in the first Tunisian soccer league were evaluated three times (T1, T2, and T3) over 12 weeks. The non-congested period of match play was from T1 to T2, when the players played 6 games over 6 weeks. The congested period was from T2 to T3, when the players played 10 games over 6 weeks. From T1 to T3, players performed the Yo-Yo intermittent recovery test level 1 (YYIR1), the repeated shuttle sprint ability test (RSSA), the countermovement jump test (CMJ), and the squat jump test (SJ). Plasma Cortisol (C), Testosterone (T), and the T/C ratio were analyzed at T1, T2, and T3. Players had their mood dimensions (tension, depression, anger, vigor, fatigue, confusion, and a Total Mood Disturbance) assessed through the Profile of Mood State questionnaire (POMS). Training session rating of perceived exertion (sRPE) was also recorded on a daily basis in order to quantify internal training load and elements of monotony and strain.

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Results
Significant performance declines (T1 T2 T3) were found for SJ performance (p = 0.04, effect size [ES] ES1–2 = -0.15, ES2–3 = -0.22) from T1 to T3. YYIR1 performance improved significantly from T1 to T2 and declined significantly from T2 to T3 (p = 0.001, ES1–2 = 0.24, ES2–3 = –2.54). In RSSA test, Mean sprint time [RSSAmean] was significantly higher (p = 0.019, ES1–2 = –0.47, ES2–3 = 1.15) in T3 compared with T2 and T1. Best sprint time [RSSAbest] was significantly higher in T3 when compared with T2 and T1 (p = 0.006, ES2–3 = 0.47, ES1–2 = –0.56), but significantly lower in T2 when compared with to T1. T and T/C were significantly lower in T3 when compared with T2 and T1 (T: p = 0.03, ES3–2 = –0.51, ES3–1 = –0.51, T/C: p = 0.017, ES3–2 = –1.1, ES3–1 = –1.07). Significant decreases were found for the vigor scores in T3 when compared to T2 and T1 (p = 0.002, ES1–2 = 0.31, ES3–2 = –1.25). A significant increase was found in fatigue scores in T3 as compared to T1 and T2 (p = 0.002, ES1–2 = 0.43, ES2–3 = 0.81). A significant increase (T1 < T2 < T3) was found for the tension score (p = 0.002, ES1–2 = 1.1, ES2–3 = 0.2) and anger score (p = 0.03, ES1–2 = 0.47, ES2–3 = 0.33) over the study period. Total mood disturbance increased significantly (p = 0.02, ES1–2 = 0.91, ES2–3 = 1.1) from T1 to T3. Between T1-T2, significant relationships were observed between workload and changes in T (r = 0.66, p = 0.003), and T/C ratio (r = 0.62, p = 0.01). There were significant relationships between RSSAbest and training load parameters (workload: r = 0.52, p = 0.03; monotony: r = 0.62, p = 0.01; strain: r = 0.62, p = 0.009). Between T2-T3, there was a significant relationship between Δ% of total mood disturbance and Δ% of YYIR1 (r = –0.54; p = 0.04), RSSAbest (r = 0.58, p = 0.01), SJ (r = –0,55, p = 0.01), T (r = 0.53; p = 0.03), and T/C (r = 0.5; p = 0.04).

Conclusion
An intensive period of congested match play significantly compromised elite soccer players' physical and mental fitness. These changes were related to psychological but not hormonal parameters; even though significant alterations were detected for selected measures. Mood monitoring could be a simple and useful tool to determine the degree of preparedness for match play during a congested period in professional soccer.

Keywords: training, hormones, overtraining, overreaching, recovery

Validity and Reliability of the Favero's Assioma Duo pedals Power Meter

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Introduction
The health context has forced the sports world to reorganize its practices. This is the case for cycling, where cyclists had to find tools to measure their indoor performance. Favero's Assioma Duo pedals, with their minimalist design, low weight and ease of use, are an ideal candidate in this race for power.

Methods
To challenge the pedals, 11 endurance athletes (9 men, 2 women; 4 triathletes, 4 cyclists, 3 runners) of recreational to intermediate level (weekly training 4.9 hours ± 4.1; number of years of training 10.1 ± 13.9) agreed to participate in our experiment (age 26.4 ± 11.3; height 176.1 ± 6.7; body fat 17.7 ± 4.5; lean mass 40% ± 4.6). They performed 9 randomized exercises (100W, 200W, 300W) at 75, 85, and 100 rpm in a seated position. They also performed exercises at 200, 300 and 400 W in dancing position followed by a record power profile (test that consists of developing maximum power over 10sec, 30sec, 5min and 20min). A Scientific SRM model and Favero Assioma Duo pedals continuously recorded power and cadence data.

Results and discussion
The Favero Assioma Duo pedals appear to underestimate power and cadence by 1.6% (1.48W) and 0.28% (0.26rpm) respectively, compared to the reference system, which is in agreement with the manufacturer's stated data. In dancing position, this difference is respectively of 2,4 % (6,11 W) and 0,62 % (0,43 W). At 75, 85 and 100 rpm the underestimation of power is about 1.44% (2.47W); 0.95% (1.75W) and 1.01% (1.62W). At 100, 200, and 300 W, the underestimation of rate is about 0.54% (0.46 rpm); 0.59% (0.51 rpm); 0.45% (0.44 rpm) Strong linear relationships were noticed between the two systems for rate (r2=0.944) and power (r2=0.948). A Bland-Atlman analysis revealed that in absolute value, the underestimation of power and cadence increases with the measured parameter. In relative terms, this difference normalizes. A sample of all pedal power data when the SRM was reading 200 W was collected. The sample was split into 3 subparts and a Kruskall-Wallis test was performed. This analysis proved that there was no difference between the power data of the 3 samples (p=0.858). Therefore, we concluded that the power data of the pedals are reproducible. The pedals are also sensitive as a Student's T detects a significant difference (p=0.025) between two samples from the pedals when increasing or decreasing the power by 3 Watts. The regression analysis between the pedal and SRM data allows us to propose the following equation: 0.9434x + 9.3173 which allows us to correct the pedal data to be closer to the data obtained by an SRM.

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Conclusion
This new power sensor is therefore a valid, reproducible and sensitive tool that can be used by cyclists and triathletes to measure the power they develop, whether in competition or in training.

Keywords: Cycling, cycle ergometer, mobile power meter, power output, testing

Relationships between anthropometric measurements and sensory and motor current thresholds in healthy men

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Introduction
Neuromuscular electrical stimulation (NMES) is largely adopted in sport and rehabilitation settings to improve or restore muscle function. Differences in age, sex, body composition, body impedance, and pain tolerance are all known to contribute to the individual ability to reach specific levels of current intensity [1,2,3]. Because sensory and motor current thresholds are influenced by sex and obesity, there may exist relationships between subcutaneous adipose tissue thickness and sensory excitability as well as between muscle mass and motor excitability [1,2]. The aim of this study was therefore to investigate the hypothetical relationships between anthropometric measurements and current thresholds in healthy men, for quadriceps NMES with two different modalities.

Methods
First, anthropometric measurements were done on the right thigh of 25 healthy men (27 ± 6 yrs; 178 ± 8 cm; 73 ± 9 kg): skinfold thickness at half of femur length on the anterior aspect of the thigh, estimated quadriceps cross sectional area (eCSA) [4] and estimated quadriceps volume (eVolume) [5]. Then, subjects performed three maximal voluntary contractions (MVC) of the knee extensors. Sensory, motor, supramotor and maximal tolerable thresholds were determined for two NMES protocols, in a random order: narrow-pulses (0.2 ms) applied at 50 Hz (CONV), and wide-pulses (1 ms) applied at 100 Hz (WPHF). For each protocol, current intensity was progressively increased by the investigator from 0 mA to the following levels: (a) sensory threshold, i.e., initial perception of stimulus sensation; (b) motor threshold, i.e., minimal torque production (i.e. usually 1 Nm); (c) supramotor threshold, i.e., evoked torque of 10% MVC; and (d) maximal tolerable threshold. Correlations between anthropometric parameters and current intensities required to reach each threshold were calculated.

Results & Discussion
For both NMES protocols, no relationship was observed between skinfold thickness and all tested thresholds ($p > 0.05$). Moderate but significant relationships were found between eCSA and sensory as well as maximal tolerable threshold for both protocols (R range: 0.409-0.416; $p < 0.05$),

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except maximal tolerable threshold during CONV (p=0.054). eVolume was also moderately correlated to all tested thresholds for both NMES modalities (R range: 0.422-0.531, $p< 0.05$), except sensory threshold during CONV (p=0.377). Moderate relationships were even observed between body mass and supramotor (R range: 0.435-0.562; $p< 0.05$) or maximal tolerable (R range: 0.454-0.473; $p< 0.05$) thresholds for both CONV and WPHF. Sensory excitability seems to depend more on the number/sensitivity of cutaneous and subcutaneous receptors rather than on subcutaneous adipose thickness [1]. Altogether, these results suggest that when using quadriceps NMES in healthy men, motor excitability depends on muscle mass but not on subcutaneous adipose thickness. Because electrode area was the same for all subjects, these results may be explained by the relative area of stimulated muscle that was greater for a given intensity in subjects with less muscle mass [1].

Conclusion

This study confirms the link between muscle mass and motor excitability but discards the influence of subcutaneous adipose thickness on sensory and motor excitability in healthy men. Further research is needed to confirm these findings in clinical populations.

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Keywords: Neuromuscular electrical stimulation, Skinfold thickness, Muscle mass, Current thresholds

Effect of epoch length on intensity classification and on accuracy of measurement under controlled conditions on treadmill: towards a better understanding of accelerometer measurement.

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Introduction
Accelerometers are useful tools to assess objectively physical activity (PA) level. However, the validity of the accelerometers is questionable for intermittent activities [1]. The problem with the PA level measurement during intermittent activities comes mainly from the sampling interval, also called epoch length [2]. Thus, the aim of this study was to analyze the effect of epoch length on intensity classification and on energy expenditure (EE) estimates during continuous and intermittent activities.

Methods
Ten active students exercised under controlled conditions on a treadmill for four 5min bouts by combining two effort intensities (running and walking) and two PA patterns (continuous or intermittent). Since the testing session was designed to generate a known level of moderate to vigorous PA (MVPA) for each condition, these PA levels were used as criterion measures to compare with the accelerometer measures (CRIT1). The criterion measure of EE was achieved using indirect calorimetry (CRIT2). Data obtained from the accelerometer were reintegrated into 1sec, 10sec, 30sec and 60sec epochs. Equivalence testing was used to examine measurement agreements between MVPA values obtained with the different epochs and the reference values. Mean absolute percent errors (MAPE) were also calculated to provide an indicator of overall measurement error.

Results
During the intermittent conditions, only the value obtained with the 1sec epoch was significantly equivalent to CRIT1. With longer epochs the difference increased for both intermittent conditions but in an opposite way: with longer epochs, MVPA decreased during walking but increased during running. Regarding the measurement accuracy, the pattern of variations according to the epoch length selected during the intermittent conditions was identical between walking and running: MAPE increased with the increase in epoch length.
The opposite trends were observed when compared to CRIT2. During intermittent running, EE and MVPA estimates from the accelerometer were no different from CRIT2 with 30 and 60sec

*Speaker

epoch lengths but they were different with shorter epoch lengths. During intermittent walking, no difference was observed between EE estimates and CRIT2, regardless of the epoch length. During continuous running, EE estimated from the accelerometer was significantly lower than the EE obtained with CRIT2, regardless of the epoch length. During continuous walking, no difference was observed.

Conclusion

This study highlighted the misclassification of exercise intensity based on accelerometer measurement and described the extent and the direction of this misclassification. Moreover it appeared that, if the criterion measure represents the internal load (*i.e.*, EE), longer accelerometer epochs are the most accurate for intermittent running but if the criterion measure represents the external load (*i.e.*, the actual PA in terms of exercise speed and duration), then, the shorter epochs are the most accurate. Thus by moduling epoch length it seems possible to infer different and complementary information to precisely describe the PA level.

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Keywords: Accelerometer, Physical Activity, Validity, Epoch length, intermittent activities

Effectiveness of soft versus rigid back-support exoskeletons during a lifting/lowering task.

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Problem Statement
Handling tasks induce mechanical strain in the lumbar region and are associated with the development of low back pain (LPB). Back-support exoskeletons (BSE) have been specifically designed to prevent the occurrence of LBP. Several evidences have been reported about the efficiency of BSE to limit lumbar muscular efforts during the handling tasks involving a trunk flexion/extension (Theurel and Desbrosses, 2019). However, the disparities in the protocols – including exoskeleton designs (e.g., soft (elastic) vs. rigid components), postures adopted (i.e. trunk inclination), loads lifted, task modalities (static vs. dynamic), and populations (gender, age) – likely account for the substantial differences in the results of previous studies about the effectiveness of using BSE to reduce the back muscle activity.

Objective
This study investigated the influence of design, trunk sagittal inclination (TSI), and gender on the effectiveness of BSE in reducing the erector spinae muscle (ES) activity during a sagittal lifting/lowering task.

Methodology
Twenty-nine volunteers (gender-balanced) performed an experimental dynamic trunk flexion / extension task with two BSE (soft (SUIT) vs. rigid (SKEL)), and without equipment (FREE). For ES activity analyses, the full TSI range of motion has been divided into 8 equal parts. The first four parts (P1 (84◦ ± 9.6 ◦) to P4 (14◦ ± 6.9◦)) corresponded to lifting motion (_˜ 95◦ to 2◦ of trunk flexion, 0◦ corresponding to the upright position), and the last four (P5 (15◦ ± 7.7◦) to P8 (86◦ ± 9.2◦)) to the lowering motion (_˜ 4◦, to 97◦).

Results
The impact of BSE on ES activity depended on the interaction between exoskeleton design and TSI. Using SKEL involved a significantly ($p < 0.05$) higher ES activity for P8 (+36.8%), compared to FREE and tended to reduce it for P3 (-7.2%, $p=0.06$). SUIT resulted in significant ($p < 0.05$) lower ES activity for P2 (-9.6%) and P7 (-11.1%), compared to FREE. No interaction between gender and exoskeleton was observed on ES activity over the full range of motion.

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Discussion
During the experimental task, the use of both BSE resulted in significant changes in ES activity, depending on both design and TSI. These observations are consistent with the literature. However, more surprisingly, the use of SKEL involved an increase in ES activity when the trunk was maximally flexed at the end of lowering motion. This last result could be linked to a change in the spine kinematics due to the rigid design of SKEL, contrasting with the soft design of SUIT. The effectiveness of SKEL to reduce back muscle efforts could be mainly related to the hip flexion while, the effectiveness of SUIT could depend on the spine flexion.

Conclusion
In practice, the choice of a BSE for an occupational use, between rigid and soft design, requires an evaluation of human-exoskeleton interaction in real task conditions. The characterization of trunk kinematics and ranges of motion appears essential to identify the benefits and negative effects to take into account with each exoskeleton design.

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Keywords: MSD prevention, Workload, Exoskeleton, EMG, Handling task, Low back pain.

Mechanisms modulating spinal excitability after nerve stimulation inducing extra torque

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It has been previously reported that spinal excitability following stimulation trains inducing extra torque is differentially modulated according to the stimulation frequency. A low stimulation frequency entailed a down-regulation of spinal excitability, while a high stimulation frequency led to an up-regulation of spinal excitability (6). Although some hypotheses have been advanced to explain this distinct regulation, the exact mechanisms still remain unclear. Presynaptic inhibitory mechanisms, including homosynaptic post-activation depression of the Ia afferents terminals (HPAD) (3) and primary afferent depolarizing interneurons (4), resulting in decreased neurotransmitter release at the Ia afferent-alpha motoneuron synapse were proposed to explain the decrease observed after the low stimulation frequency. On the other hand, regulation of intrinsic motoneurons' properties by persistent inward currents resulting in enhanced motoneuron response to a given synaptic input, was put forward as an explanatory mechanism for the increased spinal excitability observed after the high stimulation frequency. Consequently, the aim of the present study was to shed light on the mechanisms responsible for this frequency-dependent modulation.
To respond to this objective, three experiments were performed. A first experiment (n = 15) was led to evaluate changes in presynaptic inhibition acting on Ia afferents induced by these electrical stimulation trains, assessed by conditioning the soleus H-reflex (tibial nerve stimulation) with stimulation of the common peroneal nerve (D1 inhibition) (2) and of the femoral nerve (heteronymous Ia facilitation, HF) (3). A second experiment (n = 12) was designed to investigate HPAD (1) changes after the stimulation trains. A third experiment (n = 14) analysed changes in motoneuron intrinsic properties after the stimulation trains, by electrically stimulating the descending corticospinal tract at the thoracic level, evoking thoracic motor evoked potentials (TMEP) (5).

Main results showed that in all experiments spinal excitabilitydecreased after the 20-Hz train ($P < 0.05$), while this parameter significantly increased after the 100-Hz stimulation ($P < 0.05$). D1 and HF were not significantly modified after either stimulation, as observed in Experiment 1, while HPAD was significantly decreased only after the 20-Hz train in Experiment 2. Finally, TMEP was significantly increased only after the 100-Hz train ($P < 0.05$) in Experiment 3.

Present results corroborate the previously observed frequency-dependent modulation of spinal excitability. They further demonstrate that the decreased spinal excitability at rest observed after the 20-Hz train cannot be attributed to changes in D1 presynaptic inhibition or HF, but

*Speaker

rather to increased HPAD of the Ia afferents terminals. On the other hand, the increase of spinal excitability after the 100-Hz train can be assigned to changes in intrinsic motoneuron properties inducing an increase of their excitability. These results provide new evidence for the use of low and high-stimulation frequencies in the rehabilitation domain, according to the desired NMES-induced effect on spinal circuitry.

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Keywords: Extra torque, H, reflex, D1 presynaptic inhibition, homosynaptic post, activation depression, motoneuron excitability

Development and assessment of test-retest reliability of a new simple test to evaluate performance fatigability in adolescents and young adults: study protocol

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Introduction
More than 80% of school children are not sufficiently physically active [1]. Yet there is evidence that regular physical activity during childhood positively influences the health status of young individuals and prevents or delays the development of various chronic diseases at adult age. The increase in sedentary behaviors translates into a general decrease in physical abilities, which is one of the reliable markers of health-related quality of life. Performance fatigability, that refers to objective changes in a performance indicator (e.g. muscle strength) during and/or after a physical task is a good index of overall physical abilities. Some studies already investigated performance fatigability in adolescents (e.g. [2]). However, these protocols often require expensive and cumbersome laboratory equipment thus limiting their use in daily life settings (e.g. home, school, sport clubs). The objective of our study is to develop and assess the test-retest reliability of a simple and low-cost performance fatigability test in both adolescents and young adults.

Methods
Twenty healthy young adults will be initially recruited to confirm the sensitivity of two fatigability indicators (derived from single sit-to-stand and squat jump exercises, see below). Fifty-six healthy subjects (i.e. 28 adolescents and 28 young adults) will then be recruited. Following an initial familiarization session, each subject will perform two experimental sessions separated by 2-5 days to evaluate the test-retest reliability of the fatigability test. This test will consist in maintaining an isometric chair position against a wall. The duration of the fatiguing exercise will be progressively incremented (i.e. 15 s, 30 s, 45 s ...) until exhaustion. Immediately at the end of each stage, the subject will perform two squat jump and two sit-to-stand (from a chair) exercises. *MyJump2* [3] and *Sit to Stand* [4] mobiles Apps will be used to assess vertical jump height and sit-to-stand time, respectively. The kinetics of changes in these indicators will be used as index of performance fatigability. Heart rate, perception of muscle and respiratory efforts will also be monitored at the end of each stage.

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Results
Experiments started on 12th March 2021. Data will be analyzed once data collection is complete (planned for the end of June 2021). Test-retest reliability will be assessed using intra-class correlation coefficient and standard error of measurement. Repeated-measures ANOVAs will be performed on every dependent variable (e.g. jump height, sit-to-stand time) to assess the kinetics of performance fatigability and the potential differences between adolescents and young adults.

Discussion
This will be the first study to develop and validate an easily implemented test to evaluate the kinetics of performance fatigability in young populations. We anticipate that the low cost and ease of use of this test will favor its implementation in various contexts and populations. The use of two different fatigability indicators may eventually lead to two versions of this test that may be suitable in clinical populations exhibiting different degrees and nature of physical impairments.

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Keywords: fatigability, exercise testing, muscle function, children

Effect of motor imagery training on motor unit recruitment

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Introduction

Motor imagery is the mental simulation of an action without concomitant production of movement (Jeannerod, 1994). It is now well-established that motor imagery shares similar neural networks with those underlying actual movement execution (Decety et al., 1994). Similarly to physical practice, motor imagery training further improves motor performance, with strength gains observed on both upper (e.g. elbow flexors) and lower limb (e.g. knee extensors, dorsiflexors) (e.g., Yue & Cole, 1992 ; Zijdewind et al., 2003). Strength gains mainly result from neural factors, especially the improvement of cortical gain on motor unit networks. Common hypotheses propose that motor imagery could increase the discharge rate of the motor units. However, this has yet not been demonstrated, due to technical limitations. Recently, high-density electromyography (HD EMG) has been developed to study motor unit behavior non-invasively, hence allowing the exploration of the mechanisms underlying strength gains with motor imagery. The aim of the present study was to evaluate strength gains and changes in motor units discharge rate induced by motor imagery training of ankle dorsiflexors.

Methods

Eleven young subjects performed 5 sessions per week of motor imagery training during 4 weeks. Each training session consisted of 4 blocks of 10 maximal imagined contractions of dorsiflexor muscles (5-s on/ 10-s off) with 45 s of rest between blocks. Maximal voluntary contraction (MVC) of the dorsiflexor muscles was assessed before and after the training intervention. Participants also performed trapezoidal contractions that involved a linear increase in force to a target value at a rate of 5% MVC.s-1, 10 s of constant force at the target force, and a linear decrease in force back to the resting value at the same rate as the increase phase. Two trials were performed at each of the three target forces (35%, 50% and 70% MVC), with 3 min of rest between each contraction. HD EMG signals were recorded on the tibialis anterior muscle during the trapezoidal contractions with an adhesive grid of 64 electrodes. Motor units recruitment and derecruitment thresholds as well as mean discharge rate were analyzed. We hypothesized an increase in MVC after the 4-week motor imagery training. Based on a similar study investing the effects of actual strength training (Del Vecchio et al., 2019), we further hypothesized that recruitment threshold would decrease after training, derecruitment threshold would increase and the mean discharge rate during the plateau of the trapezoidal contraction would increase. Data are currently collected and the results will be presented during the congress.

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Keywords: High, Density Electromyography, Strength, Dorsiflexors, Discharge Frequency, Recruitment Threshold

The effect of knee joint angle on neuromuscular changes after an exercise-induced muscle damage

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Introduction

It has been well established that performing a bout of unaccustomed, predominantly eccentric exercise may result in a short (immediately post: *fatigue*) and long-lasting (> 24 h: *muscle damage*) muscle function deficit and neuromuscular function (NMF) alterations. The peripheral (i.e., muscle) changes are mainly assessed by electrical stimulation of motor nerves at rest. The characteristics of the evoked response to electrical stimulation could inform about the mechanical and contractile state of the muscle. These mechanical and contractile properties are known to be modified by joint angle (short vs. long muscle lengths). However, the effect of joint angle on NMF alterations evaluated after fatiguing and/or damaging exercise is currently debated, possibly because of differences of resting stiffness across muscles and lengths. The first aim of the present study was to investigate whether the most commonly NM function assessments were differently affected by the articular joint angle after a fatiguing/damaging exercise. We hypothesized that NMF would be less affected at long muscle length compared to short muscle length owing to the higher resting stiffness and greater force transmission. The second aim was to investigate whether the muscle-tendon complex, within a muscle group, would be differently modified by articular joint angle after exercise.

Methods

12 participants performed a 45-min downhill walking (DW) on a treadmill with a load 30% of the body mass, at a 25%-gradient and a velocity of 4.5 km.h-1. NMF assessments, delayed-onset muscle damage (DOMS), knee range of motion (ROM), muscle architecture and ultra-fast imagery parameters, creatine kinase (CK) and myoglobin (Mb) were assessed before (PRE), within 1h (POST) and 4h after the exercise (POST), and the days after exercise (24h, 48h, 72h and 168h). Maximal voluntary contraction and evoked torque of the knee extensors (KE) were measured from the participant's right leg which was fixed at 40◦ (SHORT), 90◦ (NEUTRAL), 120◦ (LONG). Peripheral properties of the KE muscles were assessed from the amplitude of potentiated responses to single (Tw) and low/high frequency double (Db10Hz and Db100Hz)

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electrical stimulations at rest. Rate of torque development (RTD) and contraction time (Ct) were also calculated for Tw. Muscle architecture and muscle stiffness were evaluated using B-mode ultrasound and ultra-fast sequences among different KE muscles.

Results
A significant time x angle interaction effect was found for Db10/Db100, Db10hz, RTD and Ct. Db10/Db100 was significantly different between LONG (-20.6 ± 7.6%) and SHORT/NEUTRAL (-33.6 ± 20.2%, -31.0 ± 14.6%; respectively) only at POST. Db10 was significantly different between SHORT (-46.1 ± 19.3%) and LONG (-34.4 ± 14.1%) only at POST. RTD was significantly different between LONG (-6.4 ± 14.8%) and SHORT/NEUTRAL (-41.2 ± 20.9%, -31.0 ± 15.1%, respectively) only at POST. Ct was significantly different between SHORT (+1.1 ± 8.7%) and LONG (-23.9 ± 12.0%) only at POST. Biological and imagery parameters analysis are in progress.

Conclusion
Our results showed that peripheral alterations are less pronounced at LONG compare to SHORT immediately after the exercise, possibly because of the mechanical state of the muscle-tendon unit. NMF should be evaluated at several articular joint angles in order to better understand changes of the mechanical state of the muscle after fatiguing/damaging exercises.

Keywords: neuromuscular fatigue, eccentric, exercise, induced muscle damage, elastography, ultrasound

Validity of the indirect biomarkers used in exercise-induced muscle damage: A systematic review with meta-analysis

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Introduction
It has extensively been reported that performing unaccustomed, prolonged and/or vigorous exercise may result in exercise-induced muscle damage (EIMD). Muscle function measured at 24-48h is considered a reliable, valid and indirect marker of the degree of EIMD. However, early measurements (< 2h) must be interpreted with caution because these measures may reflect a combination of muscle damage and muscle fatigue rather than muscle damage alone. In the clinical and sport context, it is important to identify valid and/or early markers to determine the extent of EIMD. The aim of the present work was to conduct a systematic review and meta-analysis to: 1) describe the time-course of the most commonly used EIMD markers for different levels of muscle damage; 2) test whether some of these markers were associated with the magnitude of strength loss.

Methods
Databases were searched using the following terms: *("muscle damage" OR "muscle injury" OR "EIMD") AND (contraction OR exercise) AND (strength OR MVC OR torque OR force OR "muscle function" OR "neuromuscular function" OR "maximal voluntary contraction") NOT ("mouse" OR "Mice" OR "rat" OR "animal").* 2209 articles were then screened for eligibility using the following criteria: (1) they implemented a model to study EIMD of the lower limb muscles in healthy human's adults (2) the outcome included valid measures of strength at least two times (before and 24h or 48h after exercise) combined with the evaluation of at least one indirect marker of EIMD (3) they did not use recovery techniques or others interventions (4) they

*Speaker

reported all necessary data to calculate effect sizes. Standardized mean differences of the most commonly used EIMD markers were calculated for each experimental group at several timing of measurement ($<$ 6, 24, 48, 72, $>$ 96h). Meta-regressions were performed to determine the association between the largest decrease in maximal voluntary contraction (MVC) force observed at 1-2 days after EIMD and muscle damage biomarkers kinetics. In order to compare EIMD markers changes across different levels of MVC force reduction (i.e., 24h – 48h), a k-medoids analysis was performed to identify clusters.

Results and discussion
Experimental groups were classified into three clusters with low, moderate and high MVC reductions. Meta-Analyses were performed for jump height (JH), range of motion (ROM), limb circumference, delayed-onset muscle soreness (DOMS), pressure pain, creatine kinase (CK), myoglobin (Mb), lactate dehydrogenase, interleukin-6, rate of force development (RFD), evoked response, voluntary activation level (VAL), transverse relaxation time (T2). Meta-regressions showed significant correlations between peak changes in maximal voluntary contraction (MVC) and changes in JH ($<$ 6, 24 ,72h), ROM ($<$ 6, 48h) CK (72h), Mb ($<$ 6h), DOMS ($<$ 6, 48, 72, $>$ 96h), RFD (24h), VAL ($<$ 6, 72h), evoked response (24, 48, 72, $>$ 96h) and T2 (24, 48h).

Conclusion
The time-course of the most commonly used EIMD markers could vary as a function of levels of muscle damage (low, moderate and high). Kinetics of biomarkers of EIMD must be interpreted cautiously between studies and take into account methodological factors which could determine the extent of the strength loss.

Keywords: meta, regression, eccentric exercise, EIMD, rhabdomyolysis, neuromuscular function, creatine kinase, myoglobin, DOMS.

Influence of core stability on knee joint loading during change of direction

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Anterior cruciate ligament (ACL) rupture is a major injury occurring frequently during non-contact changes of direction. Trunk position and control have been identified in the literature as risk factors. Indeed, an elevated knee joint loading possibly stems from higher lateral trunk motion [1]. The role of the pelvis motion in 3D and of the trunk displacement in the frontal or transversal planes on peak knee abduction moment (PKAM) is still debated in the literature [2-3]. Thus, the purpose of this study was i) to understand core kinematic parameters predicting PKAM, and ii) to determine neuromuscular parameters controlling core kinematics.
Twenty-seven males, practicing either handball or karate, participated in the study (age: 24.3 ± 6.6 years old; height: 1.79 ± 0.06 m; mass: 73.3 ± 7.1 kg). Participants were asked to perform three different unanticipated tasks on a force plate (1000 Hz, Bertec Corp, Columbus, Ohio) in a randomized order, including a cross-over to -20◦ to the left, a straight forward deceleration and a cutting maneuver to 45◦ to the right. Kinematics was captured in 3D at 100 Hz (SIMI Reality Motion Systems, Germany). The PKAM was calculated by inverse dynamics. Surface electromyography recordings (EMG) of the rectus abdominis, the external oblique, the erector spinae, the gluteus maximus (GMax) and of the gluteus medius (GMed) of the right and left sides were recorded at 1000 Hz (Trigno™, Delsys, Natick, MA, USA). From the EMG – RMS of these muscles, directed co-contraction ratios (DCCR) were computed for each functional movement of the trunk and the pelvis. DCCR expressed the ratio between agonists and antagonists with respect to body direction. To investigate pelvis lateral lean neuromuscular control, only GMed and GMax RMS were used. Data was only analyzed for the 45◦ cutting task. A total of 162 trials were used to perform linear mixed model analyses to predict PKAM at the initial contact (IC) and during the weight acceptance (WA), using kinematics and ground reaction forces (GRF). Significant core kinematic predictors were then associated with neuromuscular parameters in another model.

Core kinematics predicted significantly PKAM at IC and during the WA ($p < 0.05$). At IC, trunk lateral lean (estimate = 33.9, CI = [15.9; 51.9]), trunk axial rotation (estimate = 13.1, CI = [1.6; 24.6]) and pelvis anterior tilt (estimate = 20.4, CI = [2.3; 38.5]) predicted PKAM. During the WA, trunk axial rotation (estimate = 11.8, CI = [3.0; 20.6]), pelvis lateral lean (estimate = 23.2, CI = [2.7; 43.7]) and peak posterior GRF (estimate = 40.9, CI = [10.0; 71.7]) predicted PKAM. Therefore, an increase of trunk lateral lean at IC is linked to an increase of PKAM. Moreover, the rotation of the trunk towards the new direction seems to be, during unanticipated sidesteps, related to an increase of PKAM. Interestingly, pelvis kinematics impact PKAM in the frontal and sagittal planes. Besides, at IC, trunk lateral lean was predicted by the lateral DCCR

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(estimate = 3.11, CI = [1.38; 4.85]), while rotation DCCR didn't predict trunk axial rotation, and pelvis anterior tilt was predicted by pelvis DCCR (estimate = 3.11, CI = [1.38; 4.85]). During the WA, rotation DCCR didn't predict trunk axial rotation, whereas pelvis lateral lean was predicted by left GMed (estimate = 0.030, CI = [0.011; 0.049]) and right GMed (estimate = -0.026, CI = [-0.044; -0.007]) and GMax (estimate = -0.081, CI = [-0.156; -0.006]). Thus, DCCR can predict core kinematics in the frontal and sagittal plane but can not in the transversal plane.

Pelvis and trunk are therefore implied in knee joint loading and performance [4], and DCCR seems to be a functional ratio helping the understanding of neuromuscular control during complex and dynamic movements.

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Keywords: trunk lateral lean, trunk rotation, pelvis, neuromuscular control, knee abduction moment, ACL

Melatonin supplementation ameliorates cellular damage and physical performances recovery during an intensive training schedule

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Introduction

It is well established that intensive physical training induces muscle damage that can contribute to fatigue and injuries. In this context, several studies have reported that optimized nutrition, notably in terms of increased content of nutritional antioxidants, may reduce fatigue (McKenna et al. 2006), and facilitate muscle recovery (Ives et al. 2017). In this regard, numerous studies addressed the potential role of melatonin (N-acetyl-5- méthoxytryptamine) (MEL) supplementation to help athletes tolerate increased training loads and demanding competitive schedules (Leonardo-Mendonça et al. 2017; Ortiz-Franco et al. 2017). The present study aimed to evaluate the effect of daily melatonin supplementation on the recovery of repeated sprint (RSA) performance and cellular damage after an intensive training camp (TC).

Methods

Twenty soccer players performed an RSA test before and after an intensive six-day TC associated with nocturnal MEL (5 mg) (n = 10) or placebo (n = 10) ingestion. Resting and post-RSA

*Speaker

test blood samples were obtained before and after the TC for the assessment of the biomarkers of muscle and hepatic damage.

Results
Compared to placebo, MEL intake decreased resting biomarkers of cellular damage (i.e. creatine kinase (CK)). It also lowered post-exercise levels of these biomarkers (i.e. CK, aspartate aminotransferase (ASAT), alanine aminotransferase (ALAT)). MEL also helped to reduce the drop in performance observed after the TC ($p < 0.05$) and decreased muscle pain ($p < 0.05$).

Discussion
Our findings suggests a protective effect of melatonin on skeletal muscles. This is in accord with previous reports showing that melatonin decreases markers of muscle injury in rats (Hibaoui et al. 2011) and humans (Chahbouni et al. 2010; Leonardo-Mendonça et al. 2017) and improves muscle function (Hibaoui et al. 2011).

Significant difference in RSA performances after TC might be due to greater deterioration of the performance of those in the placebo group rather than improvement in the performance of the melatonin group. The present findings could be attributed to melatonin-induced improvement in sleep quality and quantity (Cheikh et al. 2018).

Conclusion
Nocturnal MEL supplementation during an intensive TC alleviated cellular damage and muscle pain and improved recovery of RSA performance in soccer players.

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Keywords: cellular damage, exhaustive training, recovery, melatonin

Circulating microRNAs after a 24-h ultramarathon run in relation to muscle damage markers in elite athletes

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Introduction

Ultra-endurance sports are growing in popularity but can be associated with adverse health effects, such as exercise-induced muscle damage (EIMD), which can lead to exertional rhabdomyolysis. Although delayed loss of muscle function (i.e. 24-48 h) is considered to be the best indirect marker to evaluate the magnitude of EIMD, measurements within a few hours after the end of exercise may reflect a combination of muscle damage and muscle fatigue rather than muscle damage alone. Moreover, the most commonly used biomarkers of EIMD (Creatine kinase and Myoglobin) are affected by high inter-individual variability and does not necessarily reflect the magnitude of delayed loss of muscle function. MicroRNAs (miRNAs), small non-coding RNA involved in the post-transcriptional regulation of gene expression, may be useful for the accurate evaluation of the degree of EIMD. Indeed, muscle specific/enriched miRNAs (also called myomiRs) can be actively secreted by or passively leak out of injured myocytes and measured in the blood. Thus, we aimed to: 1) investigate the relevance of circulating myomiRs as biomarkers of muscle damage and 2) examine the acute response of skeletal/cardiac muscle and kidney biomarkers to the 24-h run World Championships in elite athletes.

Methods

Athletes of the French national team (n = 11) participated in the 24-h Run World Championships. Counter-movement jump (CMJ), delayed-onset muscle damage (DOMS), creatine

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kinase (CK), myoglobin (Mb), creatinine (Cr), high-sensitivity cardiac troponin T (hs-cTnT) and muscle-specific miRNAs (myomiRs) levels were measured before (PRE), immediately after (POST), 24 and 48h after the race.

Results
CMJ height was reduced immediately after the race (-84.0 ± 25.2%, $p < 0.001$) and remained low at 24h (-43.6 ± 20.4%, $p = 0.002$). DOMS (53 ± 30 mm, $p < 0.05$), CK activity (53,239 ± 63,608 U/L, $p < 0.001$) and Mb concentration (9,748 ± 7,997 ng/mL) increased immediately after the race and remained elevated 24h after ($p < 0.01$). The hs-cTnT concentrations were significantly higher at POST (34.1, ± 18.3 ng/L, $p < 0.001$) compared to PRE values (6.3 ± 2.3 ng/L). There were no significant differences in Cr levels or estimated glomerular filtration rate between PRE and POST, 24 h or 48, but the values were significantly lower at 24-48 h than at POST ($p < 0.01$). Circulating myomiRs levels (miR-1-3p, miR-133a-3p, miR-133b, miR-208a-3p, miR-208b-3p, and miR-499a-5p) were elevated immediately after the 24-h run (fold changes: 18–124,723, $p < 0.001$). The CMJ height loss at 24h was significantly ($p < 0.05$) or tended to be significantly ($p < 0.07$) correlated with a set of myomiRs, but not with CK ($p = 0.23$) or Mb ($p = 0.41$) values.

Conclusion
All elite ultramarathon runners included in our study were diagnosed with hyperCKemia (CK > 10,000 U/L) after the 24-h run World Championships. However, despite the high level of sarcoplasmic proteins into the bloodstream, the deterioration of kidney function was moderate and transient in this population. The elevation of cardiac biomarkers was likely due to exercise-related cytosolic release rather than cardiac necrosis. Importantly, the present study is the first to show that the circulating levels of muscle-specific miRNAs may reflect the muscle function loss 24h after EIMD, suggesting myomiRs may be a useful to approach the magnitude of muscle damage. MyomiRs may have a future interest in the diagnosis of muscle damage both in sport medicine and in the monitoring of physical activity.

Keywords: exercise, rhabdomyolysis, ultra endurance, muscle function, cardiac stress, acute kidney injury, biomarkers

De la biomécanique de course spontanée à l'épidémiologie des blessures.

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Introduction
La course à pied est l'une des activités sportives les plus populaires au monde. Elle est pratiquée à des fins de santé, mais n'est pas pour autant dénuée d'effets indésirables. Nous proposons dans cette étude épidémiologique, d'analyser les liens existent entre l'évaluation globale du style de course choisi spontanément par le coureur (telle que définie par la méthode Volodalen) et les blessures de surcharge liées à la pratique. L'approche conduite par Volodalen distingue le long d'un continuum, un modèle de course *Aérien* (AER) fondé sur le stockage et la restitution d'énergie élastique ; et un modèle de course *Terrien* (TER) basé sur l'horizontalité avec un long temps de contact, un temps de vol réduit et une faible oscillation verticale. Nous émettons l'hypothèse que ces manières différentes de courir pourraient être associées à des blessures différentes.

Méthodes
Les données anthropométriques (âge, sexe, taille, poids, IMC) ; d'entraînement (années d'expériences, activité hebdomadaire, fréquence d'entrainement, autres activités physiques) ; des chaussures de course (marque, modèle, poids, drop, hauteur du talon) ; et de l'historique des blessures (examen clinique, localisation, pathologie, douleur) ont été collectées via une enquête rétrospective en ligne menée depuis décembre 2020 à l'échelle mondiale. Deux entraîneurs expert en course à pied ont noté subjectivement avec l'échelle Volodalen® le style de course des participants. Ce score subjectif global a permis de classer les coureurs en deux catégories (AER et TER). Une analyse des proportions des blessures entre AER et TER a été mesurée à l'aide du Test du Chi-2. Le niveau de significativité a été fixé à $p < .05$.

Résultats
Sur les 322 coureurs ayant répondus, les expérimentateurs ont identifiés 169 AER et 153 TER. Au total, 152 coureurs déclarent avoir eu au moins une blessure liée à la pratique de leur sport au cours des douze mois précédant l'étude. La fréquence des blessures pour les AER (0.52 blessures par coureur par an) est similaire aux TER (0.48 blessures par coureur par an). Concernant la localisation anatomique, le genou constitue la région la plus touchée (31.1%) suivis par la

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cheville et le pied (27.0%), qui représentaient plus de la moitié des blessures signalées, avec une différence significative entre les deux catégories de coureurs ($p< .05$). Parmi les pathologies courantes, le syndrome de la bandelette ilio-tibiale (9.9% AER et 7.2% TER), la tendinopathie Achille (8.6% AER et 5.4% TER) et la lombalgie (0.9% AER et 5.4% TER), sont les plus fréquemment relevées, avec une différence significative entre les deux groupes ($p< .001$).

Discussion/Conclusion
Les résultats de cette enquête rétrospective en ligne montre une distribution des blessures liées à la course différente entre les coureurs AER et TER, contrairement aux taux d'incidence qui sont statistiquement non différents. Les coureurs AER favorisent une foulée verticale, appliquant une force de réaction au sol plus importantes permettant une meilleure restitution d'énergie élastique, ce qui explique les blessures de tendinopathie d'Achille chez ces coureurs, contrairement aux coureurs TER qui atténuent les forces de réaction avec une flexion proximale de hanche-genou, et une pose de pied en talon, semblable à un risque important de blessure au genou. Des études complémentaires axées sur une analyse prospective et des évaluations régulières, sont nécessaires pour expliquer les blessures.

Keywords: Course à pied, blessures, étiologie, épidémiologie, biomécanique

Psychology - Education sciences

Changes in motivation towards physical activity during interventions for adults with chronic diseases: systematic review and meta-analysis

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Introduction
Physical activity (PA) has positive health-related effects in adults with chronic diseases. Because motivation is a proximal determinant of PA, a better understanding of how interventions can increase motivation in this population is needed to improve their efficacy. According the M-PAC approach **(Rhodes, 2017)**, motivation refers to several constructs linked to one of the three phases of the behavior change process (intention formation; adoption of action control; maintenance of action control). There is currently a lack of research exploring constructs representative of all three phases **(Knittle et al., 2018)**. The present meta-analysis aims to assess the efficacy of behavior change interventions in impacting motivation for PA in adults with respiratory, metabolic, and/or cardiovascular chronic diseases. In addition, this review seeks to identify clinical and intervention characteristics associated to this efficacy, including disease, mode of delivery, nature of motivational outcome and behavior change techniques (BCTs) using v1 taxonomy **(Michie et al., 2013)**.

Methods
The electronic bibliographic databases consulted were PubMed, PsycINFO, Web of Science and Open Grey. Studies involving adults ($\geq$ 18 years) with chronic cardiovascular and/or respiratory and/or metabolic diseases were included. For study design, only randomized control trials (RCT) were eligible for inclusion, and all modes of interventions explicitly targeting a change in PA motivation - measuring a motivational outcome at pre and post intervention - and/or in PA behavior were eligible. We applied a multilevel approach in order to deal with the interdependency of effect sizes.

Results
The meta-analysis was conducted on 43 studies (k=202; N=15 361); the analyses revealed a medium effect of interventions on motivation at the end of the intervention (d=0.5; 95% CI

*Speaker

[0.283;0.716]; p < .001; k = 200) and a few months after (d=0.40 (95% CI [0.008, 0.801]; p < .001; k = 30). The presence of BCT 13.2 Framing/reframing led to a higher effect on PA motivation (d=1.586; 95% CI [1.055;2.117]; p < .001; k = 16). Other BCTs as well as clinical / intervention moderators were not significant.

Discussion
There is a need for research assessing the constructs related to the sustainability of behavior change (habit and identity)and which implement BCTs associated with them (BCT 7. Associations; 8. Repetition and substitution; 13. Antecedents).

Conclusion
This meta-analysis is the first to consider a variety of constructs using the M-PAC model. The results indicate that PA interventions are effective to change motivation and the BCT framing/reframing leads to higher effects.

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Keywords: Meta analysis, physical activity, motivation, chronic disease, behavior change techniques

Social dimensions of situational interest in young adults in a exergames setting: an exploratory study

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More than 25% of people around the world do not practice enough Physical Activity (PA) (Guthold et al., 2018), which makes it a public health issue. Antecedents of motivation for PA were primarily studied through individual factors. However, from an interactionist perspective, individual motivation is influenced by interest in activity. For Deci (1992), interest is defined as an interactive individual-environment experience, supported by activity and social context. For twenty years, situational interest theory propound a construct and methodological tools (e.g., EMIS-EP ; Roure et al., 2016) to study students' interest in a learning task in Physical Education (PE). Situational interest in a PE setting has been reduced to five sources or dimensions (Chen & Darst, 2001) : novelty, challenge, attention demand, exploration intention, and instant enjoyment. Nevertheless, to date, alternative dimensions of SI have never been examined out of PE, in other PA contexts. Moreover, given the recent debates on the structure of situation interest construct (Garn, 2017), the purpose of this study is to explore and to adapt SI construct in an exergames setting and, more specifically to explore social dimensions of the situational interest construct in PA with young adults participating to solo, cooperative and competitive exergames.

A qualitative design including 20 young adults was used. They participated in exergames according to 4 conditions: (1) single player, (2) single player with peer support, (3) competition, and (4) cooperation. Three types of data were gathered: declared PA (IPAQ-SF; Craig et al., 2003), PA levels during exergames (ActiGraph GT3X+ accelerometers), and retroactive verbalizations about experiences in exergames (semi-structured interviews). The analysis followed an inductive thematic analysis steps (e.g., Braun & Clarke, 2006). Using mixed method, data relating to declared PA, PA levels and qualitative categories were processed by discriminant factor analysis to identify possible prototypical experiences.

The results will consist of dimensions that will emerge from the qualitative-quantitative data analysis. We expect an extension of the situational interest construct with the emergence of hypothetic social and context-specific dimensions. Integration of PA level data is supposed to consolidate content validity of the experience reported by participants (triangulation).

From this exploratory study, one perspective is to develop a new scale for measuring situational interest in PA, integrating the experience' social dimensions. A better understanding

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of situational interest in a exergames setting allows to design PA program, supporting lasting motivation for PA in sedentary young adults (Chen & Hancock, 2006).

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Keywords: physical activity, situational interest, social dimensions, young adults, exergames

The MoVe toward Physical Activity (MVPA) Game: A Study Protocol

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Introduction
Each year, physical inactivity is responsible for five million deaths worldwide. To counteract this pandemic of physical inactivity, many studies have examined the effects of interventions on the adoption of active behaviors. Nevertheless, meta-analyses show that these interventions exert a small effect on behaviors. At least two features explain this limited influence. First, the majority of interventions only target deliberative processes (e.g., intention). Yet, it is now widely admitted that automatic processes (e.g., approach tendencies) also govern physical activity. Only a handful of studies have developed interventions targeting automatic processes, yielding promising results. Second, previous interventions have focused on the forces driving individuals toward physical activity, but disregarded the forces restraining them to convert their intention into action. According to the theory of effort minimization in physical activity (1), individuals' ability to resist the innate attraction toward sedentary behaviors plays a key role in the adoption of active behaviors. Our study aims to develop an intervention addressing these two limitations. Using a gamified approach, we designed a smartphone videogame, the MoVe toward Physical Activity (MVPA) game, which intends to reduce the intention-action gap by developing approach tendencies toward physical activity, in the presence of sedentary opportunities.

Methods
This study will be a two-arm randomized controlled trial. Participants with a moderate-to-strong intention to be active will be included in the study (N= 70) and their approach tendencies toward physical activity will be first assessed using a manikin task. Their level of physical activity will be measured using a device-based measure (i.e., Actigraph GT3X+) during a seven-day period. Then, they will be randomly allocated to one experimental condition: the MVPA condition or the Control Game (CG) condition. In the MVPA game, participants will move their finger on the screen to move an avatar in order to follow a winding path, with the aim of traveling the longest distance as possible. To obtain bonus points, the player will have to approach physical activity opportunities by collecting related items and to avoid sedentary opportunities by getting away from related items. In the CG condition, participants will play a similar game (i.e., Temple Run) which includes bonus coins, instead of items of physical activity and sedentary behaviors. Participants in both conditions will be asked to daily play for at least ten minutes for a period of seven days. After this period, participants' approach tendencies and level of physical activity

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during a seven-day period will be measured again. Mixed-effect models will be used to compare the effects of experimental conditions on the pre-post evolution of the level of physical activity (primary outcomes) and approach tendencies toward physical activity (secondary outcome).

Results and Discussion
We predict that, in comparison with the CG condition, participants in the MVPA condition will report a greater increase of level of physical activity and of approach tendencies toward physical activity.

Conclusion
This protocol study introduces an innovative intervention, whose feasibility, acceptance and effectiveness remain to be examined.

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Keywords: Physical activity, Sedentary behaviors, Intervention, Gamification, Approach tendencies

Identifying approach and avoidance motivational attractors in sport: A cluster analysis

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Introduction
Approach and avoidance motivations have been conceptualized as two competing attractors, the landscape of which is determined by a control parameter K: K = (C × Bs) – [Ts × (1 – C)], with C as competence expectancies, Bs as benefit for the self, and Ts as threat for the self [1]. The present study aimed to bring evidence for the existence of these attractors within time series of athletes' motivational states regarding a sport goal to achieve.

Method
Five regional- or national-level athletes (3 males, 2 females; age = 17-45) from various sports (tennis, running, and kayak) indicated on an online platform their most important sport goal to achieve over the coming months. Then they responded every week to 11 items belonging to the Approach-Avoidance System Questionnaire, which measures C, Bs, and Ts with respect to the goal pursued [2], the scales Behavioral Approach (BAp) and Behavioral Avoidance (BAv) that we created specifically, and the revised Sport Motivation Scale (SMS-II) [3].
To allow the analysis of sufficiently long time series, only participants who responded to the items for at least 50 weeks were retained (i.e., two men for 87 and 62 weeks). Times series of Z scores of the parameter K (as calculated from the values of C, Bs, and Ts), as well as BAp, BAv, and a Perceived Autonomy Index (PAI) calculated from the scores of the scales of the SMS-II [4] were analyzed using cluster analyses. The non-hierarchical k-means analysis method was used to test hypotheses with two (approach, avoidance) and three (approach, avoidance, neutral) recurrent motivational patterns within each time series.

Results
For both participants, only two clusters could be clearly identified (see Figure below).
For participant 1, one cluster-the adaptive cluster-included K, BAp, and PAI positive, as well as BAv negative ($n = 44$), and an opposite cluster-the maladaptive cluster-included K, BAp, and PAI negative, as well as BAv positive ($n = 43$). The same clusters were observed for participant 2 ($n = 47$; $n = 15$), except that PAI was close to 0 for both clusters.

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Discussion and Conclusion
This two-cluster solution emerging from time series supports the two-attractor dynamics that has been proposed in the dynamical model of approach and avoidance in achievement context [1]. This support needs to be confirmed more broadly, for every gender and in various achievement contexts.

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Keywords: approach motivation, avoidance motivation, attractors, cluster analysis

Effects of exergames on situational interest and physical activity in high school students: a pilot program in Physical Education

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Introduction
Less than half of French people over 15 meet the recommendations of the World Health Organization in terms of physical activity (PA). Exergames (digital games involving whole body movements) could be introduced in Physical Education (PE) to arouse students' interest and increase their PA (Trout & Christie, 2007). Situational Interest (SI) is an individual's form of intrinsic and ephemeral motivation for an activity or content (Chen & Darst, 2001). However, the issue of maintaining IS, beyond a discovery phase of a novel activity, has been little addressed until now (Roure et Pasco, 2017). The objective of this pilot study was to design a PE program based on exergames in order to maintain SI and moderate-to-vigorous PA (MVPA) in high school students throughout the five weeks of program implementation.

Method
45 students from two high schools in Brest (France) took part in this program during their PE lessons. This five-week pilot program was developed by a research team, based on three different exergames . This program's design was based on the different dimensions of SI that were supposed to sustain motivation and PA over time. Repeated measures were performed during PE lessons. Accelerometers were used to record PA intensity during each session. SI 19 items questionnaire (Roure et al., 2016) was used to collect SI on lesson 1 and 3.

Results
The program had negative effects on students' SI and positive effects on their PA displayed during the lessons. MVPA increase between first lesson (M=39.326; SD=9.259) and second lesson (M=44.683; SD=11.479; $t(23)=-3.678$, $p< .01$) and decrease between second and fourth lesson (M=39,497; SD=11,763; $t(20)=2.155$; $p< .05$). Moreover, the overall decreasing is not significant and the percentage of time spent in MVPA is 39.56% in 4 lessons. SI decrease from lesson 1 (M=16.379; SD=3.401) to 3 (M=14.550; SD=5.559) $t(26)=3.229$, $p< .01$). SI average obtained over all sessions is 16.47 (min 5, max 25).

Discussion
These results partly agree with those of Sun et al. (2013) which conclude that PA increases, but SI decreases over the course of an exergames program in PE. First, 39.56% MVPA is very

*Speaker

positive, compared to a study of 232 middle school students reporting an average of 25% MVPA in conventional EP (Brusseau & Burns, 2015). SI average over all sessions is also a positive result compared to SI measure in conventional PE carried out on 422 students in France, with an average score of 14.1 (Allard-Latour et al., submitted).

Conclusion

This 5-week program, based on exergames, appears to be beneficial for SI and effective PA compared to conventional PE. It offers a favourable prospect for the promotion of PA to a type of public that is little involved in practicing PE outside the school setting, thanks to its design oriented towards increasing the SI. However, it remains to test the hypothesis of the transformation of IS into a more stable "individual interest" in PA on programs of a longer duration.

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Keywords: situational interest, physical actvity, exergames, physical education, program

Why do adolescents like watch risky sports programs on television? A protective frame approach

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Introduction
Technology and media are often involved in high-risk sports (Fischer et al., 2011). The amount of TV adolescents watch may be likely to bias their views of high-risk behavior and it may lead to rekless risk taking (Russell & Buhrau, 2015). The study explored the psychological links that may exist among adolescents between the feeling of being threatened and the perceived risk of sports situations, the interest for television sports programs, and the interest for conversations about these television sports reports. Within the reversal theory, the concept of protective frame could explain these links (Apter, 2001). It was never tested among adolescents from quantitative approach to understand the attractiveness for risky sports program on TV.

Method
The participants were 181 adolescents ($Mage = 15.23$; $SD = 1.76$). As in Fruchart et al. (2018), there were six questionnaires. Each of them presented 15 sports situations where the risk involved varied, and each of them focused on a singular dimension : (1) the degree of threat, (2) the perceived risk, (3) the amount of personal experience, (4) the viewing habits, (5) the degree of interest for television sports programs, (6) the degree of interest shown for participating in conversations about these sports programs. Bivariate Pearson's correlations between the assessments under the six dimensions were conducted.

Results
The main findings were that (i) the more the sports were considered threatening and perceived as risky, the more the participants were interested in watching these sports on television and to talk about these television programs and (ii) the perception of risk was more associated with the threatening character of the real sports situations (no protective frame) than with the interest for watching (one protective frame) and for hearing conversations (two protective frames) about TV sports programs.

Discussion/Conclusion
The findings were consistent with Fruchart et al. (2018)'s results showing that adolescents are more interested in watching frightening television programs and in choosing conversation topics about high risk situations. The protective frame explains the links between the feeling of being

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threatened and the perceived risk of sports situations, the interest for television sports programs, and the interest for conversations about these television sports reports (Kerr & Mackenzie, 2014). It is necessary to taken into consideration this concept to understand high-risk sport.

Keywords: television, protective frame, high, risk sports, adolescents

Co-construct, implement and evaluate a multilevel intervention for the prevention of sedentary lifestyle in school-aged children: the CIPRES project – protocol design and pilot study

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Background
A sedentary lifestyle is associated with higher mortality and the development of chronic pathologies. In children and adolescents, sedentary behavior for more than 2 h/day is associated with unfavorable body composition and physical condition, and lower levels of self-esteem, sociability and school level. However, more than 50% of children (6-10 years) spend on average more than 3 h/day in front of a screen, and this time continues to increase (+20 min from 2007 to 2015) [1]. In this context, designing and testing effective interventions to decrease sedentary behavior in children is a major public health research gap.
Objective: The CIPRES intervention is co-constructed with key local actors, multilevel with a socio-ecological approach [2], and theory-based on the transcontextual model [3]. The CIPRES intervention aims to reduce sedentary time in school-age children (7-10 years). A secondary aim is to evaluate the effect of the CIPRES intervention on sedentarity according to social deprivation level.

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Methods
The intervention will be evaluated by a cluster-randomized and controlled study. The target population will be made up of 1000 children in CE2-CM1 from primary schools in 4 towns in Toulon area with different levels of social deprivation. The study involves 2 phases: (1) Co-construction of an intervention for sedentary prevention adapted to the local context by using a participatory approach including representatives of each "level" of actor (i.e., children, teachers, parents, associative and municipal staff, educational advisers). (2) Implementation of the intervention in the local context [4]: the intervention lasts 6 weeks and aims to reduce sedentary behavior at different times in the child's life: school, after-school and family times. The effects of the intervention will be assessed before (T0), after the intervention (T1) and 6 months after the end of the intervention (T2). Main outcomes include sedentary behavior, level of physical activity, sleep, and variables of the transcontextual model (i.e., motivation, attitudes, norms, perceived control, intentions), and will be measured by accelerometry, diary or questionnaires.

Results/discussion
A pilot intervention was co-constructed and a feasibility study is currently underway. This feasibility study involves around 90 children from primary schools. The first results on the feasibility of the implementation and the pre- vs post-intervention effects on children's sedentary time and variables of the transcontextual model will be available by summer 2021.

Conclusion
The CIPRES study will assess a multilevel intervention aiming at reducing sedentary behavior in school-aged children. The intervention is based on the socio-ecological perspective and relies on a participatory design, in line with recent concerns regarding complex public health programs, social inequalities and the need to combine both agentic and structural strategies in such interventions.

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Keywords: sedentarité, activité physique, intervention, enfant, inégalités sociales

Contextualisation de l'activité physique traditionnelle EKIENGA en éducation physique à l'école primaire

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L'éducation physique et sportive (EPS), en intègrant la dimension corporelle (Caumel, 2000). Pour cela, elle utilise les Activités Physiques et Sportiveset Artistiques comme moyens d'enseignement. Parmi celles-ci, figurent de nos jours les Activités Physiques Traditionnelles (APT), conformément aux recommandations de l'UNESCO. Face à la menace d'une disparition des APT au Congo-Brazzaville, nous nous sommes investis activement pour sauvegarder ces APT et maintenir les traces de cette culture physique populaire. C'est dans ce cadre que nous avons mené une dissertation doctorale en 2012 sur "*Recontextualisation des activités physiques traditionnelles à l'école primaire en République du Congo"* (Lembé, 2012), suivie d'autres travaux (Lembé et al., 2020, 2019). Ces études ont permis d'effectuer une ethnographie minutieuse des APT congolaises et montrer l'existence des logiques internes au sein des APT congolaises suivantes : Ekienga, Mfongo et Ndzango, en se focalisant sur leur décontextualisation en vue de leur intégration dans l'enseignement de l'EPS à l'école primaire congolaise. La présente étude qui poursuit les précédents travaux, a pour but d'identifier et analyser les comportements moteurs des pratiquants de l'activité traditionnelle congolaise Ekienga, et proposer des contenus d'enseignement de cette activité à l'école primaire dans le contexte de l'EPS. Elle s'est appuyée sur la théorie de Parlebas (2003) qui traite du processus de sportification des pratiques corporelles régionales. Notre réflexion part du questionnement suivant : l'intégration d'Ekienga dans l'enseignement de l'EPS concourt-t-elle à aboutir à la mise en valeur de cette APT et de sa spécificité ? L'hypothèse qui en découle peut être ainsi formulée : si Ekienga se pratique selon la logique interne existante, sa décontextualisation peut permettre son intégration dans l'enseignement de l'EPS à l'école primaire. La recherche, observationnelle et didactique, s'est reposée sur l'évaluation des gestes corporels réalisés au cours d'Ekienga chez 34 hommes adultes, et la construction de programmes d'enseignement. Après filmage des pratiques d'Ekienga chez ces sujets, le décryptage et le séquençage des films ont été effectué. Par la suite, en s'appuyant sur la logique interne d'Ekienga, des contenus d'enseignement ont été élaborés dans le but de contextualiser la pratique d'Ekienga chez des écoliers congolais au cours d'éducation physique. Les principaux indicateurs évalués, en lien avec les gestes corporels exécutés, étaient : 1) la vision périphérique pour apprécier le mouvement de l'engin ou de la cible ; 2) l'angle d'ouverture du bras pour le lanceur et la posture idéale pour le rouleur du cylindre ; 3) la position des sujets de l'autre groupe et du cylindre roulant ; 4) les capacités relationnelles ; 5) l'anticipation et l'adresse. Deux barèmes descriptivo-numérique de type Likert élaborés dans les études antérieures ont été utilisés. Les résultats obtenus montrent que la logique interne d'Ekienga permet la construction de savoirs et des contenus d'enseignement pertinents en éducation physique à l'école primaire

*Speaker

au Congo. De plus, les contenus d'enseignement d'Ekienga, ont permis d'élaborer des savoirs à enseigner en termes d'objectifs et de contenus notionnels.

Keywords: activité physique traditionnelle, Ekienga, savoirs, contenus d'enseignement, éducation physique

Effectiveness of multilevel interventions based on socioecological model to decrease sedentary time in children: a systematic review of controlled studies

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Introduction
Preventive actions of sedentary behavior and/or promotion actions of physical activity (PA) are needed among children and adolescents as their physical activity level decrease with age, progressively replaced by sedentary behaviors (1), mainly screen-related activities. Intervention strategies often focus on intraindividual factors, mainly according to the social cognitive theories (2). However, to be effective, public health interventions must consider health behaviors in the light of the contexts in which they take place. In this perspective, the socio-ecological model is of particular interest, as it involves consideration of multiple levels of agency from macro to micro, and focuses on the interrelationships between individuals and the social, physical and policy environment (3).
The aim of this systematic review is to evaluate the effectiveness of multilevel controlled interventions (or targeting at least 2 levels) in reducing sedentary time (ST) in young populations aged 5-14, without any disease.

Methods
According to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, articles were searched in 3 databases (PubMed, PsycInfo and ERIC). Trials were stratified depending on their methodological quality (using an 11-item scale derived from the Cochrane tool). We applied the PICOS method to check if the data fit the inclusion criteria. Moreover, trials were stratified according to the number of levels targeted, and type of strategies (e.g., informative, behavioral) used in each level. Degree of involvement of caregivers were also described.

Results
40 studies were included (for a total of 6572 publications screened). Trials mostly showed acceptable (scoring > = 6, n = 35) to high (> = 8, n = 25) methodological quality. Most of interventions targeted sedentary factors in three levels (n= 27), mainly with a combination of intrapersonal, interpersonal, and organizational levels. More than half of them (n= 14) were efficient in reducing ST. Few trials (n = 10, 8 studies being efficient) targeted four levels (i.e., intra, inter, organizational and community), and no intervention achieved to target the macro-environment or public policies level. Studies mainly used a combination of informational and behavioral strategies (e.g., key learning messages and active break in class). Most of studies

*Speaker

actively engaged caregivers (i.e., parents, teachers, educators), using not only informational, passive approach (e.g., newsletter sent to parents) but also involving them as a key target of the intervention (e.g., giving homework family activities).

Discussion
Overall, in line with previous works, our findings showed a high heterogeneity (e.g., duration, settings, strategies), but suggest that interventions tend to be more effective when they involve several levels, targeting intrinsic determinants (e.g., with strategies using behavioral strategies), in the organizational environment of the child (i.e., school, home), including an active and high involvement of caregivers (e.g., parents, teachers).

Conclusion
Findings of this review underline the relevance of multilevel strategies using both agentic and structural strategies to reduce ST in young populations. A systemic approach as the socio-ecological model is thus relevant, but still represents a challenge to operationalize in public health interventions (4).

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Keywords: sedentary time, interventions, socioecological model, children

Effects of orienteering game on directional skills and geometric thinking in children 7-8 aged.

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Introduction

The child must organize the space according to himself (his body, his experience, his way of thinking) and perceive the dimensions, the shape, the limits, the layout of the places, obstacles, and this to be able to dispose of them according to their needs (Piaget &Inhelder, 1948). Indeed, Péruch&Corazzini (2001) describe spatial cognition as the ability to combine spatial information from different sources and events and to use this knowledge to estimate directions and distances and manage movements. In fact, spatial knowledge which is an integral part of school knowledge concerns sensitive space in the sense that it leads the child to master the usual relationships maintained with this space (Douaire, Emprin & Rajain, 2009). Research by Cheng and Mix (2012) also asserts that improvements in spatial thinking lead to improvements in math and geometric scores. Consequently, geometry is constituted above all in the field of sensory and mechanical experiences. The main goal of this study was to examine the effect of practicing orienteering Game OG on directional skills and geometric thinking.

Method

Forty students 7.3 years had voluntarily participated in this study. They are schooled in both mixed classes of the second year of primary school each one containing twenty students. The classes belong to the same public school and with two different teachers. But we chose two teachers with the same basic training and with the same number of years' experience. To this end, we arrange to work with an experimental group EG and a control group CG.

Our procedure would be of a quasi-experimental type and based on an OG . Our intervention program was spread over 8 weeks, with 3 sessions of 40 minutes per week. The CG followed conventional learning respecting the same hourly volume as the EG.

This program is used to, provide these children with OG that challenge their directional skills and geometric thinking through played learning situations. In this study, we used two tests:

-RTD (Topological and Directional Relation Test byLacert (2010)

-A drawing for geometric thinking

Results and discussion

The main findings from this study were: the benefits of practicing OG on directional skills. Analysis of the RTD Test results confirms them for EG in all variables at $p < 0.05$. Our results are consistent with the propositions of Piaget &Inhelder (1948) which mention that movement is at the source of spatial knowledge. In the same sense, many studies have documented the intertwined nature of motor and cognitive development. This evidence supports the embodied

*Speaker

cognition theory in which the development of cognitive processes is rooted in the physical interactions of the body with the world (Daniel 2018).
Otherwise, the child acquires during his development, first of all, the ability to orient his body, then to understand and designate his position in space, and finally to locate himself in the environment until developing a real organization of space (De Lièvre et Staes, 2012 ; Bidet-Ildéi, Orliaguet & Coello 2011).
To be represented, space must be experienced because, by moving, the child simultaneously modifies his perception of the environment and thus develops his directional skills acquisition. The drawings of the children in the experimental group also show an improvement in observed reality as well as in proportionality.
This study is one of the rare works that have been interested in studying the effect of the practice of OG on the directional skills and geometric thinking of the child, but additional studies are essential to improve his interest on cognitive and motor needs.

Keywords: Child, orienteering game, directional skills, geometric thinking

Effets du confinement COVID-19 sur les comportements d'agression chez les footballeurs à Brazzaville (Congo)

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Cette communication rapporte les résultats d'une étude exploratoire sur les effets du confinement COVID-19 sur les comportements d'agression chez des footballeurs congolais en fonction du type de violence et du poste occupé par le joueur. En effet, la pandémie de la COVID-19 qui frappe la planète est un 'événement au sens plein du terme, un surgissement imprévu qui chamboule notre quotidien, jusque dans nos gestes, nos espaces les plus intimes et nos projets particulièrement les projets de recherche. La pandémie de la COVID-19 et les mesures sanitaires pour la contenir s'accompagnent chez les individus d'une modification radicale des activités quotidiennes et des routines de vie, avec des conséquences nombreuses dont la perturbation importante des rythmes biologiques. En situation de confinement, la majorité des synchroniseurs environnementaux ou "Zeitgeber" (lumière, activité physique, alimentation, interactions sociales) se trouvent fortement modifiés voire supprimés-en conséquence, les troubles du sommeil et des rythmes veille-sommeil peuvent apparaitre. Par conséquent, le confinement est susceptible d'affecter certains paramètres psychosociologiques notamment les comportements d'agression. C'est dans ce contexte que des footballeurs présélectionnés dans l'équipe nationale masculine de football en vue du Championnat d'Afrique des Nations (CHAN) de Yaoundé-Cameroun 2021, ont été suivis tout au long du confinement. Au total, 25 footballeurs ont participé à l'étude. Ces sujets ont été observés et enquêtés lors des matchs tests avant le confinement (février 2020) et à la reprise des entrainements (octobre 2020). En référence à la démarche ethnologique, la théorie de référence privilégiée dans ce travail était celle des buts d'implication de l'égo (White et Duda, 1993) qui porte sur les interactions aversives (Pfister, 2010). Celles-ci sont définies comme des actions par lesquelles on s'oppose, des actions réalisées contre autrui ou soi-même, contre un objet ou une circonstance. Lorsque, dans la pratique sportive, de telles actions d'opposition transgressent les règles de l'activité, nous les appelons " Interactions Aversives non codifiées " (IANC). Celles-ci sont observées telles qu'elles surviennent au cours de situations réelles de compétition qui leur confèrent leurs significations. Une analyse qualitative de ces interactions a conduit à la distinction entre deux catégories fondamentalement différentes : IANC opératoires et IANC non-opératoires. L'instrument de mesure de l'agressivité était le questionnaire de Buss et Perry, version française du Buss-Perry Agression Questionnaire. Il a été mis sous forme numérique et envoyé par mail ou WhatsApp chez les joueurs retenus après les matchs tests. Après remplissage, les questionnaires nous ont été retournés par le même canal. Ainsi, n'ont été inclus dans l'étude que les joueurs maitrisant l'outil informatique et disposant d'un microordinateur ou

*Speaker

d'un smartphone. Ainsi n'ont été retenus dans l'étude que 21sujets. Il a été observé chez tous les sujets, avant et après le confinement, une augmentation significative ($p< 0,05$) des IANC opératoires et non-opératoires. Un effet négatif du confinement COVID-10 sur les repulsions et les retentions a été retrouvé. Les défenseurs et les milieux de terrain présentaient un niveau élevé de comportements transgressifs, tant pour les intimidations verbales que physiques. En somme, les conduites violentes des joueurs étudiés sont exacerbées en situation de confinement COVID-19, tout en se positionnant au cœur même de la logique sportive.

Keywords: confinement COVID, 19, comportements agressifs, football, Congo, Brazzaville

EPS à l'école primaire : un état des pratiques d'enseignement

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L'activité physique (AP) est aujourd'hui reconnue comme un pilier fondamental d'une bonne santé, et sa pratique en est recommandée à tous les âges, selon des modalités variées. Ainsi, ces habitudes d'AP prennent une importance particulière chez l'enfant puisqu'elle en conditionnera en partie sa pérennité à l'âge adulte. A ce titre, l'Education Physique et Sportive (EPS) à l'école primaire reste parfois le lieu unique de la pratique d'une AP pour l'enfant et les modalités de son enseignement y revêtent donc un rôle fondamental. Bien qu'aucune enquête n'ait été menée au niveau national, des rapports parlementaires au début des années 2010 ont cependant souligné que l'EPS constituait une " variable d'ajustement horaire " en regard de matières sujettes à " pression " comme la langue française ou les mathématiques. Pour cerner plus objectivement les contours de l'EPS à l'école primaire, nous avons lancé un questionnaire en ligne à l'intention des Professeurs des Ecoles du Pas-de-Calais afin de connaître leurs usages d'enseignement d'EPS, mais également, le cas échéant, les freins pouvant les limiter.
Les résultats préliminaires confirment que le volume horaire fixé par les programmes n'est pas atteint. Les freins principaux aux enseignements de l'EPS concernent le manque et l'éloignement d'infrastructures ainsi que les conditions météorologiques.
En revanche, il n'existe pas de différence selon la formation initiale de l'enseignant (STAPS, Littérature, Economie,...) ou ses habitudes d'activités physiques et sportives (personnelles ou en club), soulignant l'investissement néanmoins dans l'enseignement de l'EPS des professeurs des écoles à priori n'ayant pas d'affinités avec le sport en général.

Keywords: EPS, enseignement, premier degré, freins : volume horaire : intervenants

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Evaluation des parcours aménagés dans le domaine des STAPS : une approche pluridisciplinaire

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Depuis la loi du 8 mars 2018 relative à l'Orientation et à la Réussite des Étudiants (loi ORE) visant à répondre à l'hétérogénéité des étudiants et à " leur permettre de mieux réussir leurs études supérieures[1] ", des dispositifs d'accompagnement sont proposés à ceux qui sont affectés par la nouvelle plateforme en ligne Parcoursup au sein d'une formation avec la mention " Oui Si ". Si la ventilation des publics dans ces dispositifs est faite par le ministère de l'enseignement supérieur, le parcours, quant à lui, est défini par les équipes de formation puisque " rien n'est dit dans la loi sur le contenu et les modalités de cette formation adventice, dont la définition est laissée entièrement à la charge (et à la discrétion) des universités " (Beaud, Vatin, 2018, p. 692).

La présente communication s'inscrit dans la continuité des études scientifiques concernant la réussite des étudiant-e-s à l'université en général (Morlaix et Suchaut, 2015 ; Duguet et al., 2016) et, en particulier, dans les UFRSTAPS (Chevalier et Coinaud, 2008 ; Danner et al., 2016 ; Érard et al., 2017 ; Guégnard et al. 2019). Nous partons du postulat selon lequel l'évaluation des parcours aménagés doit passer par une étude pluridisciplinaire considérant à la fois les variations individuelles, les identités plurielles (rapports des étudiants à l'institution scolaire, aux savoirs, au sport, etc.) et les pratiques pédagogiques des professionnel-le-s de l'éducation/formation. Notre étude prend donc pour socle les apports issus de la sociologie dispositionnaliste (Lahire, 2006) et les connaissances produites en sciences de l'éducation et de la formation dont notamment celles ayant trait à l'évaluation " écologique " des dispositifs de formation (Younès, 2010).

La recherche combine des méthodes de recueil de données quantitatives et qualitatives. La première étape de l'enquête a été de construire un questionnaire transmis à 38 étudiant-e-s ayant intégré le parcours aménagé d'un département STAPS au cours des trois dernières années. Il s'agissait de saisir les caractéristiques socio-démographiques, les trajectoires et environnement d'études, les parcours sportifs et les rapports à la formation et au parcours aménagé. Une analyse descriptive des réponses apportées par les étudiant-e-s et des tris (tri à plat, tri croisé) sont en cours de réalisation et seront présentés lors du congrès. La deuxième étape de l'enquête (qui sera réalisée en 2022) consistera à recueillir des données qualitatives via des entretiens semi-directifs permettant de saisir finement les dispositions des étudiant-e-s et leur rapport au parcours aménagé. Enfin, l'organisation de ce dernier et les pratiques pédagogiques afférentes seront appréhendées dans la dernière étape du recueil de données (envisagée également en 2022).

Keywords: STAPS, parcours aménagé, réussite, université, Parcoursup

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Influence de la formation initiale sur l'action didactique des enseignants d'EPS Congolais

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L'objectif de cette communication est de comparer les pratiques enseignantes chez les différentes catégories d'enseignants d'EPS: Professeurs Certifiés d'éducation physique (PC), Professeurs Adjoints d'éducation physique (PA) et les Maîtres d'éducation physique et sportive (MEPS) évoluant au lycée Savorgnan De Brazza dans l'approche pédagogique dite pédagogie par objectifs (PPO). Il s'agit de comparer les contenus enseignés de même que les mécanismes d'aiguillage, de contrôle et d'ajustement des élèves effectués par les trois catégories socioprofessionnelles en s'intéressant aux variables didactiques mises de l'avant par ces enseignants. La théorie de l'action conjointe en didactique (TACD) (Sensevy, 2007 ; 2011) a été le cadre conceptuel de la recherche dans deux perspectives : transitoire et comparatiste. De l'analyse, on ne note pas d'écart aux résultats obtenus au triple saut. Cependant, au cycle de basketball les écarts ont été obtenus. S'agissant des régulations didactiques, les stratégies régulatrices et organisationnelles sont similaires. Cette similarité témoigne sans doute les insuffisances, surtout celle des professeurs certifiés puisque l'étude a été menée dans leur champ d'intervention

Keywords: Formation initiale des enseignants d'EPS, pédagogie par objectifs, régulation didactique, transposition didactique.

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L'effet de l'utilisation de certaines méthodes d'enseignement sur le niveau de certains éléments de forme physique chez les étudiants en éducation physique de l'Université technique de Palestine "Khadouri"

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Introduction
Enseigner est un concept plus extensif (Mosston et Ashworth, 2006). Cela a favorisé l'apparition de plusieurs styles d'enseignement préconisés par les intervenants pour améliorer le transfert de l'apprentissage (Legendre, 2005 ; Therer et Willemart, 1984).
L'objectif consiste à analyser la différence entre l'utilisation de trois méthodes d'enseignement. **1**. Le style transmissive (ST) fondée sur les directives de l'enseignant, **2**. Le style associative (SA) avec l'aide de pairs. **3**. le style incitatif (SI) avec auto-application des élèves, sur le développement des aptitudes physiques (vitesse (V), force musculaire des bras (FMB) et flexibilité (FL)) chez les étudiantes en éducation physique (EP).

Méthode
60 étudiantes (âge : 19±0,92) formant les groupes expérimentaux (GExp1, GExp2, GExp3). L'intervention du formateur été réalisée suivant un modèle longitudinal de trois mois. Les données ont été traitées (SPSS version 24) en utilisant le test d'analyse de la variance à deux facteurs (Howell, 1998).

Résultats
Une amélioration des résultats des tests de V et de FMB entre les trois moments de prélèvements pour la valeur de $p < 0,05$. Il se montre que c'est le GExp2, en comparaison avec les autres groupes, qui a enregistré une meilleure progression en termes de moyennes entre T1, T2 et T3. Aucune amélioration de V et FMB n'a été enregistré d'une part, entre les différents groupes respectivement pour les valeurs de $p = 0,208$ et $p = 0,476$, d'autre part, entre les groupes et

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selon T1, T2 et T3 respectivement pour p = 0.347 et p = 0.234.
Les résultats pour FL soulèvent une différence significative entre les groupes étudiés (p = 0,000), entre les trois moments de prélèvements (p = 0,04) et entre les groupes combinés avec T1, T2 et T3 (p = 0,001) pour la valeur de p < 0,05. Il se montre que c'est toujours le GExp2 qui s'est mieux progressé en termes de moyennes (40,07 ± 7,86 à T1, 41,23 ± 8,41 à T2 pour atteindre finalement une moyenne 43,15 ± 8,05 à T3).

Discussion
Une amélioration plus grande en termes de moyennes du GExp2 concernant les deux tests V et FMB. Il se montre que c'est le SI combinant un effet centré au même temps sur l'apprenant (Therer et Willemart, 1984) et les connaissances été mieux adapté pour les étudiantes de notre échantillon. Les résultats du FL reconfirment les mêmes propos (SI). Nous supposons que le SI a entrainé des changements positifs concernant leurs autonomies (Caudron, 2001) permettant une focalisation sur leurs besoins et leurs intérêts (Sarrazin et al., 2010) tout en augmentant leurs motivations pour l'apprentissage (Karsenti, 1993) ainsi que leurs sentiments d'auto-efficacité (Bandura, 2007).

Conclusion
Nous poussons qu'il serait intéressant au future de procéder par l'usage des devis mixtes (Cresswell & Plano Clark, 2003). Cela favoriserait sans doute la compréhension du pourquoi de l'action des différents intervenants.

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Keywords: Forme physique, vitesse, force musculaire, flexibilité, méthodes d'enseignement.

Le ” Body language ” exemple de formation en communication à la fin de cursus universitaire des métiers liée à la profession enseignante quel (s) enjeu(x) et quelle(s) formation(s)

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This research aims at experimenting a training program ” Body Language and Public speaking ” at the end of initial training in physical education teachers. Materials and methods: The sample formed by student volunteer is divided in to 2 groups. The first reference group (A) n = 25 (15 men, 10 women) and the second experimental group (B) n = 22 (9 men, 13 women). For the observation, each of these two cohorts (A and B) we will retain 10 students (subsample) volunteers for the observation. Résultats: We find that the Experimental Group showed a much better distribution of learning time than the Control Group. Indeed, the distribution of learning time after the training makes it possible to affirm that at the level of the time devoted to the Preparatory Situation (PS): a decrease of 11.5% was recorded for experimental group and of 5, 01% for Control Group. While at the level of the time devoted to the Cognitive Development (CD) and Motor Development (MD) significantly greater increase in the experimental group than the control group. Conclusion: The results of this study showed that the training program has a positive impact on the time spent in the situations of: Motor Development (MD), Cognitive Development (CD) and Preparatory Situation (PS).

Keywords: Training, preparatory situation, physical education, body language and public speaking, cognitive development, motor development.

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Lockdown and gender effects in 1219 young athletes aged 15 to 21

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Introduction
75% of young people aged 16 to 25 practice a sporting activity at least once a week. What happened when 38% of French people restricted their practice during the lockdown (INJEP, 2021)? Based on a survey involving 1,219 young sportsmen and women aged 15 to 21, this paper attempts to shed light on the impact of the first lockdown on their pace of life, their fears of the disease (for themselves, for their loved ones), their training (duration and frequency) and their daily practices (sitting, walking, time in front of the screen), depending on their age, gender and level of sport.

Methods
608B and 611G with a average of 18.3 +1.8 answered a 78-item questionnaire inspired by the HAS survey (2020). The statistics used (repeated measures anova Fact3 Sex, Age and Sports Level) were carried out using Statistica 13 software and Bonferoni post hoc tests. We present here the significant effects. The level of sport was broken down into: sedentary (sed): -1h/week; occasional: -3h without sport level; department, region, national, international). Fear of disease was rated from "not at all" (1) to "very afraid" (5). Maintaining a healthy lifestyle was rated from "not at all" (1) to "very healthy" (5).

Results
We notice a gender effect on the number of hours of practice during the 3 months of lockdown ($p< 0.0001$) as well as on the practice frequency ($p< 0.001$) and a tendency just after the lockdown ($p< 0.06$). Girls practiced on average (1.1 hours) less than boys (3.3 hours).
The level of the athlete has a very significant influence. The higher the level, the more the athlete practised before and the more the athlete kept a high duration of training (2.4h versus (vs) 1h sed) ($p< 0.0001$). This decreased by almost 2.7h for the international level vs. unchanged for the sed ($p< 0.0001$).
The higher the level, the more the athlete is afraid for their family (3.7 vs. 2.4 sed) ($p< 0.0001$), and the more they are afraid of going back to school or university ($p< 0.02$). Fear for oneself does not depend on the sports level.
The higher the level, the more the athlete managed to maintain a healthy lifestyle (3.8 vs. 3 sed) ($p< 0.0001$). Finally, both girls and boys spent more time in front of a screen (+3.2h) with no indicative difference between girls and boys. However, the sportmen stayed 1.1h less than the sedentary ones (8.8h/day) ($p< 0.0001$). The sportsmen also spent less time sitting (3.8 hrs

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vs. 4.6 hrs sedentary ($p< 0.0001$) and had a significantly higher walking time (1.8 hrs vs. 1.3 hrs sedentary) ($p< 0.0001$). We do not notice indicative age effects on these variables.

Conclusion
We note significant effects of gender and level of sport before, during and after the lockdown on duration of practice, frequency of training, and greater continuity of a healthy lifestyle. Fears of the disease, especially for their family and friends, and fear of returning to school are also notable.

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Keywords: Gender, Lockdown, Level of sport practice, Lifestyle

Problématique de l'élaboration de la fiche pédagogique sur les contenus d'enseignement en EPS

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Au Congo-Brazzaville, l'analyse des rapports des conseils nationaux sur l'enseignement de l'EPS tenus chaque année révèle la complexité des tâches des enseignants dans l'applicabilité de la fiche pédagogique actuelle. L'objectif de cette étude exploratoire était d'identifier les difficultés qu'éprouvent les enseignants d'EPS dans la préparation de la fiche de préparation pédagogique. Nous avons recouru à la théorie de l'action conjointe de Sensevy (2011, 2007) qui s'appuie sur les notions de généricité, de spécificité, de contrat didactique, de l'environnement et de l'action didactique. L'étude a été réalisée dans la commune de Brazzaville de Novembre 2017 à Mars 2018. Au total, 250 enseignants d'EPS actifs ont participé à l'enquête: 80 Professeurs de lycées, 57 Professeurs de collèges, et 113 Maitres. Ils évoluaient au sein des collèges et lycées de Brazzaville (Congo). Un questionnaire après pré-enquête, a été proposé aux enseignants afin d'identifier et analyser leurs difficultés sur la préparation de la fiche pédagogique proposée par les instituions et actuellement mise en œuvre. Il comprenait 10 items ouverts et fermés, répartis en 3 parties essentielles :
1) identification de l'enseignant ;
2) connaissances générales et spécifiques sur la fiche de préparation d'une leçon d'EPS ;
3) Perceptions des enseignants sur la fiche de préparation.
Par la suite, 195 fiches de préparation ont été tirées de 8 cycles de gymnastique, 3 de saut en longueur, 4 de lancer de poids, 2 de triple saut et 5 de la course de vitesse (100m). L'analyse documentaire s'était appuyée sur les écarts des contenus des fiches préparées par les enseignants selon la grille d'analyse de Kinyoka Kabalumuna (2011). Elle a permis d'évaluer et analyser la qualité des objets pédagogiques mis en place pour favoriser l'appropriation des compétences chez les apprenants. Quatre pôles d'indicateurs d'observation ont été retenus selon les normes de rapports aux savoirs et de transaction didactique
Les données obtenues montrent que malgré l'importance que révèle la fiche de préparation de la leçon, 65% des enseignants éprouvaient des difficultés dans la mise en œuvre des contenus d'enseignement. Les indicateurs d'observation étaient moins connus et respectés par les enseignants. De plus, 3 registres ont été retrouvés au cours de l'analyse des fiches :
1) 75 % des fiches ne permettaient pas de lire leur conformité. Elles restituaient plus les simples tâches motrices ;
2) 10% des fiches analysées se focalisaient sur les propositions des tâches motrices à faire exécuter par les apprenants et l'identification des obstacles à surmonter par ces derniers, assorties des variables de régulation ;
3) 15% seulement des fiches pédagogiques ont obéit aux normes didactiques et pédagogiques.

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Par ailleurs, les objectifs de l'enseignant sur un problème identifié, l'activité de l'apprenant, le rôle de l'enseignant et les situations pédagogiques proposées y ont été clairement définis. En somme, l'application de la fiche pédagogique actuelle retenue dans la préparation des leçons d'EPS renseigne sur les faiblesses (négligence dans l'utilisation et la bonne tenue des documents pédagogiques) des acteurs de l'enseignement et les insuffisances dans la formation initiale.

Keywords: Contenus d'enseignement, Enseignants, EPS, Difficultés, Perspectives

Regards sur les motivations psychosociologiques des adultes congolais à la pratique des activités physiques et sportives

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Dans le cadre de la lutte contre l'obésité et les comorbidités associées, et suite à l'augmentation de l'inactivité physique au Congo-Brazzaville [prévalence : 29,2%-29,6% selon des données de l'OMS (2018)], le Ministère de la Santé et de la Population a institué une journée nationale mensuelle de pratique de l'activité dans les centres urbains du pays. Par ailleurs, afin de promouvoir cette politique la commune de Brazzaville (capitale de la République du Congo), par arrêté municipal, a décidé de la fermeture (interdiction de circulation aux véhicules et engins motorisés) de l'avenue de la Corniche tous les dimanches, avenue qui longe la rive droite du Fleuve Congo afin de facilité la pratique des activités athlétiques et autres dans et autour de ce couloir. Malgré l'existence de plusieurs clubs de marcheurs, il n'existe pas à notre connaissance d'étude ayant apprécié les motivations des pratiquants adultes des diverses activités physiques. D'où cette communication qui rapporte les résultats d'un travail qui s'est fixé pour objectif d'identifier et analyser les motifs de pratique des APS chez les adultes brazzavillois.

Pour effectuer cette analyse, nous sommes parti de la question de recherche suivante : Quels sont les liens qu'entretiennent la motivation et la qualité de vie avec la pratique de l'activité physique ? Afin d'identifier quels sont les principaux prédicteurs psychologiques qui favorisent l'adoption et le maintien de l'activité pratiquée par chaque individu, nous nous sommes intéressés aux concepts de motivation intrinsèque et extrinsèque de la *théorie de l'Autodétermination* (TAD, Deci et Ryan, 2000), ainsi qu'à 4 dimensions de la qualité de vie (Santé physique, Bien-être psychologique, Relations sociales, et Environnement).

Au total 106 sujets âgés de 21 à 63 ans ont été recrutés pendant la période du 16 mai au 16 novembre 2020 (période d'un confinement COVID-19 allégé), à l'aide d'affiches publicitaires et prospectus distribués le dimanche matin le long de l'avenue de la Corniche. Un lien internet permettait de s'informer sur l'enquête et les conditions de participation. En se connectant sur le smartphone, le programme affichait deux questionnaires : "Motivation for Physical Activities Measure-Revised" (MPAM-R) de Frederick et Ryan (1993) et "World Health Organisation Quality of Life-Bref" (WHOQOL-Brief) de l'OMS (1998). Cependant, seuls 72 sujets ont pleinement participé à l'enquête en remplissant correctement les 2 questionnaires. La présence des répondants dans les sites de pratique jusqu'à terme a été vérifié chaque semaine à l'insu des pratiquants. Les résultats obtenus révèlent que les choix des AP pratiquées étaient fonction de l'âge et du sexe. Par exemple, la gymnastique était l'apanage des femmes, alors que les hommes

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s'adonnaient plus au footing. Les activités étaient à caractère plus collectif qu'individuel. Le classement des motifs de pratique mettait en évidence la place prépondérante qu'occupent la santé et la forme physique. Enfin, il existait une relation entre motivation autodéterminée et assiduité observée dans la pratique de l'activité physique.

Keywords: motivations de pratique, activités physiques et sportives, adulte, Brazzaville, Théorie de Nicholls

Relationship between physical literacy and physical activity levels among college students

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Background
The national prevalence of overweight and obesity has been stable for the past decade among adolescents (6-17 years), respectively 17.0% and 3.9% of adolescents. However, their level of physical activity (PA) is clearly decreasing (between 2014 and 2018, we go from 16 to 14% in boys and from 9 to 7% in girls reaching the recommendations). On the other hand, we are witnessing a significant increase in time dedicated to sedentary activities. Indeed, 73% of them spend more than 2 hours a day in front of screens. Physical literacy (PL) is defined as the possession of knowledge, will and power with respect to physical activity. Thus, having a high level of physical literacy would be associated with an active behavior and a less degraded health status.
The purpose of the study is to assess associations between college students' LP levels and levels of PA, sedentary behavior, and physical fitness.

Methods
The level of physical literacy was assessed in 82 adolescents of a 6th grade school in the Basque Country by a French adaptation of the "Perceived physical literacy instrument" (PPLI). The first version of 18 items was used, they are scored on a 5-point Likert scale. These 18 items are divided into three subscales related to PL "knowledge and understanding", "personal expression and communication with others" and "self-confidence".
PA time and screen time were assessed by the Youth Risk Behavior Surveillance System questionnaire. Physical fitness was measured by the "20-m adapted walk/shuttle run test" and anthropometric data are being analyzed (TANITA MC-780MA S).

Results and discussion
82 adolescents, 53 boys and 29 girls. A mean PPLI score of 76 (11) out of 90 possible points. A mean maximum aerobic speed of 11.2km/h (1.4) and a mean PA time of 325 minutes per week (149.9). A positive significant association ($r = 0.3$, $p = < 0.05$) was found between physical fitness and LP score and between LP score and PA time ($r = 0.5$, $p = 0.001$). A significant negative association was found between screen time and LP score ($r = -0.4$, $p = < 0.001$). The associations between the relationships were considered weak to moderate. These results are consistent with those found in the scientific literature. Having a high level of physical literacy would be associated with better physical fitness and higher PA behavior. The small number of

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subjects and the limitations of each measurement tool used do not allow us to conclude strong links between PL and physical fitness and between PL and PA behavior.

Conclusions
These results show that physical literacy is associated with physical fitness and PA behavior, which are two determinants of adolescent health status. Assessing and developing PL in health promotion programs would therefore be relevant.

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Keywords: physical literacy, physical activity school children, physical fitness

The impact of music while racing on sport performances and motivation of students in physical education

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Introduction
We are trying to prove the interest of music in physical education (PE) and at school to promote the development of physical abilities, in order to create a sport habit and favor the well-being of the students.
We used 3 variables: with music proposed by the teacher, by the students and without music. We want to know for which of these variables the students perform better on a 400m and what the impact on their motivations.

Methods
101 students from 4th, 3rd and 1st grades, 55 boys and 46 girls with an average age of 14.9 years +/- 1,25 years participated in the study. Our protocol will be detailed in 3 parts:
One week before the physical tests, the students took a survey about their music's taste. The scale was between 1 to 10 (1 is the lower). We created 3 homogeneous groups in each class based on their music choices and frequency (BPM).
The tests were realised in different order of execution (race with music from the teacher, race with music from the student, race without music) in order to exclude the fatigue from the parameters. The students used their phones with headphones during the races. They ran, by grade, all together.
At the end of each race, the student had to "analyse" their feeling in a survey (muscular, effort, breathing, heat) (scale from 1 to 10). The sensations scale was built on the Borg model (in 10 descriptive adjective points = 1 to = 10).
At the end of the 3 races, the students have to complete a survey about their motivation to run according to these 3 variables (teacher's music/ student / without) and to classify them by the order of preference.
We have done our statistical analyses (PCA, Anova repeated measures, Post Hoc Bonferroni) on Statistica 13.

Results and discussion
The performance in the races with student's music was significantly better than without ($p < 0.04$). The difference between students' music and teacher's music was not significant and there was only a trend between teacher's music and no music.
In terms of the motivational impact of music, we observed that the students enjoyed running with music and that motivated them. The students would like to have music more often in PE.

*Speaker

Finally, the students preferred running with their music instead of the teacher's music ($p< 0.001$) which was itself preferred to running without music ($p< 0.01$), (student music versus no music, $p< 0.001$). There were also gender and/or age effects on the sensations experienced (muscular, heat, breathing, effort) after the races (Gender: perception of the first race $p=0.001$, age: perception of the first race $p=0.002$), and on the preference of the variables (Gender: race without music $p=0.0003$).
We obtain results similar to those of Simpson and Karageorghi who use 3 variables: neutral music, motivating music and without on sprints of 400m. The subjects were also significantly faster on runs with music (neutral and motivating) than without. They also didn't find significant differences between the 2 types of music.

Conclusion
In a school setting, we can conclude that music has an impact on performance and motivation to run and therefore has an important place in PE. However, this choice is more or less accentuated according to gender and age. We would like to deepen this study by looking at its influence in other PE activities.

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Keywords: sports performance, PE, physical education, music, motivation

The impact of the institutionalization of women's soccer: a comparative analysis of the careers of French and Canadian women players

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In 2018, Canada had 289,000 players and France 125,000. Although these statistics place both countries far behind their respective neighbors, the United States and Germany, they show that women's participation in soccer is quantitatively significant. Moreover, Canada (2015) and France (2019) were the last two nations to host the FIFA Women's World Cup, demonstrating the federations' investment in developing women's football. However, the organization and development of women's soccer in these two countries is also subject to institutional, cultural and geographical differences. In Canada, women's football developed massively during the 1960s, with the creation of teams and championships in different provinces of the country, and it was not taken into account by the Canadian Soccer Association (Canadian Federation) until 1977 (Hall, 2003). In France, on the other hand, the French Football Federation first institutionalized women's soccer (in 1970), before it slowly spread throughout the country (Prudhomme-Poncet, 2002). However, until 2010 and the strengthening of public action in terms of gender equality in sport, women's participation was marginalized. These different chronologies and development strategies mean that today, soccer is massively practiced by young girls/women in Canada, even though the activity is poorly organized at the federal level and the professionalization of female players is almost non-existent. Conversely, in France, although girls play soccer much less than boys, more and more female players are under federal contracts and live from playing soccer (Arrondel & Duhautois, 2020). Furthermore, the cultural positioning of soccer in each country also differs greatly. While in France, soccer is "the" national sport, a bastion of masculinity (Plaza et al., 2017), in Canada, it is a "sport of choice," i.e., massively invested by young people, but not an identity symbol, like field hockey (Lorrain, 2018). Finally, the geographical differences between the two countries and the differences in the organization of championships (Bourg & Gouguet, 2012) lead to different ways of practicing: while in France women play in a pyramidal championship, which extends from the departmental level to the national level, in Canada, the championships are organized by province, there is no national championship. In light of these similarities and differences, thirty French and thirty Canadian players will be, or were, interviewed through semi-directive interviews allowing for a life story approach (Bertaux, 2010). The objective of these interviews is to account for the impact of material conditions (Delphy, 2013) and the impact of the players' interactions with their various social spheres

*Speaker

(Forté, 2006) on the evolution of their careers. In fact, this contribution is part of a thesis that compares the careers of French and Canadian women footballers in order to account for the impact of the historical, structural, social and cultural context on the development of the material conditions of women players. The first interviews (19) were conducted in France and allow us to distinguish different types of careers according to the interactions maintained by the players with their different social spheres. Thus, 3 constructed ideals (Becker, 1940) were developed: the favored career, the thwarted career and the pleasure career. Interviews with Canadian players have not yet been conducted.

Keywords: football, comparison, women, France, Canada

Effects and acceptability of technology-based physical activity interventions in bariatric surgery: a scoping review

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Introduction
Bariatric surgery is the most effective treatment for severe obesity, but it must be combined with increased physical activity to maintain weight loss (e.g., Varkevisser et al., 2019). Despite recommendations for physical activity, most individuals are not sufficiently physically active after bariatric surgery, as evidenced by objective technological measures by devices like pedometers and accelerometers. Technology can also serve as an intervention to promote physical activity in many contexts (Gao, 2019). Although several reviews and meta-analyses have focused on the problem of obesity (e.g., Cotie et al., 2018), little is known about technology-based physical activity interventions pre- and post-bariatric surgery. A scoping review seemed called for to identify the types of evidence in the field.

Methods
The main objectives of this study were to highlight current trends in the emerging field of technology-based physical activity interventions pre- and post-bariatric surgery and to identify and discuss the knowledge gaps. The protocol of this study was drafted using the PRISMA Extension for Scoping Reviews (Tricco et al., 2018) and has been preregistered on the OSF platform (osf.io/tcn9p, December 2020). Eight electronic databases were searched to select original articles published in English between 2000 and 2020 and focused on eHealth, bariatric surgery, and physical activity.

Results
Nine full-text articles were included in the scoping review. No articles were published before 2015, the country of origin was often the United States (n=5), and the studies were often feasibility studies with limited sample sizes. The technology-based physical activity interventions resulted in no or small increases in physical activity. The underlying mechanisms of the technology-based interventions were barely detailed, and the mechanisms of acceptability were not measured based on established theoretical concepts.

Discussion
Our review revealed that technology-based physical activity interventions pre- and/or post-bariatric surgery are a focus in an emerging area of research, with varied objectives and methodologies and numerous knowledge gaps.

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Conclusion
Further research is needed in this context to clarify the effects and acceptability of technology-based physical activity interventions.

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Keywords: Technology, physical activity, bariatric surgery, eHealth, promotion

Acceptance of a virtual reality headset designed for fall prevention in older adults

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Introduction
Falls are common among older adults aged 65 and over. A number of recent reviews and meta-analyses (e.g., Neri et al., 2018) revealed that new technologies have opened the door to a new generation of intervention programs designed to prevent the occurrence of older adults' falls, whose effectiveness has often been validated (e.g., Mirelman et al., 2016). Among these new technologies, the use of virtual reality headset (VRH) appears promising, because intervention program may combine gait training and virtual environments strewn with obstacles (e.g., Mirelman et al., 2013), providing more realistic/ecological stimulations of physical, cognitive, and sensory resources. But to be effective, these programs based on VRH must first be accepted by older adults. Based on the Technology Acceptance Model (TAM, Davis, 1989), the aim of the study was to examine, before a first use, the acceptance among older adults of a virtual reality headset (VRH) used in a subsequent intervention program designed to prevent falls.

Method
The study included 271 French older adults (mean age 73.69 years, SD 6.37 years) who voluntarily and anonymously filled out a questionnaire containing i) the TAM constructs (perceived usefulness, perceived enjoyment, perceived ease of use, intention to use) adapted to the VRH designed to prevent falls, and ii) two external variables (fall-related self-efficacy and self-avoidance goals).

Results
A structural equation modeling analysis was conducted. Perceived usefulness, perceived enjoyment, and perceived ease of use were positive predictors of intention to use the VRH. Fall-related self-efficacy (i.e., the perceived level of confidence of an individual when performing daily activities without falling) and self-avoidance goals (i.e., participating in a physical activity to avoid physical regression) were negative and positive predictors of perceived usefulness of this VRH, respectively.

Discussion
These findings validated the TAM with older adults and a particular technological device: the VRH intended to be used in intervention programs designed to prevent falls. They also highlighted that psychological variables (fall-related self-efficacy and self-avoidance goals) may influence perceived usefulness of this VRH.

*Speaker

Conclusion
Examining the initial acceptance among older adults of such a VRH is necessary to better understand the involvement of older adults in intervention programs designed to prevent falls based on this technological device.

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Keywords: Virtual reality, acceptance, older adults, fall prevention, fall, related self, efficacy, achievement goals

Does gamification improve physical activity? A systematic review and meta-analysis.

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Introduction
Gamification is the use of game elements in nongame contexts (Deterding et al., 2011). Made possible by the advent of numeric devices in our daily life permitting to track activities in natural context, gamification appears as a promising avenue to change behaviors and promote physical activity. However, we do not have yet evidence of the effectiveness of gamified interventions with the existence of mixed results in the literature and a meta-analysis appears as timely as there are now enough randomized controlled trials to conduct such analysis.

Methods
We conducted a systematic review and meta-analysis on randomized controlled trials to evaluate the effectiveness of gamified interventions on physical activity outcomes. To this end, five electronic databases (Pubmed, EMBASE, Scopus, Web of Science, and CENTRAL) were searched for trials published in English from 2010 to 2020. Different meta-analyses using a random effects model approach were performed associated with sensitivity analyses, influence analyses and publication bias analyses to examine the robustness of our results.

Results
The main meta-analysis performed on 16 studies and 2407 participants, revealed a small to medium summary effect of gamified interventions on physical activity behavior (g = 0.42 (95%CI [0.14, 0.69]). No statistical difference between different population subgroups and no interaction effects with moderators like age, gender or BMI were found, suggesting good generalizability of gamified interventions to different user populations. The effect was statistically significant both when gamified interventions were compared to inactive control group such as waiting lists (g = 0.58, 95%CI [0.08, 1.07]) and to active control groups including an equivalent non-gamified intervention (g = 0.23, 95%CI [0.05, 0.41]), suggesting that gamified interventions are not only efficient in changing behavior but also effective compared to other similar interventions. The long-term effect, measured with follow-up averaging 14 weeks after the end of the intervention, is weaker but still statistically significant with a very small to small effect (g = 0.15, 95%CI [0.07, 0.23]).

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Discussion
This meta-analysis confirms that gamified interventions are promising to promote PA in various publics. The effect persists after follow-up periods, suggesting that the effect of gamification is not just a novelty effect due to its playful nature. Many health benefits can be envisaged with gamification considering its effect and its assets from an interventional point of view. This kind of intervention can potentially challenge current interventions and be implemented in prevention or in care for patients requiring adapted physical activity. Future rigorous trials are needed to confirm these perspectives and to better understand the mechanisms underlying the gamification effects.

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Keywords: behavior change, e health, gamification, intervention, meta analysis

Videoconference-based adapted physical activity interventions for health purposes. Shared qualitative approach in oncology and cystic fibrosis.

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Introduction
Adapted and regular physical activity (PA) is considered a necessary care conveyor for people with cancer(1) or cystic fibrosis(2). However, PA access remains often limited by physical, organizational and psycho-social factors(3), especially for frail population. Recent technology advances play a facilitator role to allow adapted PA, with a proven efficacy in the field of oncology or cystic fibrosis (an APA program entirely carried out with the VisioMoov® videoconferencing system developed by Mooven). To increase the impact of this innovation, Mooven designed mutualized sessions across different pathologies, the assumption being a positive educational, motivational and economic impact.

Method
After an initial interview, 120 patients suffering either from cancer or cystic fibrosis were recruited from five French centers. They were grouped according to their physical tests, objectives (health objective, and personal objective), and prefered activities, but not according to their pathology and syndromes. After a 3-months intervention, they filled in questionnaires ("System Usability Scale", CSQ-8) and had a follow-up interview with their PA instructor.

Results
(1) The number of slots offered to participants increased 3-fold over a 3-month period without inducing an extra-cost; (2) participants were able to access more varied interventions than before the mutualization. (3) 69% of participants rated the intervention in terms to satisfied needs with a score at least equal to 3 on a 4-point scale, and 28% with the top score of 4, saying that most of their needs were met. (4) The cancellation rate for shared sessions has decreased. And (5), interviews showed that shared interventions create motivation and social links despite the distance and the screen, this last result being relevant with previous observations on remote PA through videoconference.

Discussion
Mutualized sessions allowed an economic gain by optimizing PA sessions. This support during the period of confinement due to the COVID19 sanitary crisis allowed participants not only to maintain a PA whereas all structures were closed (inducing also more overall videoconference sessions than usual), but also to maintain a social link and conviviality for isolated people).

*Speaker

Conclusion

Mooven innovation showed that not only mutualization impacts economic levels by optimizing the number of virtual rooms and their occupancy rate, but also care levels. Indeed, grouping participants by objectives rather than pathology breaking stigma and associated stereotypes. Despite strong suggestions of the benefits of such strategy, further studies need to be conducted to precisely evaluate the nature of these impacts and the underlying mechanism at the bio-psycho-social levels. Finally, monitoring motivation and behavioral change will be necessary to drive such procedure toward the standards of an evidence-based intervention.

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Keywords: videoconference, adapted physical activity, cystic fibrosis, oncology

The use of digital technology in school placement: the self-confrontation interview instead of the traditional post-lesson interview

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Introduction

The Physical Education Teachers in Training (PETT) is underpinned with intense emotions (Ria & Durand, 2013). The traditional post-lesson student teacher interviews seem to be questioned by the francophone literature (Bertone, Chaliès & Clot, 2009). It would appear that the supervisor supports the PETT emotionally, by masking his/her criticisms to protect him/herself, through overlooking the student's difficulties and mistakes.

Methods

During a longitudinal qualitative study with five PETTs (with a contract as PE teachers in a secondary school), all PE lessons were filmed with a tablet and transcribed language material from 24 self-confrontation interviews (SCI) was collected.

The research contract was: a) To film all the PE lessons of the chosen class with the tablet lent by the researcher, b) If nothing emotionally significant occurred, the filmed sequence could be deleted, c) If an emotionally significant situation occurred, the participant had to contact the researcher for a SCI. The PETT selected, Before the SCI, the moments he/she wanted to share with the researcher, because they were significant for him/her, positively or negatively.

The professional development of PETTs is treated here from the perspective of the clinical activity (Clot, 1999). The developmental process has its origin in the actor's capacity to be affected by a situation (in this case, the fact of seeing oneself on a screen during teaching) and generates intrapsychic conflicts especially regarding the impeded activity (what the actor was unable to achieve).

Results and discussion

The transcriptions show that the PETT, confronted with tracking his experience at the SCI with the supervisor and the presence of the researcher, is in a favourable position to develop his teaching. The findings from the SCI highlight the "realisation" is evident in *I realise when I see this* or *I hadn't thought about it* appear as indicators of the potential development of the PETTs' activity.

The value of this type of interview is that it takes into account the subjective data of the PETTs' activity. Indeed, the vision of oneself teaching may be full of emotions, as when a PETT says

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that she would have preferred that the video be lost to avoid seeing herself losing control by getting angry in front of the pupils. Or when another PETT, watching himself, mentions his lack of professionalism, his *I don't care attitude* and says that he *sweats when he sees himself teaching*. He ended the interview by saying that it was *confronting* to observe himself teaching. The fact of being confronted in the post-lesson interview with their own image as a PETT in activity allows them to explore new possibilities to bring forward their teaching and explain new learning. PETTs become aware of their activity by reliving it, as they develop (Descoeudres, 2019). This research has led to the resolution of particular professional challenges, with recommendations of possible solutions to consider as alternatives.

Conclusion

To conclude, we can say that despite the psychological cost of the self-confrontation interview, we propose the potential use of these SCI for teacher education, in order to contribute to promote the development of PETTs' activity. The use of digital technology during school placement improves PETTs teaching and allows new professional skills.

Keywords: post, lesson interview, teaching education, self, confrontation interview

Schooling Yoga in High School: From Teaching Experiences to the Design of a Professional Training System for Physical Education Teachers

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Introduction
While yoga has recently been integrated into the Physical and Sports Education (PSE) programs in high school, this activity remains little taught. The aim of this paper is to show how the follow-up of training and teaching experiences in yoga can feed the design of training paths. Using the theoretical framework of culturalist anthropology (Chaliès and Bertone, 2017), this paper proposes (i) to study the experiences of seven "pioneer" PE teachers in exploiting yoga in the teaching of Learning Field (LF) #5, (ii) to propose a professional training device for PE teachers so that they can exploit yoga as a supporting activity to achieve the goals of LF #5.

Method
This study is part of a multidisciplinary exploratory investigation project on the "Scolarisation du Yoga, Formations et Rapports au Métier d'Enseignant" (SYFRAME) carried out in collaboration between a Sociology team (Cresco Toulouse) and another in Education and Training Sciences (UMR EFTS Toulouse). This project studies the modes of institutionalization of yoga in schools, the privileged knowledge and uses, as well as the professional trainings dedicated to PE teachers. Within this project, a qualitative study was conducted. The ambition was to access the activity of PE teachers and their meanings of the experiences mobilized to teach this activity to students. The perspectives were (i) to understand the most favorable circumstances for the process of schooling yoga in the school environment, (ii) to encourage the design of new professional training devices for teachers in the process of schooling new practices.

Results
The first results underline that when we finely follow the flow of the experiences of the PE teachers, from their initial training to their teaching of yoga in class, we notice (i) that there is a significant "porosity" between these different lived experiences, (ii) that the redeployment of the experiences of yoga training in the framework of the teaching of PE is mainly nourished by the finalities and the school concerns of the LF #5.

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Discussion
Of the avenues of discussion engaged, the one that seems most interesting is undoubtedly that relating to how PE teachers create intermediate spaces of schooling where singular forms of yoga practice are played out. In other words, PE teachers create spaces of schooling that both maintain a "family resemblance" to the spaces in which they initially practiced yoga and allow for the displacement of yoga practice into a school context.

Conclusion
Based on these initial results and their discussion, we wished to propose a training device integrating digital tools (Tribet and Chaliès, 2017). It is composed of several successive training sequences aiming at signifying experiences as a yoga practitioner and learning to teach yoga from the experiences signified as a practitioner. In the end, this study tried to propose ways to adapt the training of PE teachers to the teaching of yoga in order to meet the challenge of "well-being" of students in PE and more broadly at school.

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Keywords: Keywords: yoga, experience, teacher, training device, physical and sports education.

Analyse de l'activité enseignante au cours d'un cycle de football, en milieux " ordinaire " et " difficile " : une double approche ergonomique et didactique

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Introduction
Cette recherche analyse l'activité de deux enseignants en éducation physique et sportive (EPS) issus de deux milieux différents (éducation " prioritaire " et " ordinaire "), au cours d'un cycle de football avec deux classes de 4e en collège. L'activité enseignante observée est déterminée par un artefact qui est le débat d'idées (DI).

Méthodes
Cette étude prend appui sur l'approche clinique de l'activité en ergonomie (Amigues, Faïta, Saujat, 2004) et la théorie de l'action conjointe en didactique (Sensevy et Mercier, 2007 ; Schubauer-Leoni et Leutenegger, 2008) afin de mobiliser une nouvelle approche ergo-didactique (Brière, 2017). Le recours à cette approche novatrice vise à apporter un regard original sur les enseignants d'EPS, entre ce qu'ils veulent faire, ce qu'ils devraient faire et ce qu'ils ont fait réellement en termes d'arbitrage de dilemmes, sur l'activité et le rôle de l'enseignant, entre sens et efficience, et enfin, sur la place des élèves.

Résultats
Les données recueillies à la suite des autoconfrontations simples et croisées ainsi que les synopsis montrent que l'activité des deux enseignants, au-delà de leur appartenance, a été perturbée par rapport à l'appropriation et l'instrumentalisation de l'artefact (DI) durant leur enseignement.

Discussion
Avec le premier enseignant, le débat d'idées a retrouvé plus ou moins sa robustesse en tant qu'artefact didactique, et sa viabilité et son potentiel éducatif en tant qu'artefact instrumentalisé dans le développement de l'activité enseignante. A contrario, ce moment discursif n'a pas résisté lors des enseignements du deuxième enseignant. Dans ce cadre, il nous paraît légitime de recourir à nouveau aux réflexions qui ont alimenté notre piste de recherche. Ces auteurs essayent de combiner la didactique et l'ergonomie, une fusion difficile mais souhaitable pour avoir une vision plus large sur les pôles (enseignant - élève - savoirs) constituant le champ de recherche en EPS et ainsi prendre en compte l'activité des élèves du point de vue ergonomique.

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Conclusion
Nous pouvons dire, en guise de conclusion, qu'il existe une différence au niveau de l'instrumentalisation du débat d'idées (Rabardel, 1995) par les deux enseignants. Celui-ci est manipulé uniquement du point de vue didactique depuis son apparition il y a vingt ans. Donc, le recours à une double approche ergo-didactique en EPS s'inscrit dans la réflexion de plusieurs chercheurs, telle l'équipe ADEF à Marseille (Brière-Guenoun, 2018).

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Keywords: Approche ergo, didactique, Débat d'idées, EPS, Football

An Ecological Conceptualization of the strategy for using new technology among PE teachers

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Background
Derived from ideas of Newell (1986), Davids et al. (2008) and Immonen et al. (2018), teachers can be considered as complex adaptive systems. Consider that the strategies used by an individual emerge from a network of interacting constraints related to the characteristics of the individual and his or her history, the tasks pursued and the characteristics of the environment (Newell, 1986; Immonen et al., 2018).
Indeed, the comprehensive lens of ecological dynamics is illustrated on multiple levels of analysis to define strategy for using new technology among PE teachers.
The main purpose of this study is to identify the determinants of the different strategies for the use of new technologies in PE.

Method
According to a set of variables characterizing the PE teacher's strategies (professional & personal utilization, connexion's score, professional material, digital training, material barriers, etc.), sociological variables (motivation, age, gender, etc.), his or her environment (professional and personal) and the types of activities with new technologies, it is necessary to identify typologies of PE teachers relating to new technologies and their use in PE setting.
281 teachers in Hauts-de-France participated in the study. Data were collected by questionnaire between September 2019 and December 2019 All responses were scored according to their position on the Lickert scale.
A Factor Analysis of Mixed Data (AFMD) was used to detect multiple levels of strategy for using new technology among PE teachers. In addition, a hierarchical top-down classification was used on this AFMD to identify clusters of teachers according to their strategies.

Results and discussion
Results showed that dimension 1 discriminates individual strategy for using new technology and PE teachers. Clusters' analysis highlighted three profiles of PE's teachers depending on their strategy, age, motivation and beliefs using these technologies, the habits of children with TICE, the professional material and the connexion's score.
According to these analyses, cluster 1 characterizes an important use of new technologies in PE. There are young age PE teachers, with a professional & personal utilization of new technology and an important connexion's score. At the opposite, cluster 3 represents older teachers, without digital training and with material barriers.

*Speaker

Conclusion
The adoption of digital strategies among PE teachers depends on multiple factors. Our results show the interest in identifying teacher profiles in order to specify training needs.

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Keywords: TICE, ecological dynamics, strategy, physical education, teachers

Analyse de l'Intelligence Émotionnelle des enseignants d'Éducation Physique Sportive : Comparatif avec les enseignants des autres disciplines.

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Notre objet de recherche s'articule autour du concept d'intelligence émotionnelle (IE). Elle se définit comme la capacité de contrôler ses émotions et celles des autres, de les distinguer et d'utiliser ces informations pour orienter ses pensées et ses émotions (Mayer & Salovey, 1997). Principalement développée dans le milieu du management en entreprise (Goleman, 1995), cette habileté n'a pas encore réellement été investiguée dans le milieu éducatif, ou alors à travers les croyances des enseignants sur l'apprentissage social et émotionnel (Brackett *et al.*, 2012). Or, les interactions enseignant-élèves dans le cadre des apprentissages à l'école représentent un terrain privilégié d'expression de l'IE (Lopes & Salovey, 2005), notamment durant les séances d'EPS où les apprentissages sociaux et émotionnels sont prépondérants (Debois, Blondel, & Vettraino, 2007).
Cette IE, notamment chez les enseignants d'EPS, doit constituer un levier à actionner pour mettre en place des conditions d'apprentissage optimales, d'autant qu'une classe prosociale favorise la réussite scolaire (Jennings & Greenberg, 2009). Nous faisons l'hypothèse que les enseignants d'EPS disposent d'une IE plus élevée que les enseignants d'autres disciplines de par leur pratique physique et sportive.

Méthode
Le GENIE des enseignants (Grande Enquête Nationale sur l'Intelligence Émotionnelle) a été proposé sous forme de questionnaire. 10136 enseignants de la France entière y ont répondu, dont 403 enseignants d'EPS (221 femmes et 182 hommes). Les variables socio-démographiques, professionnelles et celles liées à la pratique sportive ont été relevées (âge, nombre d'année d'expérience professionnelle, le type de milieu, le type d'établissement, la pratique d'activité physique, le type d'activité, le niveau auto-évalué et le nombre d'année d'expérience sportive).
Pour évaluer l'IE, le PEC-50 auto-administré a été utilisé (Profil of Emotional Competences, 50 items, 5-point Likert, Brasseur & Mikolajczak, 2012) et a permis d'obtenir un score total des compétences émotionnelles (moyenne de tous les items), un sous-score des compétences émotionnelles intrapersonnelles (moyenne des scores aux échelles d'identification, compréhension,

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expression, régulation et utilisation de ses propres émotions) et un sous-score des compétences émotionnelles interpersonnelles (moyenne des scores aux échelles d'identification, compréhension, expression, régulation et utilisation des émotions d'autrui).

Résultats

L'utilisation d'un test du Chi^2 d'indépendance révèle que la pratique sportive des enseignants dépend de la matière enseignée, $\chi^2(2,\ N = 10136) = 134.08$, $p< .001$. Ainsi, la proportion des enseignants d'EPS pratiquant une activité physique est significativement plus élevée rapport aux autres professeurs enseignant une autre discipline. Les enseignants d'EPS pratiquent significativement plus une activité physique individuelle que collective, $\chi^2(1,\ N = 388) = 111.50$, $p< .001$, il en est de même pour les enseignants des autres disciplines, $\chi^2(1,\ N = 6758) = 3640.37$, $p< .001$.

Les enseignants d'EPS établissent leur expérience sportive à 19 ans et 8 mois en moyenne ce qui est significativement supérieur aux autres enseignants pour qui elle est de 13 ans en moyenne, $t(388) = 9{,}66$, $p< .001$. Le temps d'activité sportive hebdomadaire est aussi significativement différent entre les enseignants, $t(408) = 12{,}04$, $p< .001$. En effet, il s'établit à 4 heures 30 minutes en moyenne chez les enseignants d'EPS contre 2 heures 54 minutes en moyenne pour les autres enseignants.

Concernant les compétences émotionnelles, les enseignants d'EPS possèdent des scores significativement plus élevés que les autres enseignants pour les compétences émotionnelles globales, $t(437) = 3{,}37$, $p< .001$, et pour les compétences émotionnelles intrapersonnelles, $t(438) = 4{,}24$, $p< .001$. En revanche, les niveaux de compétences émotionnelles interpersonnelles sont identiques entre les enseignants d'EPS et les autres enseignants, $t(435) = 1{,}68$, $p=.09$.

Discussion

L'originalité de ce projet réside en premier dans l'application du concept d'intelligence émotionnelle au sein du milieu éducatif. De plus, cette recherche s'inscrit dans le domaine prioritaire de la réussite de tous car elle vise à comprendre l'effet de l'IE sur la mise en place de stratégies d'apprentissage optimales dans le but de permettre aux enseignants de toucher tous les élèves et de ne laisser personne de côté.

Les résultats nous permettent de constater que les enseignants d'EPS sont significativement plus nombreux à pratiquer une activité sportive par rapport aux autres enseignants et que leur expérience sportive et leur temps d'activité sportive hebdomadaire sont également significativement supérieurs aux autres enseignants. En outre, concernant les compétences émotionnelles, les enseignants d'EPS ont un score total et un score intrapersonnel plus élevés que leurs collègues. Le score intrapersonnel élevé peut s'expliquer par le fait que ce soit l'activité physique individuelle couplée à une longue expérience dans la discipline et à l'assiduité hebdomadaire de leur pratique qui prédomine chez les enseignants d'EPS.

En revanche, il apparaît qu'il n'y ait pas de différence significative pour le score interpersonnel entre les deux groupes. De fait, la pratique d'une activité physique collective est minoritaire chez les deux groupes d'enseignants. Il serait alors intéressant de comparer le score interpersonnel des enseignants déclarant pratiquer une activité physique collective pour mesurer s'il y a une différence entre les enseignants d'EPS et les autres enseignants.

La pratique physique et sportive régulière semble alors être un atout pour les enseignants d'EPS et leur permettent d'avoir des compétences émotionnelles élevées. En effet, un enseignant sachant reconnaître, comprendre et agir sur ses émotions et celles de ses élèves sera en mesure de mettre en place des interventions efficientes pour favoriser leur engagement et leurs apprentissages.

Keywords: Compétence, Intelligence, Émotionnelle, EPS

Findings about School-Based Interventions to Promote 24-Hour Movement Guidelines among Children

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Introduction
Insufficient physical activity (PA) as well as high levels of sedentary behaviors (SB) are two of the most important unhealthy behaviors (WHO, 2014), and 80% of the world's children and adolescents do not meet the PA recommendations (Hallal et al., 2012). Moreover, SB take over 50% of the waking day at 7 years and 75% at 15 years (Janssen et al., 2016). Concerning sleep (SLP), some studies have shown that low SLP quality is associated with poor health benefits among youths (Chaput et al., 2016). Due to the lack of a common research approach of the three behaviors, an integrated framework was developed in 2016, named the 24–hour Movement Guidelines (Tremblay et al., 2016). Nevertheless, school health research has been mainly focused on PA or SB (Chaput et al., 2014), and SLP research has usually been treated independently from the other two behaviours (Blunden & Rigney, 2015). There is a lack of reviews about multiple movement behavior interventions (i.e., PA, SB and SLP). Therefore, to fill this gap in the literature, we aimed to systematically review and summarize effective school-based interventions targeting at least two movement behaviors in children aged 5-12 years old.

Method
This systematic review is written following the previous published review protocol (Rodrigo-Sanjoaquín et al., 2020), and the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines (Page et al., 2021). Also, the present review study was registered in PROSPERO (CRD42020199154). A structured electronic bibliographic search of 5 databases (Pubmed, Scopus, SPORTDiscuss, The Cochrane Library and Web of Science) was conducted to retrieve peer-reviewed intervention articles published in English language between January 2010 and October 2020.

Results
Using the search strategy previously described, 13982 records were identified. After removing duplicates and other records by automatization tools, 3908 articles remained for screening. These 3908 were screened by the abstract and 3779 were excluded based on eligibility criteria. 129 full-text articles were screened, of which 35 publications were deemed valid based on eligibility criteria. We also found 7 records based on citation searching of which 2 were assessed

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for eligibility. Finally, 37 intervention studies fulfilled the criteria and were deemed eligible and included in the systematic review process. Due to the data heterogeneity, we finally decided to not conduct a meta-analyses to avoid misleading errors.

Discussion
Through the 37 studies included, 23 effectively improved PA and/or SB outcomes, but there was no effect on SLP. The findings of this systematic review suggest that school-based multiple health behavior interventions significantly increased accelerometer-measured and self-reported PA, and reduced SB immediately after the intervention. Long-term effects were found but follow-up measures were only taken in a few studies. Overall, we found that 10 to 12 months' duration, the Social Cognitive Theory, the Behavior Change Techniques and $>$ 2 h/week of School Curriculum appear to be very important resources to build an effective intervention.

Conclusion
These findings can help to improve our understanding about the interplay between the the intervention details and their consequent children health behavior improvement.

Keywords: Movement Behaviours, Physical Activity, Sedentary Behavior, Sleep, School, Children.

Social sciences

L'engagement managérial, (in)compatible avec les actions d'Activités Physiques en entreprise ?

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Introduction et objectifs
L'Activité Physique (AP) en entreprise pourrait non seulement avoir un impact sur la santé des employés (e.g., réduction des facteurs de risque cardiovasculaire) (Zavanela et al., 2012), sur le bien-être des managers (Neck et Cooper, 2000), mais également sur l'attractivité et la marque employeur (Merk et Büttgen, 2016). Malgré ces résultats encourageants, certaines études ont montré que les efforts portés sur le déploiement de ces actions n'ont abouti qu'à de faibles taux d'implantation (Burnes and Jackson, 2011) et d'adhésion des salariés sur le long terme (Amireault et al., 2013). Le manager a été identifié comme la pierre angulaire de cette démarche à la fois facilitateur et/ou résistant (Tarakci et al., 2018). À notre connaissance, peu d'études ont questionné le rôle et la perception des managers face aux AP en entreprise (Justesen et al., 2017). C'est dans cette optique que nous mené cette étude qualitative décrivant et analysant les rôles et les points de vue des managers dans un contexte d'AP en entreprise.

Cadre théorique
Les managers occupent une place centrale dans la structure organisationnelle des entreprises, à l'interface entre les décisions stratégiques prises par la direction et leurs applications terrain (Christensen et al., 2019). La théorie du rôle des managers souligne que leur engagement dans de nouvelles actions d'entreprise s'exprime à travers une communication adaptée, la diffusion d'informations nécessaires et un accompagnement constant auprès des salariés afin de favoriser l'implantation et le succès de ces actions (Birken et al., 2012). Néanmoins, leur fonction les amène parfois à gérer des situations paradoxales voire conflictuelles entre une stratégie organisationnelle imposée et des réalités opérationnelles contradictoires. Il a été suggéré, selon la théorie de l'identité du manager et de l'identification organisationnelle, qu'ils pouvaient alors adopter différentes postures face à cette situation, à la fois contrôleur/contrôlé et résistant/résisté (Harding et al., 2014).

Méthodologie
23 entretiens semi-directifs (11 managers de proximité et 12 managers intermédiaires) ont été menés. Un guide d'entretien a été construit autour de 3 dimensions: caractéristiques des entreprises, profils des managers et rôles/perceptions concernant les AP en entreprise. Nous avons mené un pré-test auprès de 6 managers et réajusté le contenu du guide d'entretien. Nous avons utilisé la théorie ancrée, basée sur l'approche thématique, pour analyser les données qualitatives et répondre à la problématique de recherche.

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Principaux résultats et conclusion
17 managers estimaient avoir un rôle à jouer dans la promotion des AP en entreprise. 5 rôles ont émergé de l'analyse thématique: " coach ", relais d'information, contrôleur résistant, réalisateur et médiateur. La fonction managériale (probable discordance entre les missions principales et l'AP en entreprise) et la contrainte temporelle ont été les principaux freins de leur engagement. Par opposition, les bienfaits pour la santé et le bien-être ont été mentionnés comme des leviers. La formation, la co-construction et l'accompagnement pourraient être des étapes nécessaires au succès des AP en entreprise.

Keywords: Manager, Activité Physique en Entreprise, Engagement, Freins, Leviers

From Esports to Virtual Sports: The Olympic Strategy Regarding Competitive Video Gaming

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Organized video games competitions, or esports, has been growing in popularity since the turn of the 2010s among younger generation, as evidenced by the continuous increase in the number of players, the size of audiences, or the revenues generated (Scholz, 2019). At the same time, the Olympic movement (OM) is developing a global strategy to attract new audiences and rejuvenate its fanbase (Thorpe & Wheaton, 2011), whether through the creation of the YOG, the implementation of digital-led content, or the integration of new disciplines such as skateboarding or breakdancing. To pursue this ambition, the IOC has started since 2017 a reflection about possible synergies with the esports industry (Miah & Fenton, 2020). How have these reflections been conducted? What are the main outcomes? And what issues does this convergence reveal? To answer these questions, I conducted an ethnographic study as an advisor to the international OM between March 2018 and December 2020. I took part in the multiple formal and informal meetings that occurred within the Esports & Gaming Liaison Group, the thematic group specially created by the IOC. In addition, secondary data was collected and analyzed, such as all official publications (e.g. Olympic Summits, Agenda 2020, IOC sessions).

The data reveals an evolution in the way the OM apprehends esports and its integration. If the first statement made by the IOC in 2017 indicated a relative acceptance of all competitive forms of video games, the Agenda 2020+5 presented in early 2021 definitively targets a specific genre of games designated under the term "Virtual Sports". The Olympic Virtual Series (OVS) held in June 2021 confirm this choice since the competition is composed of five virtual versions of existing sports: cycling, sailing, rowing, baseball and motor sports. Beyond the stated desire to make the term "esports" invisible, the new categorization proposed by the OM is implicitly symbolized by the ELG chairperson position granted to the president of the International Cycling Union (UCI), whose electronic version of cycling is presented as a reference. At the same time, the IOC is encouraging International Federations to take control and regulate the virtual and electronic versions of their sports, at the risk of coming into conflict with the publishers who own the intellectual property of these games.

These findings confirm the challenges facing the OM, from the game publishers monopoly (Gries, 2019) to the esports compatibility with the Olympic Games (Pack & Heldlund, 2020). In addition, the study also reveals how the IOC is attempting to leverage this collaboration, by redefining the types of games worthy of interest and by using players as a vehicle to promote its own values.

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Keywords: Esports, Virtual Sports, Olympics

A turning point? Evaluating the impact of the 2019 FIFA Women World Cup in France on sports' clubs in host cities

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Aim and objectives
The impact and legacy of major sport events remain an important issue, for public and sport decision-makers, local communities as well as for the academic community (Preuss, 2015). This question is particularly important as existing knowledge does not universally support strong impact and legacies (Thompson et al., 2019), and that sport events are intrinsically extremely diverse and are hosted in similarly diverse context and locations (Spaaij, 2009). One growing objective, and thus justification, for organising sporting events relates to the social impact/legacy they can have (Chalip, 2008). For this reason, and responding to a call from the Local Organising Committee of the FIFA WWC France 2019, this study aimed to evaluate the impact of the event on sports clubs – football and non-football in France, which is one component of event legacy (Preuss, 2019). The event studied is particularly interesting considering that women's sporting events have been understudied and that women's football have been rapidly developing in terms of participation, image and media attention (Hallmann, 2012).

Methodology
The methodology followed a two-phase process. First, a questionnaire was conveniently administrated to sport clubs of the 9 hosting and 1 non-hosting city. The main goal was to characterize the situation of women and the club's policy regarding women's participation. The sample includes 96 clubs, comprising 17 football clubs. The second step based on phone interviews with club's board members, aimed to evaluate the WWC's specific impact on their club. The convenient sample is made of 60 clubs, comprising 3 football and 3 non-football clubs in each of the 10 cities.

Findings
The phase-1 results showed that only a minority of clubs had a formal engagement towards the promotion of women sports, but half of them declared having dedicated actions to promote gender equality. Overall, the phase-2 results indicate that although the event was very well received in the host cities it did not have any perceived impact on non-football clubs. If football

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clubs estimate that the event changed images and perceptions of women's football, they rarely observed an impact in their club, mainly through the arrival of few (< 10) women participants. Few declared wanting to develop more programmes in the near future, either because they perceive they already do a lot, or because they lack resources, especially, volunteers and training slots.

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Keywords: Women, Football, World Cup, Event, Impact, Clubs

Experiences of women footballers in clubs affiliated to the French Football Federation (FFF): between discrimination and identity construction

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This paper proposal is based on a Master 2 research dissertation (Egal'APS, University of Lyon 1, 2020) focused on the study of discrimination related to gender identity and sexual orientation experienced by women footballers within their practice space. Two spaces were studied: teams affiliated with the FFF and self-organized feminist teams (Anonymous, 2020a). Athletes behavior and degree of adherence to stereotypes related to gender and sexual orientation have already been measured, but the situation within women's teams has often only been a secondary focus of a more global research on men. Mette highlights a "*very tolerant women's football context*" (2014, p.19), while Sablik and Mennesson argue that "*homosexual practices*" sometimes represent a "*condition of entry into the practice*" for women football players (2008, p.79). If women teams can be considered as a space that facilitates the nomination of oneself as a lesbian, like the activist associative space (Chetcuti, 2010), other analytical tools allow us to temper these assertions. Griffin developed the "lesbian label" notion used to "*define the boundaries of acceptable female behavior in a patriarchal culture: when a woman is called a lesbian, she knows she is out of bounds. [...] Because women's sport has been labeled a lesbian activity, women in sport are particularly sensitive and vulnerable to the use of the lesbian label to intimidate.*" (1992, p.253). The lesbian label appears in six ways: silence, denial, apology, promotion of a heterosexual image, attacks on lesbians, and preference for male coaches. All women atlhetes are These manifestations seem to find a familiar echo in the situation within the FFF (Ravel et. Al., 2016).

A quantitative study involving 153 women footballers highlighted the ambiguity of clubs affiliated with the federation in their experiences and identity construction. Different measures were carried out: the first aimed at obtaining women footballers' degree of adherence to gender related stereotypes (Liotard, 2008; Mette 2014), the second aimed at quantifying the discriminatory experiences lived by the women players. Seven semi-structured interviews with football players were used to further explore the data collected in the interviews. The results obtained highlight the differences between the two practice spaces. Women football players registered in the French football federation are the ones who most frequently hear discriminatory comments. They face the "lesbian label" the most. Indeed, 25.5% of them say they frequently hear remarks about the supposed low level of women in soccer. They are 42.6% to say that they regularly hear remarks about the supposed homosexuality of women footballers. This paper will therefore

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analyze the role played by those two football spaces on the experience of women footballers and their identity construction.
The clubs affiliated to the FFF are still openly hostile to women and to lesbians in particular: the quantitative results and the interviews demonstrated that they do not constitute a tolerant space. The clubs are reproducers of a heterosexist system. Heterosexism is the interweaving of the sexist system and the lesbophobic system, each being dependent on the other. The aim of this research is to understand how a space could be discriminating and, at the same time, allow for solidarity to be created within the locker room, sheltered from the outside football world. There lays the ambiguity of the clubs affiliated to the federation.

Keywords: football, gender, discrimination

Une approche exploratoire des partenariats entre les fédérations sportives et les collectivités locales.

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La présente contribution propose une analyse sociologique de l'articulation entre des politiques sportives locales et les stratégies fédérales de développement. Les fédérations sportives se caractérisent par une structuration très verticale, avec des stratégies de développement de la pratique (d'une ou de plusieurs disciplines) et de performance sportive descendant des sièges fédéraux vers les clubs en passant par les comités régionaux et départementaux. Les collectivités territoriales cherchent à l'inverse à développer leur(s) territoire(s) à travers des politiques sportives menées en toute autonomie, le partage de la compétence sport renforçant ces dynamiques horizontales. Il apparaît alors légitime d'interroger l'imbrication entre le développement des pratiques sportives et celui des territoires à l'heure où ces deux types d'organisations doivent s'adapter à un contexte mouvant, marqué par de profonds bouleversements.

Quels sont les thématiques et les niveaux d'échelle territoriale qui offrent un cadre d'analyse pertinent pour étudier cette articulation ? Quels enjeux et quelles dynamiques produisent-ils ? Le cadre théorique mobilisé sera celui de la politisation des problèmes publics (Dubois, 2010) à travers l'étude des stratégies de mise à l'agenda politique local de questions stratégiques pour le développement d'organisations sportives endossant le rôle d' "entrepreneurs de partenariats" (Lascoumes & Le Galès, 2014).

Il s'agit de proposer une étude comparée de la relation qu'entretiennent différentes fédérations agréées avec les différentes strates de collectivités territoriales. Les données ont été recueillies en réalisant 25 entretiens avec des dirigeants sportifs fédéraux et locaux ainsi que des observations pariticpantes au sein de conférences (journées d'études nationales de l'Association Nationale des Directeurs d'Installations et Intervenants du Sport 2019 et 2020, forum Sportcoll sur les politiques sportives territoriales 2018, 2019 et 2020, animation d'ateliers sur la gouvernance du sport pour le CROS Ile de France) et de groupes de travail professionnels (suivi pendant trois ans de la commussion sport de l'association d'élus France Urbaine, suiv de l'installation des conférences régionales du sport en lien avec l'Agence Nationale du Sport, etc.).

La contribution modélisera les différents types de stratégies fédérales de mise à l'agenda politique local de problématiques de développement. Elle mettra notamment en évidence les thématiques récurrentes (équipements sportifs, événements sportifs, conventions de partenariat localisées) de cette articulation ainsi que les variables principales qui influencent ces résultats : logiques disciplinaires, contextes territoriaux, niveaux de développement des fédérations ou encore parcours, réseaux et représentations des dirigeants fédéraux et locaux etc. Elle soulignera les différents

*Speaker

enjeux et questionnements que recouvrent ces relations, entre concurrences et collaborations : articulation entre les différents niveaux d'échelles territoriales (Koebel, 2017), poids des stratégies respectives et des relations sociales entre les acteurs (Crozier, Friedberg, 1977) etc.

Keywords: partenariat, action publique, politique sportive, fédérations sportives, Jeux Olympiques

Analyse discursive de l'intégration des concepts de l'intégrité et de la crédibilité dans le lexique du mouvement olympique international.

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Dans un contexte marqué par une succession de scandales de gouvernance et de corruption, les organisations sportives internationales ont engagé depuis 1999 une vaste panoplie de réformes dites éthiques, comme par exemple la publication de codes disciplinaires et éthiques ou la création de commissions pour imposer des sanctions disciplinaires. Ces réformes se sont accompagnées par la mobilisation de discours autour de l'intégrité et la crédibilité.
La littérature a cherché à comprendre le fonctionnement et les résultats de ces politiques liées à l'intégrité ou la crédibilité du sport, mais sans explorer les enjeux de l'appropriation de ces discours pour les organisations sportives. Or, identifier ces interprétations est nécessaire afin de mieux comprendre les intérêts et les objectifs de ces organisations derrière leurs réformes éthiques. Le but de la présente recherche est ainsi de d'identifier la signification des discours autour de l'intégrité et de crédibilité pour les organisations du sport international. Une des principales hypothèses est que leur ntégration, progressive et fluctuante, dans le lexique des organisations sportives internationales indique une tentative de préserver leur légitimité, et ainsi de maintenir leur valeur symbolique et économique comme acteurs de référence du sport.
Nous avons procédé à une analyse discursive historique de la communication extérieure du Comité international olympique (CIO), l'organe faitier du mouvement olympique, depuis 1998, à savoir en amont de la première crise moderne de gouvernance et d'intégrité du sport international (le scandale dit de " Salt Lake City "). Les documents étudiés sont les rapports annuels, rapports thématiques, communiqués de presse, et les éditions de la Revue olympique. L'analyse couvre également les interventions publiques écrites ou orales du Président du CIO. Une approche quantitative de recensement des occurrences des deux termes, réalisée à l'aide du logiciel Nvivo, est complétée par une description qualitative de la façon dont ces termes sont employés. Présentés à la fois sous formes de frises et tableaux chronologiques et d'analyses discursives des principaux textes collectés, les résultats escomptés permettront d'illustrer la diffusion des deux termes et leur concordance avec des étapes historiques du mouvement olympique (élections présidentielles au CIO, scandales, ruptures juridiques, etc.). Les résultats noteront également l'évolution de leurs significations, et en particulier l'hypothèse d'un élargissement de la notion d'intégrité, au détriment de celui d'éthique. Enfin, une autre hypothèse est l'officialisation de la crédibilité dans la stratégie olympique autour de 2014, associée à une nouvelle posture publique du mouvement olympique face aux pressions politiques et à la crise réputationnelle des Jeux olympiques.
En montrant que l'appropriation particulière de ces termes résulte de choix stratégiques pour

*Speaker

faire face au discrédit, ces conclusions invitent, en s'inspirant d'une sociologie de la crédibilité et de la performance (Manning, 2000 ; Alexander, 2011) la recherche en sociologie et en management du sport à être attentif aux dispositifs discursifs et scéniques qui sont aux fondements de la valeur et du pouvoir des organisations sportives internationales.

Keywords: Intégrité, Crédibilité, Gouvernance, CIO, Mouvement olympique international.

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Digital Sciences and Technologies

Personality aware Self-Quantification System for Physical Activity Support

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Introduction
Physical inactivity is a major predictor of all-cause mortality. Research in movement science has already shown the benefits of physical activity (PA) on health. With the development of electronic sensors, people can use self-quantification tools to monitor and improve their PA. However, their current genericity results in drastically different effectiveness in changing behavior from one individual to another [1]. In order to provide a personalised experience tailored to the user, we propose a rationale for adapting the human-computer interaction based on user personality traits, with the ultimate goal of increasing PA in a sustainable way.

Methods
Psychology research shows that people with high levels of neuroticism are associated with less PA and a greater chance to discontinue an activity program as they do not engage with behavior change techniques traditionally used in PA promotion apps. Adopting a multidisciplinary approach around psychology and human-computer interaction, we found that individuals with high neuroticism should be more receptive to behavior change techniques informing about the emotional consequences of PA practice [2]. For this specific population, we scout for guidelines on how to implement the interaction in a principled manner and outline an evidence-based approach to effectiveness of the proposed solution.

Results
We hypothesize that the implementation of the behavior change technique informing about the emotional consequences of PA in a smartphone app using push notifications, textual feedback, and data visualization should increase PA levels of individuals with high neuroticism. To test the effect of such an app, the experimental protocol compares two randomized groups of 14 persons (18-40 y.o., high on neuroticism, and not meeting the WHO guidelines for PA) who wore an activity tracker measuring their active minutes every day for 1 month: the first with non-individualized content similar to that in generic commercial apps; the second with individualized feedback informing that PA has noticeable benefits on emotional management.

Discussion
Combining health psychology, movement science, and computer science revealed that consideration of personality is important for a quantified self approach to learning healthy PA habits.

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However, we only addressed neuroticism, whereas other personality traits, such as conscientiousness, also impact PA participation and necessitate an additional individualized intervention. It is also likely that combining behavior change techniques would be an asset to promote long-term maintenance of effects.

Conclusion

We illustrate here a multidisciplinary integrative approach towards individualizing interaction with digital tools to support PA according to personality traits defined by the Five-Factor Model [3].

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Keywords: Quantified Self, Health, Physical Activity, Behavior Change Technique, Support System, Persuasive Design, Human, Computer Interaction, User Centered Design, Individualization, Personality Traits, Big Five Inventory

Embodying digital technology in orienteering: a middle school example.

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The engagement of students in physical and motor practices is a central challenge of physical education (PE). As such, digital tools are increasingly explored as levers to foster this involvement. However, the use of these tools raises many questions about their effects on learning and their dependence.
Student activity and adaptation will be central to the creation of a digital environment (Norman 2013), open source, in a "third places", Fablabs.

This tool consists of a GPS sensor, a Raspberry battery server and an interface D.O.R.A. (Digital Orienteering Race Application), which can be consulted on a browser. This interface allows the visualisation of the student's GPS track, the validated beacons, the speed of movement for each session. The tool also allows the comments and emotions of each student to be recorded, constituting a training log, a collection of objective and subjective datas.

This research-action is taking place in a sixth grade class (24 students) of an urban middle school during an orienteering cycle. The objective is to measure the added value of the digital tool on the learning of orientation, i.e. the relation between the activity of the pupil and its effects on his environment.

All the pupils are equipped with a GPS sensor in addition to the paper map and the control card. At the end of their race, the first group (selected at random) uses D.O.R.A. with the support of the PE teacher. The control group benefits from the feedback of the "traditional" teacher on the validation of the markers and the cross-referencing of information through the student's narrative, information available during a orienteering cycle.

Our preliminary results reveal that after a discovery phase, students seek information accuracy as a source of engagement. The (allocentric) visualisation of the pupil's route on the same map as the position of the marker enables him to measure the difference between the (egocentric) representation he had made of his position and his "real" movement in the environment and thus to delay the decision error (use different neural bases according to Berthoz, 1997). The interface from the video game culture contributes to engagement but is not enough. It is the precision (datas between beacons) and the individualised feedback that allow the peaks and valleys of the student's activity to be analysed through the speed graph according to a path analysis of the experience (Theureau, 2015). The peaks and valleys show the profiles of the orienteers that can suggest remediation exercises for the teacher or the student's attention in relation to the

*Speaker

potentialities of the environment, here considered as enactive (Varela, 1991). The experience of action and perception of the environment are self-sustaining in a living cycle (autopoiesis).

This hybridization of points of view (students, teachers) and technologies (physical and digital) engages a "phygital" reflection on the "teacher designer" (Saury, 2013). The digital tool evolves students' practices and interactions, as well as those of the teacher, through the choice of parameters and their treatment. This may be a possible way of adapting to the complexity of the professional environment of a 21st century physical education teacher.

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Keywords: Enaction, phygital, cours d'expérience

Incorporating Technology in Physical Education: How increasing the uncertainty in practice can foster exploratory learning.

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Introduction
In learning efficient climbing, Seifert et al. (2015) showed that manipulation of hold orientation during a learning protocol invited individuals to both exploit their pre-existing behaviours (i.e., horizontal hold grasping pattern and trunk face to the wall) and to explore new behaviours (i.e., vertical hold grasping and trunk side to the wall), leading to a safe functional exploration during learning. The purpose of this study was to investigate the effect of providing different amount of information (i.e., increasing or decreasing the amount of uncertainty) as a way to foster exploratory activity of students in learning climbing during Physical Education lessons.

Methodology
Climbers (N=20, mean age 15.6 years (+/-1.6)) were assigned to an "experienced" group or a "novice" group based on their initial performance. They practiced 3 times not identical but similar routes, each time with a different number of visible holds. This was possible as the practice was performed on an electronic climbing wall where the holds can be light on/off from a computer (www.climbling.com). During the first trial, only the next hold was visible (the hold lights on as far as the climber actually climbs up), the second trial showed only the 3 next holds, the third trial showed only the next 5 holds. Both the i) performance (i.e., time of the ascent), ii) efficiency (i.e., geometric index of entropy) and iii) exploratory activity (hold touches) were measured during each ascent.

Results
The experienced group showed better performance and fluidity based on time of ascent and traditional index of fluidity. The geometric index of entropy was 0.76 ((+/-0.04) for experienced students and 1.52 ((+/-0.12) for novices. In the same vein, the level of exploration was very low for both groups without any significant difference between the groups (mean = 0.7 touch before grasping +/-0.4). However interestingly, a significant drop appeared in the indicators only for the expert group between the 1 visible hold condition and the 3 visible holds condition, namely the fluidity improved with 3 visible holds compared to 1 visible hold condition, when the level of exploration decreased when the number of visible holds increased. Eventually, decreasing the certainty of what will come next increased the exploratory activity of those expert climbers and appears to be an interesting way to foster exploratory learning in climbing.

*Speaker

Discussion & Conclusion

The present study advocates about a limited information gathering from the novice students in terms of the consideration of the following holds. Indeed, whatever the number of visible holds, novices did not exhibit any change in fluency, showing that this information (i.e., following holds) is not effectively used by those students). Concerning the experienced students, they showed a drop in fluency advocating that experienced climbers can ensure the fluidity of their climb by anticipating on the next 3 holds, and if those next 3 holds are not available it impacts the performance and fluidity of the climbers. In addition, removing this information for those students increased their motor exploration during practice, suggesting that the infusion of uncertainty in practice can foster exploratory learning.

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Keywords: Technology, physical Education, climbing, exploratory learning

Implementation of brief meditative practices in the training of young teachers: a pilot study based on the digital tool.

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Introduction

Teaching is known as emotionally demanding profession, especially for pre-service teachers which tend to experience higher rates of emotional exhaustion and attrition (Guarino et al., 2006). Helping teachers to thrive at work is yet to consider as a worthy goal, as it benefits simultaneously for teachers' outcomes and for students' better learning outcomes as well (eg. Jennings et al., 2017). Developing teachers' emotional competences is thus an important endeavour for teacher training organizations.

One promising line consists in implementing mindfulness practices in the training curriculum. Theses consist of "*paying attention in a particular way: on purpose, in the present moment and nonjudgmentally*" (Kabat-Zinn, 1994, p.4). Their benefits in educational context were investigated in the last decades, showing psychological well-being increasing and teaching efficacy improvement (eg. Becker et al., 2017).

Despite their promising results (see Park et al., 2020), most of these studies are based on limiting cumbersome implementation processes. Digital democratization of meditation tools might respond to this difficulty, leading us to wonder if brief autonomous meditation practices could induce significant effects on dispositional mindfulness, emotional regulation, and on the emotions felt by trainee teachers in the classroom.

Method

Study design and sample

158 pre-service teacher students were involved in a longitudinal design study. The meditation programs, built by certified expert practitioners, were given through dedicated cell phone application. Participants of the experimental conditions (G1: mindfulness; G2: compassion meditation) were asked to autonomously ensure at least one weekly 15-20 min session. Active control group did bibliographical researches.

Instruments

Dispositional mindfulness was measured with the Mindful Attention Awareness Scale (MAAS-

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French version, Jermann et al. 2009), *Emotional regulation* ability was assessed by the Emotional Regulation Questionnaire (ERQ-French version, Christophe et al. 2009), and the *Teachers' emotions* through the Teacher Emotions Scale (TES, Frenzel et al., 2009). Control variables of participants personality was assessed through Big Five Inventory tool (BFI-French version, Plaisant et al. 2010).

Statistical analysis

The data were analysed through Latent Growth Modeling (LGM) and Repeated Measures Anova (ANOVA-RM).

Results & Discussion

Results of this pilot study confirmed that a weekly session of brief mindfulness-based practice (bMBP) allows to increase dispositional mindfulness state ($p < .05$), and to significantly decrease anxiety state ($p > .001$) for both experimental groups. ANOVA-RM analysis complementarily showed that dispositional mindfulness improvement required 9 weeks of practice.

No significant effect was contrariwise observed on teaching pleasure. Surprisingly, G2 shown increased feeling of anger. This result could be linked to changes in emotional regulation strategies over time in the experimental groups ($p < .05$). Not described so far in the literature, this ascertainment deserves to be more deeply explore in future studies.

Conclusion

This pilot study is a first step towards the pragmatic implementation of meditative practices in the pre-service teachers' curriculum. Supported by technological and digital democratization, it aims at promoting the development of teachers' emotional competences, today considered as central professional competences. Following, deeper investigations are now planned extend these results and explore potential effects on classroom climate.

Keywords: brief mindfulness, based interventions, pre, service, teachers, emotions, teachers training programm

Setting up a remote care pathway for fibromyalgia patients: protocol of the Fibr'online study

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Introduction

Recent recommendations for fibromyalgia raise the importance of adapted physical activity (APA) and interdisciplinary health education as non-pharmacological strategies for the management of this syndrome [1,2]. Restrictions related to the current health situation do not allow patients to benefit from this care in hospital. The objective of this project is to develop a remote care pathway for fibromyalgia patients, who will benefit from a mixed program of APA and Therapeutic Patient Education (TPE), and to evaluate its effects on different bio-psycho-social parameters.

Method

We include patients diagnosed with fibromyalgia according to the last criteria of American College of Rheumatology [3]. Each participant benefits from two hospital visits for initial and final program tests: VO2max, upper and lower limb strength (handgrip and leg extension), baroreflex, actigraphy and symptoms questionnaires. The rest of the program is done remotely with an online tool over a 4-week period. The training program consists of two online sessions of 90 minutes per week performing a mixed program of endurance on a cycle ergometer, muscular strengthening at body weight, and stretching / relaxation. The sessions are supervised by an APA teacher. At the end of the program, each participant is invited to contact a sport-health platform in order to continue the APA practice. The TPE program includes a 90 minutes weekly workshop covering the following themes: physiopathology of fibromyalgia (internal medicine department),

*Speaker

professional activity (occupational health department), physical activity and sedentary lifestyle (sports medicine department), and a discussion group on daily life (pain assessment and treatment center). This last workshop takes place face-to-face after the final tests and concludes the program.

Discussion
The implementation of this remote care pathway allows us to maintain continuity of care for the fibromyalgia patient. Indeed, in the absence of efficient drug treatment, APA could be an effective way to reduce chronic pain and fatigue, while reversing the vicious circle of physical deconditioning.

Conclusion
If the Fibr'online study proven to be effective, continuity of care through the digital tool could be maintained for people who are geographically distant.

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Keywords: Fibromyalgia, Remote care pathway, Adapted Physical Activity, Therapeutic Patient Education, Digital Tool

Automaticity of E-health for Exercise and Physical Activity

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Background
The development of Smartphones goes hand in hand with the growth of e-health for exercise and physical activity - defined as digital, online, or internet tools intended to help people practice exercise or physical activity. Research over the last decade suggests that interaction with these technologies occurs through habitual processes (Larose, 2010), characterized by more or less automatic thinking (Bayer & Campbell, 2012). The concept of automaticity represents a cognitive process that lacks intentionality, lacks control, is wholly or partially unconscious, and is highly efficient (Bargh, 1994). So, it is likely that the use of e-health for exercise and physical activity could be highly influenced by habit automaticity, as these technologies have become embedded in everyday life and underlying cognition (Bayer, Dal Cin, Campbell, & Panek, 2016). Consequently, one might expect an effect of automaticity on physical activity levels (Gardner et al., 2011). In this research, we sought to determine the relationship between Automaticity (Boiché, Marchant, Nicaise, & Bison, 2016) using e-health and physical activity levels.

Method
An online survey was conducted during the first wave of the Covid-19 pandemic in France. A total of 569 adults participated in the study, of which 299 (58%) were eHealth users for exercise and physical activity. E-health users responded to a questionnaire on automaticity measured by nine items of the Generic Multifaceted Automaticity Scale, a validated scale in French (GMAS; Boiché et al., 2016). This instrument assesses three dimensions of automaticity (α=.78)- lack of intentionality(α=.64), lack of control (α=.66), and efficiency (α=.72). Also, physical activity behavior was measured using the International Physical Activity Short Form (IPAQ-SF; Craig et., 2003).

Results
Correlations indicated a significant and positive relation between efficiency and vigorous MET Minutes (the amount of energy expended during a minute while at rest) per week (r= .21, p < .01). Regressions showed that efficiency explained 5% of the variance of vigorous physical activity per week (ß = .20, p < .05).

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Conclusion
eHealth use can be characterized by its automaticity that, in turn, could have a positive influence on physical activity levels. Similarly, these tools offered on Smartphones could play an essential role in promoting physical activity. However, we must put any technological solution into perspective. eHealth offers possibilities to stay active, but its benefits, and the psychological mechanisms they affect, remain to be demonstrated.

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Keywords: Automaticity, Digitalisation, Motivation, Behavior

Setting up a remote care pathway for fatigue management for patients with COVID-19: the CoviMouv' protocol study.

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Introduction
The duration of hospital stay following a COVID-19 infection is possibly increased due to the persistence of fatigue in 29-46% of cases [1] and an optimized management is essential to avoid chronicization. Chronic fatigue syndrome has for example affected around 40% of patients with severe acute respiratory syndrome in 2003 and persisted beyond 3 years [2]. There is currently no specific treatment for acute or

Method
Since February 1st, 2021, we included patients hospitalized in non-intensive care unit showing post-Covid-19 fatigue, with positive RT-PCR (Reverse Transcriptase Polymerase Chain Reaction)

Discussion
Persistent fatigue following an infection to COVID-19 is frequent and can increase the duration of hospitalization of concerned patients. To adapt to sanitary restrictions, we propose a multidisciplinary online program allowing to manage persistent symptoms post-COVID. This allow to ensure a pertinent follow-up in order to promote healing and avoid the establishment of vicious circles that fuel the chronicization of symptoms, as seen in the chronic fatigue syndrome or fibromyalgia syndrome.

Conclusion
The remote care pathway for COVID-19 patients with persistent fatigue could reduce hospitalization duration of these patients by offering them an adapted and supervised care. This innovative alternative could help to relieve hospitals congestion.

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Keywords: Fatigue, COVID19, Remote care pathway, Multidisciplinary online program, Adapted Physical Activity, Functional somatic disorders

Assessment of a digital assistant for physical activity prescription: a preliminary study

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Introduction
WHO recognized that Physical Inactivity (PI) and Sedentary Behavior (SB) was a pandemic in 2006 [1]. In addition, current COVID-19 dramatically worsen PI and SB behavioural tendencies [2]. Adapted physical activity prescription (APAP) is strongly associated with behavioral change and can be a lever to reduce PI and SB in chronic diseases [3,4]. The goal of this study, conducted on a sample of general practitioners and specialists, was to evaluate a digital tool promoting APAP. We hypothized that DiAPTIC® would remove barriers to APAP effectiveness [5], increase the frequency of APAP and its adequation to national recommendations of the the French National Authority for Health (HAS).

Method
A convenient sample of french medical practitioners were contacted in national territory to participate. 11 volunteers were split randomly in a randomized control trial : 6 in the control group (GC) and 5 in the intervention group (IG). DiAPTIC® was developed in the form of decision trees based on the HAS guide. The tool provides individualized recommendations after completing some questionnaires to assess health and physical activity conditions. Participants in IG used DiAPTIC® whereas those in CG were free to use another tool or none. An APAP training was delivered to both groups. During randomization period (t1), a "PAP" questionnaire was administered to assess practitioners' knowledge, training, habits and practice. During a 2-months period (t2), after prescribing APA to chronic disease patients, practitioners completed a "Quali-HAS" questionnaire to report their APAP content. After the intervention (t3), the "PAP2" and a "System Usability Scale" were fullled. Analyses are currently being conducted (1) to compare the number of prescriptions made between the two groups (2) to compare number of validated items corresponding to national recommendations and (3) to identify the strengths and weaknesses of the tool (SUS). Next analyses will identify change in knowledge and habits through data between "PAP" and "PAP2". Finally, average scoring of "SUS" will show strengths and weaknesses of the tool.

Expected results
Comparison during interventional period should indicate more APAP in the IG than CG. We also expect a better evolution of APAP content according to HAS guidelines on the IG. Rating of the tool using the "SUS" should demonstrate that DiAPTIC® is an adapted tool to medical practitioners.

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Discussion
The results highlight relatively homogeneous groups. Health context and medical priorites of vaccination for practitioners made it difficult to recruit participants.

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Keywords: Physical activity, prescription, health assessment, digital assistant, HAS, diagnosis, usability

Design and methods of a national, multicenter, randomized controlled trial to assess the efficacy of a physical activity program to improve quality of life and reduce fatigue in women with metastatic breast cancer: the ABLE02 trial

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Introduction
Patients with a metastatic breast cancer suffer from a deteriorated quality of life and numerous symptoms such as pain, severe fatigue and a decrease of their physical fitness1. As the feasibility of a physical activity program has been demonstrated in this population, ABLE02 aims to assess the efficacy of a 6 month-physical activity program based on connected devices to improve health-related quality of life and to reduce fatigue in women with metastatic breast cancer.

Methods/Analysis
ABLE02 is a prospective, multicenter, randomized, controlled and, open-label study2. 244 patients with a metastatic breast cancer, at least one positive hormone receptor and a first-line chemotherapy planned will be randomly assigned (1:1 ratio) to: (i) the intervention arm to receive physical activity recommendations, an activity tracker to wear 24 hours a day during the

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whole intervention (6 months) with at least three walking sessions weekly and quizzes to answer each week on physical activity and nutrition (ii) the control arm to receive physical activity recommendations only. Quality of life will be assessed every 6 weeks (EORTC QLQ-C30) for the primary endpoint. Assessments will be conducted at baseline, three months, six months, twelve months and eighteen months to evaluate clinical, physical, biological and psychological parameters and survival of participants. All questionnaires will be completed online on a dedicated application.

Discussion

An activity program based on smartphone application linked to an activity tracker may help to improve quality of life and reduce fatigue of patients with a metastatic breast cancer. The growth of connected health offers the opportunity to get real-time data as well as improving patient empowerment in order to change long-term behaviors.

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Keywords: physical activity, cancer, eHealth, physical activity tracker

A Face-to-face and videoconference-based adapted physical activity training for elderly: a comparison study

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Introduction
Loss of balance, dizziness, and falls are common with advancing age. Many structural and functional changes occur with age at different levels of sensory and motor systems and can result in functional impairment. Physical training adapted to elderly population demonstrated beneficial effects on equilibrium. However, the need of transportation can be an obstacle for seniors: the situation that is currently aggravated by the COVID-19 pandemic. Videoconference-based physical activity programs are being developed, combining the benefits of supervised Adapted Physical Activity (APA) with no transportation required. However, physical activity with the use of a screen can be considered an optocinetic stimulation, and is therefore capable of inducing changes in the sensory processing, which in turn can affect postural stability.

Objectives
The objectives of this study were to compare the efficiency of the APA training delivered Face-to-Face and by Videoconferencing for amelioration of physical capacities and to evaluate the possible effects of the Videoconference-based mode on the processing of sensory information and balance in elderly population.

Methods
Twenty-eight participants aged between 66 to 79 years old were divided into two groups: Face-to-Face (n = 15) and Videoconference Training Group (n = 13). Both groups underwent APA program for sixteen weeks (one hour training session twice a week). Isometric force of the knee flexors and extensors, VO2 max, horizontal rotational vestibulo-ocular reflex and postural control were evaluated before (T1) and after (T2) the APA training.

Results and conclusion
Face-to-Face and Videoconference-based Adapted Physical Activity training improved general physical condition of all subjects by increasing the VO2 max and improving muscular force and momentum of the force in the knees and ankles. The use of the Videoconference-based training

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does not seem to have altered vestibulo-ocular sensory interactions in subjects or the impact of the visual system in postural control. Therefore, the Videoconference-based Adapted Physical Activity training can be considered a safe and efficient way to maintain good physical capacities in elderly.

Keywords: Adapted physical activity, Videoconference, Physical capacities, Balance control, Sensory information, Aging

Hybrid program based on virtual and real games increases fundamental movement skills in children with intellectual disability: A quasi-experimental study

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Introduction
A recent systematic review revealed that it is currently unclear whether the effects of Adapted Physical Activity (APA) programs are truly effective in improving Fundamental movement skills (FMS) among children with intellectual disability (ID) (Maïano et al., 2019). This review reported that the most effective type of motor skill intervention for improving FMS in children with ID should be examined thoroughly in further studies comparing various motor skill intervention programs. The purpose of this study was to examine the effects of two types of APA programs (hybrid virtual/real vs. conventional) on the FMS in children with ID.

Methods
Twenty-four children aged 7–10 years old with ID were randomly assigned to either the hybrid (experimental group : EG) or the conventional (control group : CG) groups and were evaluated across 10 weeks. The hybrid program was based on virtual (Kinect® Xbox 360) and real games situations, while the conventional program was based on adapted sports (football and long jump). The participants are characterized by mild ID with an intelligence quotient between 50 and 70 using the Wechsler Intelligence Scale for Children-V (Wechsler, 2014). The EG composed of 5 girls and 7 boys and the CG composed of 6 girls and 6 boys.
FMS were evaluated using the Test of Gross Motor Development-2 (Ulrich, 2000) at pre-program and post-program for both groups.

Results
The 2-way ANOVA showed significant main effect of the intervention factor (Locomotor Scores (LS) : $p < .001$, $\eta 2p = .63$; Object Control Scores (OCS) : $p < .001$, $\eta 2p = .71$; Gross Motor Skills (GMQS) : $p < .001$, $\eta 2p = .42$) and group* intervention interaction (LS: $p = .007$, $\eta 2p = .29$; OCS: $p < .001$, $\eta 2p = .65$; GMQS: $p < .001$, $\eta 2p = .39$) on the LS, OCS and GMQS. However, a non-significant main effect of the group factor was found on the LS ($p = .68$, $\eta 2p = .00$), OCS ($p = .719$, $\eta 2p = .00$) and the GMQS ($p = .215$, $\eta 2p = .06$).
The Post hoc test results showed that the LS was significantly higher in both of the EG (p

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$<$ .001) and CG (p = .032) after the intervention period. However, the OCS ($p <$ .001) and GMQS ($p <$ .001) were significantly higher only in the EG at post-intervention compared to pre-intervention.

Discussion

The APA hybrid program based on virtual and real games situations soliciting motivation and physical engagement could have additional beneficial effect on the FMS proficiency as well as locomotor and object control skills. Based on our results, the conventional APA program including adapted sports may improve only the locomotor skills if they do not include specific exercises to develop object control skills. Children with ID may acquire benefit from 10 weeks of an APA hybrid program including virtual and real games on their FMS.

Conclusion

Adapted physical educators or teachers could be recommended to use games situations with virtual reality device as adjuvant therapy to other proven successful conventional interventions to promote better FMS development in children with ID.

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Keywords: Adapted Physical Activity, Fundamental movement skills, Locomotor Skills, Object Control Skills, Kinect® Xbox 360, TGMD, 2

Comparative study of a respiratory rehabilitation program in hospital and tele-rehabilitation program for patients suffering from post-covid 19 sequelae

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Introduction

Some patients retain sequelae from infection after the acute phase of Covid-19. These are multiple. They can be physical (dyspnea, exercise intolerance, abnormal fatigue...) or psychic (anxiety, depression, post-traumatic syndrome...) (1). Rehabilitation support is therefore necessary for these patients. Respiratory rehabilitation in SSR (Soins de Suite et de Réadaptation) is recommended for post-covid 19 patients. It decreases symptoms of disease with an improvement of lung function and fatigue reduction (2). In this context, an important risk of saturation in SSR is to be feared. Because Covid-19, telemedicine is developing. In this sense, tele-rehabilitation is an effective option for patients with respiratory diseases like COPD. This intervention is associated with a significant improvement in exercise tolerance, life quality and dyspnea reduction (3). It should be ensured that tele-rehabilitation has a comparable effectiveness to classical rehabilitation in SSR.

Method

This randomized controlled study aims to compare two respiratory rehabilitation programs on physical and psychological patient capacities - a respiratory rehabilitation program in hospital (RR group) and a tele-rehabilitation program supervised using digital tools like heart rate monitor and GPS connected or videoconference (TRR group). Each group has multiple activities per week (8 endurance sessions, 3 gymnastics sessions and 1 sophrology session) for 4 weeks. The comparison of the two programs was made from physical performances (6MWD), fatigue (MFI), anxiety and depression (HADS) and quality of life (VQ11). A two-way (time and group) anova was used for statistical analysis.

Results

13 subjects (age: 56.8 ± 16.5 years, BMI: 30.4 ± 6.4 kg.m-2) have currently realized the protocol in totality.

*Speaker

Discussion
First results seem to show similar efficacy of RR and TRR rehabilitation on several parameters: physical performance, fatigue and quality of life. We will be able properly to compare the 2 methods at the end of the study (September 2021), when having enough subjects.

Conclusion
If the hypothesis that the two methods have similar effects is verified, this would allow the generalization of the prescription of TRR. The benefits will be individual with greater access to respiratory rehabilitation for post COVID patients. There will also be collective public health benefits by maintaining sufficient access to SSR for patients with chronic diseases.

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Keywords: Covid, 19, Respiratory rehabilitation, Telemedecine, digital tools

Neuroscience - motor control

Influences of hip abductor muscles fatigue on ankle stability

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Introduction
Ankle sprain is one of the most common injuries in sport. Additionally, 40% of those acute ankle sprains evolves towards chronic ankle instability (CAI). CAI is associated to substantial consequences, such as pain, swelling, limited motion, articular instability, motor and sensory impairments (Hertel and Corbett, 2019). Therefore, to better address acute ankle sprains and try to reduce the incidence of CAI, it seems essential to understand associated risk factors. Among those factors, hip abductor muscles weakness has been reported (Powers et al., 2017). However, there is a lack of study analyzing the specific relationship between hip abductor muscles strength and ankle stability impairments (Gafner et al., 2018). Therefore, the aim of this study is to determine the impact of hip abductor muscles fatigue on ankle stability mechanisms. It is hypothesized that both static and dynamic balance and dynamic evertors strength would be impaired in response to hip abductors fatiguing exercise.

Methods
Twenty-five active subjects (18-25 years-old) without injuries history in lower limb within 6 last months will participate to this study (April and May 2021). Subjects will be excluded if they present functional ankle instability after completed a self-reported questionnaire (CAIT : score of < 24). Experiments will include 4 tests (Unipedal eyes closed Balance test; modify Star Excursion Balance Test; Weight Bearing Ankle Inversion; Weight Bearing Ankle Eversion) allowing to assess static and dynamic balance, concentric and eccentric evertor muscles strength. In order to be specific to ankle joint, those tests will be performed on a destabilization device (Myolux Medik II). This device was previously used in literature and appeared relevant to explore evertor muscles weakness. It is composed of an articulator located under the rear foot which imply a destabilization along the physiological subtalar axis allowing both inversion and eversion movements. Tests will be executed before and after a fatiguing protocol of hip abductor muscles consisting in repetitions of hip abductions at 60 rpm with 30∘ range of motion. The fatiguing exercise will be performed until the maximal voluntary isometric contraction (MVIC) of hip abductor muscles decreased by 50% of pre-fatigue MVIC. Electromyographic activity of peroneus longus and brevis, tibialis anterior, gastrocnemius lateralis and gluteus medius muscles will be recorded during tests. In addition, angular velocity during inversion/eversion movements performed on the destabilized device will be recorded using an inertial measurement unit.

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Results/discussion
In response to the fatiguing hip abductors exercise, impairments of ankle stability mechanisms are expected. Identifying these relationships would allow to specify importance of hip abductor muscles strength on postural control and ankle evertor muscles strength. These results could help clinicians and physical trainers to improve prevention programs for ankle sprains.

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Keywords: Risk factor, Ankle sprain, Prevention, Fatigue, EMG

Effects of acute physical fatigue on gaze behaviour and performance in novice badminton players

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Introduction
In badminton, the ability to quickly gather relevant information is one of the most important determinants of performance. However, gaze behaviour has never been investigated in a real game setting, which involves fatigue, nor related to performance. The aim of this study was to evaluate the effect of fatigue on gaze behaviour during a badminton game, and to determine the relationship between fatigue, performance and gaze behaviour.

Methods
Nineteen novice badminton players equipped with eye-tracking glasses played two badminton sets: one before and one after a fatiguing task. A binocular mobile eye-tracking system (Pupil Core Labs eye-tracker, sampling frequency: 120 Hz, accuracy 0.6○) was used to record eye motion during pre-fatigue and post-fatigue sets. We measured gaze duration and the number of fixations in nine pre-defined locations of interest (Triolet et al., 2013).

Results
Performance in terms of points won or lost and successful strokes was not impacted by fatigue ($p > .05$) however fatigue induced more fixations per exchange on two areas of interests (shuttlecock,$p < .05$, $R2=.61$, Cohen's $d=-.53$ and empty area after the participant's stroke, $p < .05$, $R2=.48$, Cohen's $d=-.51$). Furthermore, two distinct gaze behaviours were found for successful and unsuccessful performance: won points were associated with fixations on the boundary lines ($p < .05$, $R2=.25$, Cohen's $d=.42$) and few fixation durations on empty area before participant's stroke ($p < .05$, $R2=.48$) ; successful strokes were related to long fixation durations ($p < .001$, $R2=.64$, Cohen's $d=2.00$) and a large number of fixations on the shuttlecock ($p < .001$, $R2=.56$, Cohen's $d=1.27$), opponent's racket ($p < .001$, $R2=.49$, Cohen's $d=1.75$), opponent's upper body ($p < .001$, $R2=.66$, Cohen's $d=2.0$) and anticipation area ($p < .001$, $R2=.77$, Cohen's $d=3.1$).

Discussion
This is the first study to use a mobile eye-tracking system to capture gaze behaviour during a real badminton game inducing fatigue: the results showed that gaze behaviour was impacted by

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fatigue (Alder et al., 2019), and that successful and unsuccessful performance were associated with two distinct gaze behaviours (Sáenz-Moncaleano et al., 2018). Moreover, the players' gaze behaviour was typical of non-experienced players, with a main focus on the shuttlecock. This study opened new researches on experts involving new variables linked with gaze behaviour like anticipation.

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Keywords: Physiological load, eye movements, visual search strategy, visual perception, racket sports

Relationship between the level of mental fatigue induced by a prolonged cognitive task and the degree of balance disturbance

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Introduction
Mental fatigue (MF) refers to a change in psychophysiological state caused by prolonged period of demanding activity (Boksem et al., 2005). MF can affect balance control by impairing executive functions and reducing attentional resources (Hachard et al., 2020). Even thought there might be large inter-individual differences in neurobehavioral responses to MF, no study has addressed the issue of inter-individual variability in balance control impairments due to MF. Hence, this study investigated the effects of MF induced by a demanding cognitive task on balance control by addressing the issue of the heterogeneity of individuals' responses.

Methods
Twenty healthy young active participants were recruited. They had two sway as little as possible with the eyes open and closed when standing on a force platform before and after performing a 90-minute AX-CPT. The NASA-TLX test was used to assess the subjective manifestations of MF. Objective cognitive performance was measured using results from the AX-CPT. Inter-individual differences in behavioural deterioration due to MF were analysed with a hierarchical cluster analysis. In order to examine the relationships that could exist between behaviour typologies from subjective workload, cognitive performance and balance control data, the cluster number of each participant was assigned as a categorical variable in each type of cluster and contingency tables between cognitive performance / subjective workload and balance control categorical variables were constructed. The link between these variables were tested with the Fisher's exact test for count data.

Results
The cluster analysis revealed that the achievement of the AX-CPT induced various levels of MF and balance impairments within the whole sample. Three clusters were identified with the NASA-TLX and balance control data and two clusters were identified with the AX-CPT data. The Fisher's exact test showed that there was a significant association between balance clusters and NASA-TLX clusters ($p = 0.02794$) and between balance clusters and AX-CPT clusters ($p = 0.02671$) only when balance control was assessed with the eyes open.

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Discussion
The significant relationship between the level of MF and the degree of balance disturbance observed when participants stood with the eyes open suggests that inter-individual differences in vulnerability to MF could stem from differences between subjects in the level of engagement of visual attention and/or from differences in field dependency for balance control. These findings show that the implementation of a similar prolonged demanding cognitive task induces a strong heterogeneity in subjects' responses, with marked individual differences in MF vulnerability that affect balance control differently according to the sensory context.

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Keywords: Fatigue mentale, posture, équilibre, tâche cognitive

Brain adaptations to mental fatigue induced by a time-trial cycling exercise; a preliminary study

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Introduction

Mental fatigue state, which is characterized by alterations in cortical activity, could be induced by high-order cognitive control tasks. This state, by increasing the subjective feeling of fatigue and decreasing cognitive capacities, can impair the cycling performance especially in Time Trial (TT). TT requires a high cognitive control on sensory cues to deal with aversive sensations and regulating the pace to realize the best performance, this adding mental fatigue (Pires *et al.*, 2018). However, no studies recorded the amount of mental fatigue accumulated following a TT and its repercussion on the cycling performance that follows. Our hypothesis is that the mental fatigue caused by TT could increase the alpha, beta, and gamma waves in the motor (MC), parietal (PC), and prefrontal (PFC) cortex and the rate of perceived exertion (RPE) at different intensity zones (IZ).

Methods

Six trained cyclists a pedaling exercise before and after a 17.8km virtual TT. The exercise consisted in pedaling 10 min on a treadmill at a 7% slope in the middle of five different IZ according to the scale of rating of subjective exercise intensity (RSEI) scale (Grappe, 2005). It was constituted of 4 consecutive blocks of 2 min at different MAP percentages (IZ1=40%, IZ2=55%, IZ3=68%, IZ4=80%), followed by 1 min recovery at 40% MAP, to finish with a block of 1 min at 93% MAP (IZ5). Electroencephalographic (EEG) power spectral density (PSD) activity of the MC, PC and PFC in the alpha (3-8 Hz), beta (13-30 Hz), and gamma bandwidth (30-40Hz) were recorded during the last 30-sec of each intensity block. RPE was measured with the CR10 scale for each IZ block. A Wilcoxon test was performed to investigate, for each IZ, the difference in RPE and alpha, beta, and gamma PSD activities in the MC before and after TT tests. Cohen effect size was calculated for each set of data. Cohen's d classification of effect size magnitude was used, whereby $d = 0.2$–0.49 = small effect; $d = 0.50$–0.8 = moderate effect and $d > 0.8$ = large effect.

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Results
After the TT, gamma PSD activity increases significantly in the MC for the gamma bandwidth during IZ4 (+77 ± 103%, $p < 0.05$, $d > 0.8$), and moderate effect size ($d > 0.8$) was reported during IZ2 (+76 ± 142%), IZ3 (+38 ± 122%) and IZ5 (+67 ± 141%). Moreover, the TT had a large size effect on the PFC gamma activity for IZ1 (+20 ± 30%), IZ4 (+89 ± 192%), and IZ5 (+43 ± 114%). Significant increases ($p < 0.05$) in RPE ($d > 0.8$) were also reported after the TT, for all IZ (+63 ± 19.5% for IZ2; +49.7 ± 46.3% for IZ3; +39.8 ± 24.7% for IZ4; +37 ± 11.5% for IZ5).

Discussion
The significant increase in the MC activity during IZ4, and the tendency of increase in the MC and PFC gamma activity observed during the treadmill test could be due to the mental fatigue accumulated during the TT. These evolutions of brain activity in these moderate to severe intensity zone would be caused by the difficulty to deal with aversive signal in an increased mental fatigue state during a high-intensity effort, which necessitates increasing the brain motor outflow to maintain the intensity effort (Pires *et al.*, 2018). It is supported by the increase in RPE that will allow preserving body integrity.

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Keywords: Electroencephalography, Mental fatigue, Cycling, Time, Trial

Effect of pre-exercise subjective fatigue on perception of effort, performance, and recovery of fatigue perception following a standardised incremental stepwise cycling test

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Introduction
Though often used synonymously [1], perceptions of effort and fatigue represent distinct constructs [2]. Understanding of how these perceptual constructs interact with the regulation of exercise performance is currently not well understood, though preliminary evidence indicates that fatigue state influences how effortful exercise is perceived to be [4]. The aim of the present study was therefore to add to this body of evidence and assess the impact of a heightened fatigue perception prior exercise on effort perception and physical performance. A second aim was to monitor fatigue state for 15 min post-exercise.

Methods
Thirty physically active participants gave written informed consent prior to the study. Each participant rated state of fatigue (0-10 Rating of fatigue (RoF) scale [2]) and trait of fatigue (Profile of Mood States (POMS-F) [5] before performing a 3-min stage incremental cycling exercise to volitional task failure, with 75 s of rest between stages (Monark 874E, Sweden). Initial power output was 50% of pre-determined peak power output (PPO; 20 W.min-1 ramp test) with a 10% PPO increment. Rating of Perceived Effort (RPE) [6] and heart rate (A300 Fitness Watch, Polar Electro Oyo, Finland) were recorded at the end of each stage. RoF was also recorded at task failure and 3-, 5-, 10-, and 15-min post-exercise. The sample was split into two: Pre-exercise RoF of 0-3 corresponding to 'A little fatigued' (LITTLE; n=22; 16 males, 6 females; mean ± SD, age: 20 ± 1 years) and RoF > 3 corresponding to a more fatigued state (MORE: n=8; 3 males, 5 females; mean ± SD, age: 23 ± 3 years). Gaussian distributions and equality of variances were verified using Shapiro-Wilk and Levene's tests. Between-group differences in time to task failure and POMS-F were compared using an independent-sample t-test. Pearson moment correlation was used to test the relationship between POMS-F and RoF. RPE and RoF were analysed using a linear mixed model (LMM) in Jamovi (v. 1.6) through the *GAMLj* module [7].

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Results
Predetermined PPO was not different between MORE and LITTLE (242 ± 61 *vs* 242 ± 61 W; t=-.65; p=.54). POMS-F was significantly higher in MORE (10.13 ± 2.42 *vs* 6.64 ± 4.51; t=-.65; p=.04) and was a predictor of pre-exercise RoF (r=.47; p=.01). MORE's RPE was higher in the first two stages of the exercise test (group x stage interaction effect, F=3.9; p=.03; 50%: 13 ± 1 *vs* 10 ± 2; 60%: 14 ± 1 *vs* 12 ± 2; End: 18 ± 1 for both) and MORE ended the test sooner (1071 ± 215 *vs* 1221 ± 181 sec; t= -2.06; p< .05). Heart rate during the test was not different between the two groups (p> 0.5). RoF decreased post-exercise (F=71, p< .01) but with no between-group difference (interaction effect F=.55, p=.08).

Discussion
These results support previous findings showing a heightened perception of fatigue pre-exercise increases RPE at submaximal intensities and reduces exercise tolerance [4]. Fatigue and effort are shown to be distinct constructs yet interact in perceptual regulation of exercise [4]. Fatigue perception modulates how effortful a (physical) task is perceived to be [4]. While fatigue state was greater pre-exercise in MORE, no difference was found with LITTLE throughout the 15-min recovery period. The investigation of both sensory information processing and autonomous nervous regulation may offer further insights into the present findings.

Conclusion
Baseline level of fatigue is associated with how hard physical exercise feels and the willingness to tolerate exhaustive exercise.

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Keywords: exercise tolerance, state of fatigue, trait of fatigue, effort, maximal exercise

Sequential NMES: an effective method to reduce fatigue during a muscle strengthening session?

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Introduction

Neuromuscular electrical stimulation (NMES) is frequently used in training or rehabilitation contexts [1]. Although its well-known beneficial effects on muscle force and atrophy, NMES has not gained widespread popularity, the reason is the rapid fatigue associated with electrical stimulation [2]. Thus, a challenge for those willing to popularize NMES in rehabilitation is to optimize stimulation patterns to produce a sufficiently high force while minimizing muscle fatigue. To this purpose, several methods have been proposed and sequential stimulation is one of them [3-4]. This method consists in decreasing the discharge frequency of the MUs by distributing the stimulation frequency among several electrodes [5]. If this technique has shown its interest during sessions using short duration stimulations ($<$ 1 s), few studies focused on the effects of sequential stimulation for both longer stimulation trains and session duration - typically used for muscle strengthening. Thus, the main objective of this study was to compare conventional (CONV) and sequential (SEQ) stimulation on fatigue and discomfort in strength training-like conditions (6s contractions, 30-min).

Method

Thirteen healthy subjects randomly participated to two testing sessions, each corresponding to a NMES protocol (CONV vs. SEQ). Each session was composed of 30 minutes of intermittent isometric stimulation (6s ON/ 6s OFF) at 40 Hz. Maximal voluntary contractions (MVC), performed immediately before and after NMES, as well as force evoked during the first / last five contractions of the session were analyzed to quantify fatigue (fatigue index, FI). In addition, the mean work (MW) developed during 30 minutes and average discomfort were compared between conditions.

Results

Force was significantly decreased at the end of both sessions as shown by the decreases in MVC (-20.5% for SEQ and -17.2% for CONV) and by the fatigue index (-55.9% for SEQ and -56% for CONV) . However, these decreases were not different between SEQ and CONV. Neither was the mean work over the session ($p = 0.85$). Discomfort was greater for SEQ than CONV ($p = 0.01$).

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Discussion
Our results showed similar mean work and fatigue between CONV and SEQ. These results are in opposition with previous results from the literature [3-4]. This might be due to the duration of contractions (6s versus 0.3s or 0.6s). Another explanation might be the discomfort induced by SEQ, which was significantly higher than for the CONV session. This result is in accordance with the literature [4].

Conclusion
While the two protocols caused similar fatigue, CONV stimulation was better tolerated than SEQ, which is a real advantage for clinical application.

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Keywords: Fatigue neuromusculaire, Électrostimulation, Stimulation Séquentielle, Renforcement musculaire, Fatigue

Mental simulation of whole-body movements implicitly influences muscle contraction and pupil diameter as a function of preference to physical effort

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Introduction
When observing a person moving, we automatically imagine the sensations of our own body in movement. Pain is sensed when viewing a hammer slam down on a finger. Many studies have investigated the role of cognitive simulation mechanisms in understanding motor intention, social interaction and empathy in human behavior (Jeannerod, 2006). However, few studies have questioned the role of mental simulation in the perception of physical effort. In the present study, we used the pupillometry method to reveal the influence of preference to effort in the mental simulation of soft physical activity.

Method
Using the PRETI-Q questionnaires (Carlier & Delevoye-Turrell, 2017), twenty-four sedentary participants were selected as a function of their preference to low and high levels of physical effort. Each participant was then invited to hold a grip force sensor while viewing videos presented on a computer screen (Blampain et al., 2018), which was mounted with an eye-tracker system to record variations in pupil size. The stimuli presented female and male actors performing physical activities at (1) low and high intensities (walking vs. running) with (2) pleasure and displeasure attitudes (smile vs. frown). The participant's task was to imagine performing the observed activity for 20 minute-sessions.

Results
Results indicated that grip force variations and pupil dilations were greater in the high than in the low intensity activities. There was an absence of preference effect in muscle contraction levels indicating that all participants engaged at a similar degree in the motor simulation task. Nevertheless, the soft exercise preference group showed larger pupil dilations when displeasure rather than pleasure was acted, suggesting a greater cognitive load when simulating high and painful intensity activities.

Discussion
Our study provides novel insights in the use of pupillometry methods to reveal the cognitive activity taken place during motor simulation as a function of an individual's preference to physical effort. They confirm that pupillometry is sensitive not only to the perception of pain (Höfle et al., 2008) but also negative affective states. Hence, this method could be used more specifically

*Speaker

to create guidelines for adapted physical sessions targeting inactive individuals with low tolerance to effort.

Conclusion
Preference and tolerance to physical effort are key elements to reengage individuals in leisure physical activity. Wearable pupillometry methods are now available for in-field testing.

Keywords: motor simulation, cognitive load, pupillometry, action observation, effort

Tracking expertise in visual information pickup when throwing basketball using virtual reality

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Introduction
The basketball court offers multiple sources of visual information for players to perceive the basket's distance. *Elevation angle* of the basket in the field of view would be of larger importance than *stereoscopy* and *motion parallax* (de Oliveira et al., 2009). Other sources of visual information should be considered to complete the picture such as the ratio between the optical height and width of the basket (i.e., *form-ratio).* The perceptual superiority of experts over novices in picking up those information sources for regulating their throw should be established.

Method
Ten experienced and thirteen novice basketball players threw naturally a basketball in a realistic simulator. Ball trajectory was captured by two CX1 Codamotion Units and extrapolated online to render onto a large stereoscopical screen it's landing on a basket embedded in a virtual gymnasium. The perception of the virtual basket's distance with respect to free-throw was manipulated by independently decorrelating from the actual throwing distance *form-ratio*, *stereoscopy*, *motion parallax*, and *elevation angle* while keeping the other sources of information specifying the basket's distance unchanged. We tracked changes in ball trajectory in response to the modified source of information.

Results
When decorrelating *form-ratio* and *stereoscopy*, induced perception of a near basket resulted in a shorter ball trajectory while far basket perception resulted in a longer trajectory. Decorrelation of the *Form-ratio* induced larger changes in ball trajectory than decorrelation of the *stereoscopy*, especially for the far basket. Novices responded less to decorrelation of *form-ratio* than experienced players. Novice responded more to decorrelation of *stereoscopy* than experienced players.

When decorrelating *motion parallax* and *elevation angle*, ball trajectory suggested that both novices and experienced did not perceive a near or far but rather an elevated or lowered basket. Overall, the influence of *Elevation angle* was stronger than those of *Motion Parallax. C*hanges in trajectories were stronger for novice than for experienced players.

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Discussion & Conclusions

Large changes in ball trajectory in the direction of a biased perception of basket's distance resulted from the decorrelation of Form-ratio. *Form-ratio* would therefore be as important for basketball players as it is for airplane pilots who use it to perceive the distance from a runway to land (Galanis et al., 1998). Smaller changes in trajectory induced by the decorrelation of *Stereoscopy*, especially for the far basket, are consistent with the usefulness of *Stereoscopy* for longer distances. Unexpected changes in trajectory when decorrelating *motion parallax* and *elevation angle* contradict de Oliveira's results (2009) and suggest that experienced would be greater calibrated to the basket height than novice players. Basketball throwing performance can thus be examinated with virtual reality without impoverishing the visual scene and without equipping basketball players with bulky eye-tracking systems.

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Keywords: Depth perception, Optical information, Expertise, Basketball throwing, Virtual reality

Influence of imaginative suggestions on motor control

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Introduction

In hypnosis, imaginative suggestions (IS) consist in invitations to experience an imaginary state or situation (e.g., your arm is heavy). They partly rely on mental imagery processes and can be efficient even without any prior hypnotic induction. Santarcangelo et al. (2005) showed for instance that when participants are required to extend the arm while listening to a script suggesting that this arm is heavy and is falling, the vertical arm movements are influenced by the script.

Our study had two goals. First, we aimed to test whether Santarcangelo et al.'s (2005) results could be replicated when (1) participants have to keep their posture stationary, (2) the script doesn't explicitly suggest any movement, and (3) no prior hypnotic induction was done. Second, the relation between participant and practitioner is thought to influence IS efficiency (Lynn et al., 1991). The mirror game (a procedure in which two participants imitate each other and synchronize their movements) is known to influence the mutual perception of participants (Feniger-Schaal et al., 2018). We aimed to test whether practicing it with the experimenter would influence the participant's response to IS.

Methods

Each participant performed four phases in a counterbalanced order. Each phase unfolded as follows. First, participant either did the mirror game with the experimenter or had to move independently. Second, he extended his left arm in parallel to the floor at shoulder level. He had to keep this position, with closed eyes, while listening to a script that described a realistic scene. From 0s to 30s, the script suggested to imagine someone in front of him carrying either a heavy dictionary (HD) or a light paper sheet (LPS). From 30s to 60s, it suggested that this object was put on his hand. From 60s to 90s, it suggested that a second similar object was added. Third, participant had to rate the task difficulty and his state of consciousness during the task. All factors, IS (HD vs LPS) and mirror game (with vs without) were manipulated within participant. We recorded arm movements.

Results/discussion

Our protocol showed several results. First, participants lowered more their arms and rated the effort as more difficult in the HD condition than in the LPS one. Second, in comparison to LPS condition, the HD one made the participants feel a more unusual consciousness state. Third, the mirror game enhanced the feeling of unusual consciousness state in comparison to the no mirror game condition, but it didn't modulate the IS influence. These results give clues about

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the imagery processes that underlie the efficiency of IS, even without prior hypnotic induction. They also offer new perspectives to investigate interactions between IS and consciousness state.

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Keywords: Imaginative Suggestion, Synchronization, Imitation, Hypnosis, Motor Control, Mental Imagery

Influence of core training and proprioceptive exercises on balance control performance in horseback riders

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Introduction
Horseback riding requires the ability to adapt to changes in balance conditions, to maintain equilibrium on the horse and to prevent falls. Postural adaptation involves specific spine movement, and implies sensorimotor processes integrating visual information and somesthesic information (Olivier et al. 2017; 2019). Indeed, 64% of horseback riders suffer from low back pain (Favory, 2011). Thus practicing only technical training does not appear sufficient to maintain physical health of the rider. Working on both technical aspects and physical conditioning is consequently critical in a horse riding training program. The objective of this study is to assess the effect of a physical training on horseback riders' postural stability and perceived pain.
Methodology: The experimental protocol consisted of 19 horseback riders participants who were divided into two groups: a training group (TG, n = 9) performing physical preparation twice a week (1 hour per sequence), and a control group (CG, n = 10) without physical preparation. The training program lasted 10 weeks. Postural control abilities were assessed pre- and post-training with a force platform through the following parameters: COP surface, mean COP velocity and VFY of movements of the center of pressure (COP). Different postural conditions were tested: (i) on stable and unstable supports, (ii) with the eyes open and the eyes closed, and (iii) with the presence of foam on the support or not. The riders' perceived pain was measured with a questionnaire using a Borg scale. An analysis of variance was performed on postural parameters followed by a post hoc Tukey test.

Results
Results showed an effect of physical preparation. More precisely TG significantly reduced COP surface with eyes closed compared to CG after training ($p < 0.05$), showing a lesser dependence on visual information. Post hoc test also showed that TG reduced the variable VFY in static condition with eyes closed ($p < 0.05$) compared to CG. Moreover, pain of TG significantly decreased while CG did not change ($p < 0.001$).

Conclusion
It can be concluded that a physical conditioning based on core training and proprioceptive exercises significantly improved balance abilities in horseback riders. These outcomes revealed the

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importance of adding proprioception and core training in a sport such as horse riding to prevent musculoskeletal disorders (Tsang & Hui-Chang, 2004).

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Keywords: Postural control, Horseback riding, Physical conditioning

Smoothness discriminates motor performance improvement following mental and physical practices of arm-reaching movements.

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Introduction

Motor acquisition of skilled arm-reaching movements improves performances, leading to the execution of faster and smoother movements. Through physical practice (PP), such acquisition would be underpinned by recalibration of internal models through sensory feedback integration. Motor imagery practice (MIP) also improves motor performances and would update internal models despite the absence of sensory feedbacks (Gentili et al., 2010). However, due to the absence of sensory feedbacks during MIP, one could hypothesize that the update of internal models following MIP leads to distinct performance improvement than for PP. In the current study, we compared the effects of MIP and PP on motor performance, focusing on spatiotemporal and smoothness parameters. The aim was to determine which performance parameters were the most relevant to discriminate between practices, and which parameters improved after practices.

Method

Movement-related trajectories were recorded on a graphic tablet to assess motor performance during an arm-reaching task with imposed accuracy. Forty-five participants were randomly assigned to PP group (n= 15), MIP group (n= 15) or control group who watched a non-emotional documentary (Ctrl, n= 15). Five parameters were assessed at PreTest and PostTest: movement duration, mean and maximal velocities, total displacement and the number of velocity peaks. First, we used a stepwise linear generalized discriminant analysis to identify the most relevant parameters that discriminated groups. Then, pre-planned comparisons were performed to test the effect of practice (i.e., Ctrl vs MIP+PP) and the effect of practice type (i.e., MIP vs PP), focusing on the discriminant parameters.

Results and discussion

Maximal velocity and number of velocity peaks were identified as the most relevant parameters to discriminate the groups. When compared to Ctrl, MIP+PP significantly increased maximal velocity and reduced the number of velocity peaks at PostTest. These results suggest that practice improved performance through the execution of faster and smoother movements. Interestingly, the improvement of maximal velocity was statistically comparable between MIP and

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PP, whereas the improvement for the number of velocity peaks was more important after PP than MIP, showing smoother movements after PP than that after MIP. We propose that this difference may be due to the absence of sensory feedbacks during MIP. Specifically, actual movements would allow sensory feedback integration to reduce the endpoint variability of movement (Khan et al., 2006), whereas imagined movements would not.

Conclusion

The present results suggest that movement smoothness discriminates motor imagery and physical practices of arm-reaching movements. Such difference might depend on online corrections, available during physical but not motor imagery practice.

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Keywords: Smoothness, Motor imagery, Motor performance

Evidence of sport-dependent effects of intensive sport training on the sensory control of balance during upright posture: a comparison between professionals in horseback riding, judo, and non-athletes.

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Maintaining balance during horseback riding requires the development of postural adjustments to counter the perturbations continuously induced by the horse motion. These adjustments requires the integration of visual, somesthetic and vestibular inputs. Previous studies on sport expertise (1,2) reported that the contribution of these sensory inputs to balance control evolves with intensive training, relying less on visual inputs and more on somesthetic inputs. Compared to most sports practiced by healthy participants (e.g. judo), horseback riding has the peculiarity to be mainly performed in a sitting posture. The present research thus tested the hypothesis that, compared to judokas, horseback riders develop specific changes in their sensory control of balance in the upright posture.
Twenty-nine international-level judokas, twenty-seven international-level horseback-riders and twenty-two non-athletes participated in the experiment. Participants stood upright with their feet on a stabilometric plate-form (static condition) or on a seewsaw device with an instability along the mediolateral or the anteroposterior direction (dynamic conditions). Each of these conditions was carried out with eyes opened or closed, and with or without a foam placed over the plate-form. Experimental variables included the average velocity of center-of-pressure (COP) displacement (VCOP) and the standard deviation (SD) of COP displacement along the mediolateral (SDX) and anteroposterior (SDY) direction. Mean values± SD were computed for each dependant variable. For the static and dynamic conditions taken separately, repeated-measures ANOVA with expertise, vision and foam as within-subjects factors were conducted. When necessary, follow-up analyses were carried out using Tukey's test. The level of statistical significance was set at α=.05. Only main results of the *post hoc* tests are reported below.

Horse-riders and judokas had a significantly lower VCOP than non-athletes in both static and dynamic conditions ($p<$ 0.05). In addition, horse-riders had a significantly lower SDY than judokas in the static condition (p=0.02). In the dynamic conditions, horse-riders had a significantly lower SDY (p=0.02) and VCOP (p=0.01) than both judokas and non-athletes when eyes

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were opened. In contrast, judokas had a significantly lower VCOP than the two other groups when eyes were closed ($p< 0.05$).

These results showed that horseback riding, like judo, improves balancing abilities in the upright posture. However, horse-riders relied more on vision than judokas to maintain balance, thus revealing that the contribution of the sensory inputs to balance control is sport-dependent. These results open up new knowledge on the sport-dependent strategies of sensory control of balance. These results may also be useful to select relevant variables of postural control for the follow-up of athletes, e.g. in rehabilitation or reathletisation.

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Keywords: Sports Expertise, Balance control, Sensory integration, Horseback riders, Judokas.

An identification method to improve the transparency of an exoskeleton: development and validation

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Introduction
Exoskeletons appear as a promising tool to reduce human efforts and thus prevent the appearance of musculoskeletal disorders. A primary requirement is to implement highly "transparent" control laws in order to reduce the influence of the exoskeleton on human movement. A transparent control law is defined as a law that minimises the interaction efforts between the exoskeleton and the user in order to produce a movement in a more natural way [1]. However, these laws still induced an average 30% movement slowdown [2], mitigating the potential impact of exoskeletons in daily life activities. Thus, the aim of this study was: (i) to improve the transparency of an upper-limb exoskeleton through a specific identification procedure, (ii) to evaluate the influence of the subsequent control law on human behaviour through relevant motor control indices [3].

Methods
Six young healthy right-handed participants were tested on elbow flexion/extension movements during pointing tasks, given the fact that these movements are well-documented movements in the motor control literature [4]. Another reason was to evaluate motor performance inside the exoskeleton by taking advantage of relevant motor control indices previously quantified on these movements. To this aim, electromyographic sensors were placed on biceps, triceps and brachioradialis. Kinematical data (3D position of markers) were also collected through an optoelectronic system (Qualisys, Sweden).

Results and discussion
In the present study, the proposed open-loop torque control law based on careful identification procedures taking into account movement direction, inspired from [5], improved the overall transparency, in comparison to a classical closed-loop position control law. An innovative performance index based on a normalized ratio between electromyographic activity (agonist burst) and peak angle acceleration was also introduced to assess the quality of human-exoskeleton interaction [3].

Conclusion
This study suggested that identification is an important step towards better transparency and that a motor control approach may be exploited to improve the interaction between a human and an exoskeleton.

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Keywords: active exoskeleton, transparency, performance index

Apprentissage par imitation motrice chez des enfants atteints du syndrôme d'Angelman

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Résumé
Les données concernant l'apprentissage par imitation pour les sujets atteints du syndrôme d'angelman (SA) sont actuellement rares. D'où l'intérêt de notre étude qui réside à évaluer l'apprentissage par imitation pour ces enfants. En partenariat avec l'Association Tunisienne du Syndrôme d'Angelman et Rett (ATSAR) nous avons évalué l'apprentissage par imitation motrice de 8 enfants. Pour cela un test par imitation des actions proposées a été effectué selon un principe d'échelonnage temporaire des exercices. Les résultats obtenus ont montré que la conformité des actions dépend des sujets car il y'a une différence significative entre les sujets pour chaque action effectuée. On a conclu que l'apprentissage par imitation est plus efficace par l'attraction visuelle qui est plus sensible au milieu familial.

Introduction
Le SA est une maladie neurogénétique entrainant des troubles cognitifs, psychomoteur où l'apprentissage est difficile pour les sujets atteints de cette maladie. Peu d'étude ont été effectuée pour évaluer l'impact de l'apprentissage sur le développement moteur et intellectuel des jeunes atteints de SA. Notre étude est conçue pour évaluer l'imitation d'actions motrices des enfants atteints de ce syndrôme.

Méthodes
On a évalué l'imitation de 10 actions motrices de 8 enfants (âge = 7.12±0.99) à l'ATSAR pendant 3 mois. Chaque action motrice à être effectuée à 3 reprises avec un intervalle de 15 secondes. Afin d'obtenir l'attention des enfants on a maintenu la concentration occulo-motrice. Le système d'obtention des notes est effectué sur la base suivante :

- Note 0 : le sujet n'a pas effectué l'action
- Note 1 : le sujet a effectué un geste ressemblant à l'action proposé
- Note 2 : le sujet a exécuté correctement l'action

Chaque sujet a eu une note globale de toutes les actions confondues (IM).

*Speaker

Résultats et Discussion
Nos résultats ont montré que la conformité de l'action effectuée ne dépend pas du mode d'attraction de l'attention mais du sujet lui-même, pour cela il y'a une différence significative entre les sujets pour chaque action effectuée. En effet, les notes sont comprise entre 0 et 2, ce qui prouve qu'il y a des sujets qui n'ont pas su imiter l'action et d'autres qu'ils l'ont imité à la perfection.
On remarque que les sujets ont des moyennes d'IM comprise entre 0.8 et 1.4.La différence est significative entre les sujets. Cette différenciation d'apprentissage par imitation est probablement dû à l'auto-apprentissage (Reveille 2013).

Conclusion
On conclut que l'apprentissage par imitation est plus efficace dans notre cas par le biais du regard. On a noté toutefois qu'il y a une différence significative entre les sujets pour plusieurs actions ce qui montre un possible apprentissage précédent probablement dans le milieu familial. La différence dans l'imitation des actions proposées est probablement due non seulement à la déficience neurologique mais aussi à un manque d'appui pour l'apprentissage au sein de la famille.

Référence
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Keywords: Syndrôme d'Angelman, Apprentissage, Imitation motrice

Building an internal model of friction for the parameterization of arm movement when sliding an object toward a target

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Introduction

When a bartender slides a shot glass across the bar to a patron, anticipating the effect of friction is crucial to control his/her movement. Although the role of an internal model of gravity for the predictive control of pointing or interceptive movements is well-established in neuroscience (McIntyre et al., 2003), literature is scarce on the internal model of friction for motor control. In the present study, we provide some evidence that the brain builds an internal model of friction in order to control parametrically (Schmidt, 2003) the kinetic energy of the upper limb segments when sliding an object on a surface toward a target distance.

Methods

33 right-handed human participants performed a striking movement (with the index finger) to slide a plastic cube-like object to a given target distance. All movements were recorded by OptiTrack motion capture system. The surface material (aluminum or balsa wood) on which the object slided, the surface slope (-10∘, 0, or +10∘) and the target distance (25 cm or 50 cm) varied across conditions, with ten successive trials in each condition. In each session the two surface material blocks of trials were performed in separate blocks. Within the latter, surface slope trials were also organized in blocks, always starting with the 0∘ condition, followed by either the -10∘ slope or +10∘ slope, depending on participants. The performance variables were spatial error measured as a percentage of target distance (with positive values for overshoots, and negative values for undershoots) and initial cube speed at the end of collision.

Results and discussion

Repeated measures ANOVAs on object speed at impact and spatial error suggest that: 1) participants chose to impart a similar speed to the object in the first trial regardless of the surface material to facilitate the estimation of the coefficient of friction (μ); 2) the movement is parameterized across repetitions to reduce spatial error; 3) an internal model of friction (subjective μ) for a given surface material can be generalized when the slope changes. Indeed, the fact that for

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each surface, spatial error at the initial trial for the -10∘ condition (that followed the last trial of the 0∘ condition) didn't differ from zero suggests that the brain successfully adjusted the control of the striking movement on the basis of an internal model of friction built and tuned across the 0∘ condition trials. We computed the subjective μ, at a given trial, from target distance d and cube speed at impact, among others.
K-mean clustering (K = 2) on the joint angular amplitude values during the striking movement (for the elbow, wrist, and index finger rotations) in the last trial of each condition, evidenced two motor strategies, one based on the rotation of the wrist (14 participants) and the other based on the rotation of the forearm (19 participants). However, whatever the motor strategy, participants adjusted finger speed at impact in order to transmit the (same) amount of kinetic energy (Bril et al., 2010) required to slide the object to the target distance.

Conclusion
In short, we provide evidence that the brain builds an internal model of friction that makes it possible to parametrically control a striking movement in order to regulate the amount of kinetic energy required to impart the appropriate initial speed to the object.

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Keywords: Coefficient of friction, Internal model, Striking movement, Kinetic energy regulation

Cognitivo-postural behaviour assessments in over 65-year-olds: Linking behavioral fluctuations to Perceptual Style

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Context

Among the intrinsic factors to the risk of falling in the elderly, the alteration of visual capacities is central. Paradoxically, this modality remains preferentially used for their postural control as proved their high field dependence [1], known to reduce sensorimotor adaptability [2].
Many studies consider that increased postural variability is a marker of aging [3]. The entropy-based complexity metrics that relates to the information content of a signal by quantifying the degree of regularity allowed detecting an exacerbated degradation of complexity in postural sway in aged people, thus indicating a failure in the dynamic re-organization of control [4]. These metrics may provide a window on the interactions across scale supporting engaged cognitive processes and might offer an original approach to the concept of adaptability [5], notably on the cognitivo-postural behaviour.
The aim of this study was twofold: i) to analyse the variability and complexity of the cognitivo-postural behaviour during different suprapostural tasks in young and over 65-y.o adults, and ii) to explore how behavioural fluctuations and field dependence level are linked in elderly.

Method

Two 12-healthy-subjects groups were recruited: one over 65 years of age (mean±sd: 75,4±5,1) and a second one of young adults (21,9±2,4). In standing posture on a force plate, each of them performed two 51.2s-suprapostural tasks separately: 1) to focus a dot (VFix); 2) to mentally count C-letters projected in front of them as fast and as efficiently as possible (VDis). During the latter, once the count verbalized, they had to continue on a new C-panel until the end of trial (Lev1). Two other similar and counterbalanced 3-trials-block but with different cognitive difficulty were carried out with same instructions: one with A-letters added to C-letters (Lev2) and another with added A- and G-letters (Lev3).
The postural variability will be assessed from the standard deviation of CoP signal (SD). The entropy index (EI) is calculated from the refined composite multiscale entropy curves and after pre-processing time series using empirical mode decomposition [6]. In order to answer to the first objective, statistical comparisons between tasks and within and between groups will be carried out on SD and EI. The choice of tests will depend on the normality of the distributions

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and the homogeneity of their variance.
To respond to the second objective, the elderly group performed a Rod & Frame Test in which they were asked to roll-adjust an initially tilted rod in a 18◦ roll-tilted frame to the direction of gravity. Higher the mean signed error (i.e. in the direction of the frame tilt), the more the subject was field dependent. Factor analyses (PCA, correlations) will be performed to explore associations among FD, SD and EI.

Results & discussion
We speculated that the older group will show higher SD, lower EI and higher FD than the younger group. The coordinated analysis of the magnitude and structure of behavioural fluctuations [7] will allow to improve knowledge of the mechanisms of cognitivo-postural adaptability with age. And the potential linking of these fluctuation indicators to perceptual style is to open a large research field around loss of flexibility associated to aging.

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Keywords: Risk of falling, Aging, behavioral fluctuation, Posture, Variability, Complexity, Entropy, Field dependence, Adaptability, Flexibility

Complexity matching for the restoration of the complexity of walking in the elderly: a potential for preventing falls.

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Introduction
Falling is a major health problem for elderly. This work aimed to treat falling via the theory of complex systems. Human organism is considered as a complex system. When 2 systems have similar complexities and interact, they provoke a complexity matching effect [1]. Morover, interaction between 2 systems induce them to harmonize their complexities [2]. Finally, when 2 systems of different levels of complexity interact, complexity matching yields an attraction of the less complex system toward the most complex, resulting in an increase of the former [3]. The analysis of walking stride series in young and healthy individuals revealed the presence of 1/f fluctuations reflecting the complexity of the locomotor system. In contrast, stride series in elderly present a loss of complexity which is correlated with falling. This work aimed at evidencing that complexity matching could allow restoring the complexity in elderly.

Method
12 participants (8 women, mean age: 72.0 yrs, SD =8.1) were involved in the study. They were randomly assigned to 2 groups, experimental (Exp) and control (Ctr).Subjects performed walking training during 4 weeks. Each week included 3 training sessions. Participants in the Exp group walked arm-in-arm with the young healthy guide with an explicit instruction to synchronize their steps with those of their guide. Participants in the Ctr group walked next to the guide without physical contact and without any synchronization instruction. Participants performed 3 post-tests.We applied the Windowed Detrended Cross-Correlation analysis to assess the nature and of synchronization between the dyads. We used the Detrended Fluctuation Analysis to estimate the complexity of each data series.

Results
We confirmed that synchronized walking was dominated by a complexity matching effect. We observed an immediate synchronization expected from a complexity matching effect.
This showed that a prolonged experience of close synchronized walking, with a young and healthy guide, allowed restoring walking complexity in elderly participants, and that this effect persisted up to 6 weeks after the end of the training.
Finally, merging our data with those obtained by Almurad et al. (2018), we evidenced a similar evolution of mean α-DFA in the 2 experiments.

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Discussion

When we invite an older person to walk in synchrony, arm-in-arm, with a young partner, synchronization is dominated by a complexity matching effect. This effect appeared spontaneously from the first trials.

The attraction of participants' complexity toward that of their guide represents a nice experimental validation of formal results [3].

We confirm that the prolonged experience of complexity matching allows restoring walking complexity in elderly, as evidenced by the increase of DFA exponents at the beginning of the 4th week and during the post-tests. We showed that the effect of complexity restoration was not related to particular guide's behavior.

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Keywords: complexity, rehabilitation, complexity matching, elderly, fall

Does indoor skydiving have an effect on the static balance of indoor skydiving elite athletes?

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Introduction
Indoor skydiving started as a training tool to practice skydiving techniques for the US. army in the 1950s. Due to the environment in which the body is lifted by the wind, at speeds between 180 and 300 km/h and the constant upward lifting force the body has to work against, factors to control balance, like visual and vestibular parameters, are altered. Over the years indoor skydiving has developed into its own sport. The first indoors skydiving world championship (WISC) was organized by the Fédération Aéronautique Internationale (FAI) in 2015. Four main disciplines are used in the competition format. They are divided into static or formation flying and dynamic or artistic flying. Formation flying has a low wind speed version in which flyers are always flying in a prone position called belly flying. Vertical formation skydiving is the higher speed version in which flyers change between Head-up and Head-Down positions. The two dynamic disciplines make use of both headings. Their main difference lies in wind speed and their focus. Dynamic is more focused on racing and therefore uses higher wind speed. Freestyle on the other hand has a more artistic approach and uses middle to low wind speeds. The objective of this study is to evaluate the difference in static balance after an indoor skydiving session.

Methods
10 Professional indoor skydiving athletes of the dynamic discipline participated in this study. Static balance was assessed before and immediately after a flying session with a Satel 40 Hz stabilometric force platform. The flying sessions consisted of 2.5 minutes of flying followed by 2.5 minutes of rest for 30 minutes. Assessments were taken in a static position with the eyes opened and closed. The posturographic variables studied were. Ellipse area (mm2). Mean X value (mm). Mean Y value (mm). Total length (mm). X length (mm). Y length (mm). Y speed (mm/s). Travelling speed (mm/s). Travelling speed (mm/s). Travelling speed (mm/s). Y length (mm). Displacement velocity (mm/s). Romberg coefficient.

Results and discussion
The sample analyzed was 90% male and 10% female, aged 27.20 (± 4.76) and a body mass index of 23.23 (± 3.22). The difference between before and after the flying session was not statisti-

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cally significant ($p \geq 0.05$) for any of the axes. This could be due to the fast accommodation and adaptation of the subjects to the altered environment, caused by the high exposure to this one. Dynamic flying uses higher speeds and implements big, fast movements with many changes in the flyers Headings. This makes it the discipline more exposed to alterations in visual and vestibular components and the most interesting one to evaluate. No studies with similar criteria related to this sport to compare our results with were found. Also, no other studies of skydiving that assessed balance factors were found.

Conclusion

No significant changes were observed in balance differences after flying in athletes. A further study could be reproduced with amateur flyers or in other disciplines to see any differences.

Keywords: balance, sport, athletes

Done in 100 ms : using intermuscular coherence to investigate the engagement of neural binding between muscles in mediating fast motor corrections.

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Introduction

Pointing to a target from a standing position when a stimulus appears is an essential motor skill. In such a task, when the target location is perturbed during the ongoing movement,participants are able to generate motor corrections to reach the new target location. This induces fast muscular responses, visible on surface electromyography (EMG) within ≈100 ms, that is about half of the time needed for a simple reaction time in an unperturbed movement (Fautrelle et al., 2010). In the present study, we aim to investigate whether the engagement of the neural binding between muscles, as quantified using time-frequency wavelet-based intermuscular coherence analysis (Bigot et al., 2011; Charissou et al., 2016), mediates fast motor corrections. We hypothesize that online fast motor corrections could induce a significant increase of the intermuscular coherence in the alpha-band (3-12 Hz), compared to simple motor initiation in an unperturbed pointing movement. In view of previous studies which suggested that a low level control may explain these express correction latencies (Gu et al., 2018), such an increase may reveal an implication of the superior colliculus activity and the parallel contribution of the tectoreticulospinal pathway.

Methods

Fifteen right-handed men (age : [21-34] years, height : [175-181] cm) volunteered to the experiment. They performed pointing movement with their right middle finger from a standing posture. From a starting button, the near and the far targets were located respectively at 20, 65, and 88 cm in front of the participants in the sagittal plane, and 15 cm below the xyphoid process. Targets were 1*1cm visual and tactile square switches which could be lit. Participants

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were asked to perform pointing movements as fast and accurately as possible when a target was lit in three conditions: two unperturbed conditions (Near or Far) and one Target Jump condition, always from the near to the far target, occurring at the hand movement onset. A total of fifty-five trials were pseudo-randomised and carried out by each participant (5 blocks of 11 trials: [5*Near + 5*Far + 1*Target Jump]). These trials were performed in a dimly illuminated room while surface EMGs (1000Hz) were recorded on participants' right side for the tibialis anterior (TAi), the anterior portion of the deltoïdus (DAi), and the triceps brachii (TBi). These three muscles were specifically chosen because they are the three first surface muscles to activate during the initiation and correction sequences for such a motor pointing task. Hand reaction times, movement times, initiation times of the TAi (in unperturbed movement) in every condition as well as motor correction times in Target Jump condition will be calculated. Then the intermuscular coherence in the alpha (3-12Hz), beta (15-35Hz) and gamma (35-60Hz) bands will be computed in the time-frequency domain (Bigot et al., 2011) for the EMG signal from TAi-DAi, TAi-TBi, and DAi-TBi pairs of muscles, during the 150 ms after the initiation time or the correction time (in target jump condition) of the TAi, i.e. the first muscle to initiate the muscle activation sequence of the movement. Repeated measures ANOVA will allow to test the impact of the target jump on the intermuscular coherence values in these three pairs of muscle and test our main hypothesis.

Results & Discussion

Due to COVID-19 context, results will be available at the end of April 2021.

Keywords: Motor flexibility, Motor control, Online correction, EMG, Intermuscular coherence

Effect of Acute Moderate and High Intensity Intermittent Exercise on Cognitive Flexibility: role of cerebral oxygenation.

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Context
The benefits of physical activity on cognitive functions provided in scientific literature are increasingly evident. Regular physical exercise is associated with better cognitive functioning, regardless of age. Interestingly, this positive effect is also observed in the very short term during or after the cessation of exercise. To date, particular attention has turned to types of physical exercise on cognitive function, and intermittent exercise is the subject of more and more studies. Indeed intermittent exercise compared to more classic form of aerobic exercise (ie, continuous), also seems to improve cognitive functions. Associated with cognitive improvements induced by exercise, many neurophysiological mechanisms are involved, including cerebral oxygenation. Several moderators like intensity of exercise are involved in the link between exercise and cognitive function.

Aim
The aim of this study was to asses the effect of exercise intensity after acute intermittent exercise (IE) on cognitive flexibility and the potential role of cerebral oxygenation.

Method
Eighteen young (22.2 ±3.4 yrs) male performed a series of six consecutive 3-min bouts of exercise at either 60 or 95% of maximal aerobic speed, interspersed by 3 min of passive recovery on a treadmill. Reaction time (ms) and accuracy (%) of switching task using a computerized Stroop task were recorded before and after warm-up, just after the cessation of exercise and every 15 min during a 1-h passive recovery following exercise. Cerebral oxygenation on prefrontal cortex (FP1/FP2) using fNIRS technology and perceived difficulty of cognitive task was assessed during each flexibility task. A two-way repeated measures ANOVA was performed to quantify the effects of exercise time (bouts) and condition (exercise intensity).

Results
The ANOVA revealed only a main effect of Time ($p < 0.05$) on reaction time and we found a shorter reaction time after the IE at 95 and 60%. This positive effect of exercise disappears

*Speaker

15 minutes after the cessation of exercise. The ANOVA revealed a main effect of Time and an interaction between Intensity and Time for perceived difficulty of cognitive tasks and prefrontal cortex oxygenation ($p < 0.05$). The session at 95% maximal aerobic speed induced a more important subjective and objective fatigue than at 60%. Indeed participants found the switching task more difficult after the cessation of the intermittent exercise at 95%. Concerning prefrontal cortex oxygenation, we found a large decrease of oxy-haemoglobin and total haemoglobin after 95% compared to 60% during the 30 minutes after the cessation of exercise.

Discussion / Conclusion
Our results demonstrate that both moderate and high exercise intensity enhance cognitive flexibility following IE. This effect was observed despite greater fatigue felt and less prefrontal cortex oxygenation after the most intense exercise. This study shows us that in young subjects, cerebral hemodynamic changes do not alter cognitive functioning and shows some resilience of young participants to perform a cognitive task under non-optimal physiological conditions.

Keywords: Intermittent exercise, executive function, flexibility, cerebral oxygenation, intensity

Effect of gender, handedness, footedness and eyedness on injuries of 3275 young athletes from 15 to 21 years old.

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Introduction
In a descriptive study linking injuries in and outside of sports focusing on 3275 young athletes from 15 to 21 years old, hand, foot and eye dominances were assessed and collected. The inter-relationships between injuries occurring in and outside of sport and dominances were assessed. This work takes part in the continuation of a previous study based on gender effect (Mekaoui and al., 2019).

Material and method
1815 boys and 1460 girls were interviewed using a survey. In order to identify their handedness they were asked : "which hand do you use to brush your teeth ?". Another part of the survey consisted to ask them to climb on a chair and to assess the dominant leg in order to identify the footedness. Eyedness was assessed from the Hole-in-the-card test.

Results
67.6% of participants have a homolateral footedness and eyedness dominance. Whatever the gender, the homolateral footedness and eyedness group revealed a 15% higher risk of injuries ($p< 0.02$), whether it be for right or left laterality dominances (1.93+2.8, 1.68+2.7, respectively). A multiple factor ANOVA for simple data (Handedness x footedness x eyedness x gender) showed an effect of gender on injuries during sport ($p< 0.005$). The number of injuries in sport for boys was 13% higher than girls in sport (2.8 and 2.4, respectively). Boys with left footedness (357 participants) have significantly less injuries than right footedness boys (1215 participants; $p< 0.0001$). On the contrary for girls, it appears that left footedness girls (469 participants) have more injuries than right footedness girls (1190 participants, $p< 0.004$). Results did not show any significant effect between handedness in and outside of sport on injuries.

Conclusion
Young athletes are more impacted by injuries during the practice of sport. We also observed an eyedness and footedness effect on injuries in and outside the practice of sport, without handedness effect on injuries. Finally, left-footedness boys are injured less often than right-footedness boys whereas left-footedness girls are injured more often than right-footedness girls.

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Keywords: Handedness, footedness, eyedness, injuries in and outside of sport

Effect of high intensity interval training (HIIT) on some neurotransmitters and perceptual motor skills in children with attention deficit hyperactivity disorder (ADHD).

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Background
Attention Deficit Hyperactivity Disorder (ADHD) is a behavioral disorder in children and adolescents that may damage the motor skills and balance of them. The aim of this study was to investigate the effect of 6 weeks high intensity interval training on dopamine levels and improvement of perceptual motor skills in adolescent girls with attention deficit hyperactivity disorder (ADHD).

Methods
In this clinical trial, 30 adolescent girls with ADHD were randomly allocated to high intensity interval training and control groups. The training group, trained for 6 weeks. The training protocol included 20 meters running 3times a week, with the repetitions of 4times at the first and second week, the repetitions of5times at the third and fourth week and the repetitions of6times in the fifth and sixth week. At the beginning and end of the sixth week, anthropometric indices, dopamine levels and scores of perceptual motor skills were assessed. Data were analyzed by paired and independent t tests. The level of statistical significance was set at $p< 0.05$.

Results
After 6 weeks, the average of serum dopamine levels (p=0.005), weight (p=0.001), body mass index (p=0.001), body fat percent (p=0.002) and the mean scores of perceptual motor skills (p=0.001) in experimental group were significantly different with control group.

Conclusion
The present study revealed that high intensity interval training as a non-pharmacological and non-invasive method has a positive impact on serum dopamine levels and perceptual-motor skills in adolescents with ADHD.

Keywords: High intensity interval training, neurotransmitters, Hyperactivity disorder, Attention deficit, Adolescent girls

*Speaker

Effect of nighttime melatonin ingestion on unipedal postural balance and functional mobility in persons with multiple sclerosis.

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Introduction
Persons with multiple sclerosis (MS) have low endogenous melatonin (MEL) secretion [1], which causes cognitive disorders [2] that impair postural balance and mobility [3,4]. The benefits of exogenous MEL in improving MS (inflammation, remyelination, oxidative stress) were demonstrated [5] but to the best of our knowledge, no study has examined the acute effect of exogenous MEL on postural balance and mobility in MS. Given that the impairment of these physical parameters affects the autonomy**, our objective** was to assess the innocuity and the effect of a nocturnal MEL ingestion on postural balance and functional mobility the next morning in MS.

Methods
Fourteen patients with relapsing remitting-MS (28.36 ± 6.81 years) were evaluated before and after a nocturnal ingestion of MEL (6 mg) or placebo (PLA). Each session included a cognitive assessment by using the Montreal Cognitive Assessment and the Simple reaction Time (SRT) test, an assessment of unipedal balance on the dominant leg using a clinical test, a Timed up and Go Test and a Timed 25-foot walk test to evaluate, respectively, functional mobility and walking speed.

Results
Results showed a significant increase in unipedal support time [Δ MEL (=before MEL ingestion – after MEL ingestion) (-15.82 s) vs Δ PLA (= Before PLA - After PLA) (1.76 s); p = 0.04; d= -0.63], and a significant improvement in functional mobility [Δ MEL (1.15) vs Δ PLA (-0.35);

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p= 0.01; d=0.72] following nocturnal MEL ingestion compared to the PLA one. Cognitive function [Δ MEL (- 3.57 points) vs Δ PLA (- 0.86); p = 0.008; d= -0.83] was improved also during MEL session compared to the PLA one. However, there is no significant effect on walking speed neither (p=0.58) on SRT (p = 0.89).

Discussion
The development of cognitive performance due to MEL ingestion could explain the improvement of postural balance and mobility observed in this study based on the fact that cognitive decline can deteriorate these parameters [6,7].

Conclusion
Acute MEL ingestion could be a safe therapeutic solution for improving unipedal postural balance and functional mobility in MS persons. More studies are needed to verify its chronic effect on these parameters.

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Keywords: Melatonin, Multiple sclerosis, Postural balance, Chronobiology, cognitive functions, mobility

Effects of motor imagery combined with transcranial direct current stimulation on the acquisition of a finger-tapping task in healthy young and older adults.

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Introduction
Motor imagery (MI) training is an effective and alternative method for motor sequence learning in young and older adults (Schuster et al., 2011). The fast /acquisition stage of learning occurring during a single MI session of a finger-tapping task (FTT) is preserved with aging (Caçola et al., 2013). In addition, anodal transcranial direct current stimulation (a-tDCS) has shown to enhance FTT performance in young and elderly people (Zimerman et al., 2013). A recent study also showed benefits of coupling those two methods during a single training session of a FTT in young adults (Saimpont et al., 2016). So far, the acquisition of a FTT by MI training combined with a-tDCS has never been compared between young and older adults.

Objective
Examining the impact of MI and the additional effects of a-tDCS on the acquisition stage of a FTT with the non-dominant hand in healthy young and older adults.

Methods
A total of 32 young (21.9 ± 1.9 years; 16 women) and 31 older (71.5 ± 4.9 years; 16 women) right-handed subjects participated in this experiment. Each age group was divided into two sub-groups: i) real a-tDCS group (*Stim*) and ii) sham stimulation group (*Sham*). During MI, a-tDCS (current intensity = 1.5mA, current density = 0.06mA/cm2) was applied over the right primary motor cortex. MI consisted in the mental repetition of an 8-items FTT with the left hand during 15 blocks of 30s. Before (pre-test) and after (post-test) MI training, participants physically repeated the sequence as fast and accurately as possible for 8 blocks of 12s. After each mental or physical sequence, they pressed the space bar to register the number of sequences. We analyzed the mean durations of the executed and imagined sequences. To explore the temporal similarity between executed and imagined sequences, we compared the mean durations of the

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sequences performed mentally and physically during the first and last two blocks of MI training with pre/post-test, respectively. Finally, we calculated an index, the imagined times divided by the physical execution times. The closer the index is to 1, the better the temporal similarity is.

Results

The main results showed that:

1) Both groups improved their physical performance after a single MI session (reflecting the acquisition process).

2) Compared to the young, the older participants performed the sequence slower, both physically and mentally. Interestingly, while the young improved the temporal similarity during acquisition (pre-acquisition: 0.48 ± 0.18; post-acquisition: 0.60 ± 0.23), the elderly decreased it (pre-acquisition 0.51 ± 0.30; post-acquisition: 0.46 ± 0.22).

3) There were no significant differences between the *Stim* and *Sham* groups.

Conclusion

In line with previous studies, we showed that MI has a positive effect on the fast learning of a FTT (Ruffino et al.,2019). The older adults were slower than the younger ones to imagine and execute the task (Caçola et al., 2013). The novel finding that the temporal similarity decreased across trials in older adults indicate that MI may be altered with aging when imagining complex tasks (Saimpont et al., 2013). Finally, a-tDCS did not enhance the beneficial effects of MI, which adds the inconsistency of results founds in tDCS studies.

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Keywords: Motor Imagery, atDCS, Motor Sequence Learning, Temporal similarity, FTT

Effects of using immersive virtual reality on parameters time and number of steps while performing " Timed Up and Go " task according to age and gender.

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Virtual Reality (VR) is a technology that has been developed considerably in recent years, particularly in health field, including research, rehabilitation programs or prevention of falls. VR consists of being immersed in a virtual environment in which the user can perceive, act and interact. Its use makes able a person to engage in sensory-motor and cognitive activities in an artificial environment, which can be a simulation of the real world. User in VR could behave like in real because the person acts according to known sensorimotor patterns. VR brings important benefits such as the reproducibility, safety and adaptability of the task to the intended objectives since the environment can be digitally modified. A recent study (Muhla, F (2020) showed a VR effect on motor control in elderly, suggesting that motor strategies employed in VR could be adapted. It is interesting to determine whether the effects encountered in VR are also present in a population of young adults. The aim of this study was therefore to assess the effect of immersive VR on motor skills according to age and gender.
Forty-five young adults (30W, 15M, 21.75) and forty-five elderly (30W, 15M, 70) volunteers, autonomous, without cognitive and neurological impairment participated. The experimentation is based on the motor task used while performing "Timed Up and Go" (TUG) by Podsiadlo & Richardson,1991. The temporal variable "time" and the motor variable "number of steps" were recorded to characterize motor behaviour and were analysed on the whole task but also on five specific phases: Get-Up, Go, Turn-Around, Return and Sit-Down. Participants performed three different TUG related conditions, in a randomized controlled: real condition, virtual reality and virtual reality in motion. VR scenarios corresponded to a simulation of a train set as realistically as possible, seen through an HTC VIVE headset, in which the person can move to perform task.

*Speaker

In the first scenario "virtual reality", the train set is stopped during the task performance. In the other one "virtual reality in motion", the train is driving, causing the landscape to scroll through the windows and hearing the train sounds.
Results showed an increase of time and number of steps used to perform both VR conditions compared to the real condition for elderly and young adults, men and women combined. In contrast, there is no significant difference when adding visual and auditory information in virtual reality in motion. Differences between the three conditions were similar according to age and gender, except for a few phases. VR use therefore reduced motor performance quality but seemed to be independent of age and gender. Being immersed in a new and unusual environment, not seeing its own body, or wearing a head-mounted display, may explain motor control changes in VR. This affected both populations proportionately in the same way on the whole task. Differences were nevertheless noted concerning few TUG phases. Age-related seemed to play a role in "Go" and "Turn-Around" phases, based essentially on visual cues. Similarly, gender seemed to affect "Get-Up" and "Return" phases, linked possibly to confidence and anthropometrics characteristics.
These results will be useful for future studies using VR. We could further imagine increasing the realism of scenarii by adding obstacles, physical and social interactions. We could also couple the scenarios with human metrology and reduce the isolation of the helmet by displaying a full body avatar.

Keywords: Immersive virtual reality, Elderly, Young adults, Motor skills

Effets de l'intensité de l'exercice et de l'expertise sur la Reconnaissance des Expressions Faciales émotionnelles.

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À travers la résonance motrice et/ou émotionnelle, les expressions faciales peuvent nous renseigner sur l'état émotionnel de l'adversaire. Le but de cette étude était de vérifier l'effet de différentes intensités d'effort physique et de la pratique sportive sur la reconnaissance des émotions. Trente experts en sport de combat (SCom) et 20 experts en sport collectif (SCol) ont participé à cette étude. Les sujets étaient appelés à courir sur un tapis roulant à différents pourcentages de leurs vitesses maximales aérobie (VMA). Durant cette course des images d'hommes et de femmes montrant différents états émotionnels (joie, colère et état neutre) étaient présentés. Les participants devaient répondre le plus rapidement possible avec le maximum de précision. Les résultats ont montré que les SCom sont plus rapides à reconnaitre les états émotionnels que les SCol. De plus ces mêmes résultats ont révélé que durant la vitesse de 120% de la VMA les SCom ainsi que les SCol aperçoivent les expressions de joies fortes comme étant émotion colère. Ceci pousse à conclure que la résonance motrice est influencée par type de sport pratiqué, par l'état interne du sujet et par l'intensité de l'effort.

Keywords: Résonance motrice, effort physique, reconnaissance des émotions, sport de combat, sport collectif.

*Speaker

Embodiment and body listening: contributions to martial arts and combat sports (MA&CS)

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Introduction
Listening to something or someone implies an openness to the world and to the situation. It is impossible to listen and not being affected, because it changes our previous perspective even if we don't think about it. Once something is listened, new information is organized to enable a reply, a move, a reflection, etc. However, one relies on verbal communication but not exclusively. The act of listening is to be in contact, in relation to otherness. It is a way to be present towards others.

Objective
To present the notion of body listening and its contributions to MA&CS, especially from a perspective on movement practices through embodiment.

Method
Theoretical approach, focusing on the notions of body, embodiment and motricity.

Results and discussion
Perception-action processes are highlighted as a primary way of engagement with the world, without necessarily thinking about it. Space-time entanglement and the perception of the other as a presence are primary, while the process of identification through reflection of what was perceived requires more time. Perception is already an action, as it is a way of engagement to the world. It consists of a process of forgetting oneself when turning to the world and to the situation, through the body. This is how an attentive body listening to MA&CS is proposed. This perceptual sensing involves an affective attunement even if one is distant from the opponent (by looking or hearing). It allows the monitoring of intensities, intentions and prospections. Body listening is related to a deep comprehension on intercorporeality, and in practical terms, it provides the ability to follow, anticipate and frustrate the opponent's actions. It is based in a sensitive norm: a pattern of aesthetic perception installed in its own reference to accommodate what is happening with the other.

Conclusion
Research into bodily practices, especially MA&CS, should consider otherness and the situation as fundamental in such perception-action processes. When fighting, the bodies move not only

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based on the previously learned techniques but also through an attentive body listening of the opponent.

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Keywords: embodiment, body listening, phenomenology, perception, martial arts, combat sports

Emotional predictions as controlling factor of reaching movement

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Introduction

If ideomotor theories claim that anticipated sensory outcomes of action are the basis of its selection and initiation (Elsner and Hommel, 2001), there is no common understanding about the impact of anticipated emotional consequences on motor organization. The aim of the present study is to show that the latter is built through a global representation of action based on the coding of its emotional outcomes.

We analyzed the pointing movement, manipulating two sources of emotional information: its emotional consequence (pleasant vs. unpleasant), and its direction (right vs. left). Indeed, the body-specificity hypothesis (Casasanto 2009) stipulates an association of the dominant hand side to positive features and negatives to the non-dominant one. We hypothesize that if these two emotional codes have the same valence (positive vs. negative) this will result in a consistent representation of action that will facilitate its organization.

Methods

Each trial begins with a clue, a happy or sad smiley, preventing the subject of the emotional outcome (respectively pleasant or unpleasant) of the future movement. To start a trial, participants had to click on the nose of the smiley face to make a target appear on the right or left side of the screen. Subjects then had to make a quick movement to reach the target. The direct consequence of this click was the displaying of a pleasant or unpleasant picture.

Right-handers' participants were divided into two groups : the first group (G1: N=32) performed 32 right directed pointing movements leading to pleasant outcomes, and 32 left directed movements leading to unpleasant outcomes (in this group the valence of the two sources of emotional information are congruent). The second one (G2: N=32) performed 32 right directed movements leading to unpleasant outcomes and 32 left directed movements leading to pleasant ones (in this group the valence of the two sources of emotional information are incongruent).

We conducted a kinematic analysis to explore planning and programming steps of the gesture, underpinned by cognitive and sensory-motor processes (Paillard, 1985).

Results and discussion

Participants of G1 showed lower reaction times (t=-3,4; p< .001; d=0,6), lower times to reach the velocity peak of their movement (t=-3; p< .01; d=0.5) and lower correction times (t=-2,2; p< .05; d=0.3) than G2. Taken together, results indicate that in situation of congruency between emotional information (i.e. anticipated emotional outcome and emotional features of dominant hand side), pointing movements are quicker organized, triggered and realized than in

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an incongruent situation.
These findings confirm that the representation of action, mainly of its emotional consequences, is automatically reactivated during response selection and execution, this representation having an important impact on motor behavior's organization at both cognitive and sensorimotor levels.

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Keywords: Motor representation, Emotional outcome, Anticipation, Motor control

Fine morphocinetic motions in ASD children: effect of writing amplitude on the isochrony principle

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Autism Spectrum Disorder (ASD) is a neurodevelopmental psychiatric condition characterized by difficulties with social interactions and communication, repeated and stereotypical movements or restricted interests. Altered motor behaviours are also observed in ASD children but they have been much less investigated. Animal models of ASD recently related motor alterations to cerebellum disorders (Jaber, 2017). Because the cerebellum is particularly involved in the control of handwriting (Palmis et al., 2017), we measured the Isochrony principle (i.e. the tendency to keep the duration of voluntary movement approximately constant through changes in amplitude) in ASD children through an handwriting task. For handwriting, the isochrony principle is formalized by the power function MT=T0* L where MT represents movement duration, $T0$ baseline time, A movement amplitude and isochrony coefficient. In typical developmental children (TD), the isochrony principle is respected with a ≈0.4 (Bidet-Ildei & Orliaguet, 2008). We hypothesized that the isochrony principle will not be respected in ASD children. Therefore, we suggest that time duration should be more proportional to size in ASD than in TD children. To this day, we recruited 15 TD (12 boys) divided into two age groups (7 children of 6-7 years, mean age = 7 years) and 8 children of 8-9 years, mean age = 8 years 7 months) and one ASD child (boy, 8 years 9 months). They handwrote five "e" letters of five different sizes in cursive mode (11.25 mm to 180 mm). For each "e", movement time and metric coordinates were recorded using a digitizer and the Eye and Pen software. Movement time and amplitude were extracted post-hoc. Finally, the isochrony coefficient () was computed for each group.
The first results showed that Isochrony coefficient for TD children was equal (6-7 years: = 0.32 ±0.11, 8-9 years: = 0.37 ±0.27), with no age effect (Mann-Whitney comparison: W=25; p=0.95). Performance from the child with ASD (= 0.43) was superior to the mean of the TD group of 8-9 years but not superior to the mean + 1SD of that same group.
Although superior to TD children, our preliminary results show that the isochrony principle could be respected in ASD child. This suggests that the cerebellum disorder in the ASD perturbation could be too small to disturb robust motor-control principles such as isochrony, which are thought by some authors to be inborn (Viviani & Schneider, 1991). Complementary analyses of larger population remain necessary to verify this assumption.

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Keywords: autism spectrum disorder, isochrony principle, handwriting

Gesture-speech synchrony in schizophrenia

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Introduction

Severe impairment of social functioning is the core feature of schizophrenia that persists despite treatment, and contributes to chronic functional disability. Current explanations of social interaction deficits emphasize neurocognitive disabilities, impaired social cognition, and a disorganized language production. The role of non-verbal behavior and particularly the temporal coordination of co-verbal gestures with language abilities have been poorly studied to date in this pathology despite its fundamental importance in human interaction (Burgoon et al., 1989). Exploring temporal dimension of non-verbal communication during a narrative task could be a new approach to report communicational skill disorders. This study aims (i) to investigate whether synchrony between hand gestures and speech is impaired in schizophrenia and (ii) to determine how this synchrony can predict social interaction outcomes.

Method

The experimental group (schizophrenic patients with all levels of symptoms, stabilized for at least 6 month) and the control group (healthy participants) will each include twenty mixed-sex participants from 20 to 60 years. They will have to answer individually open-ended questions while being filmed. Hand movements position will be captured with a skeleton autodetection program and compared with the voice signal to detect asynchronies between gestures and speech. Participant's movement kinematics will then be extracted from videos and viewed afterward by new naive observers in order to assess the utility of gesture-speech synchrony in communicational skills. Observers will have to watch half of stimuli with audio and video and the other half with video only to judge participants' social traits and willingness to interact with them, which express perceived communicational skills.

Results and discussion

Preliminary results were higher measures of asynchronies between gestures and speech in the experimental group, explained by timing deficit and increased motor delay in schizophrenic patients (Carroll et al., 2009). Observers are expected to assign less positive social traits and a lower willingness to interact to stimuli of participants with high asynchronies, leading to a correlation between perceived communicational skills and gesture-speech synchrony. In the experimental group, results are expected to be correlated with the level of negative symptoms and depression, as they are known to affect social interactions.

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Conclusion

Our study constitutes the first step in exploring temporal dimension of non-verbal communication in people with schizophrenia, leading to a novel pathway for diagnostics. Furthermore, as gesture-speech synchrony could have an important effect in quality of communication, its rehabilitation would improve relationships positivity and contribute to the end of social isolation.

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Keywords: Gesture, speech synchrony, Schizophrenia, Communication, Social interaction

How distinct are continuous and discrete movements? Hints from transfer of visuomotor adaptation between reaching and tracking movements

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Introduction
The differentiation between continuous and discrete movements is one of the pillars of motor behavior classification. Manual tracking and reaching, two typical tasks in the field of motor control, offer ways to study respectively continuous and discrete movements. Here our goal was to examine the extent of the separation between continuous and discrete movements by examining whether transfer of adaptation is possible between tracking and reaching movements.

Method
To achieve this goal we tested whether visuomotor adaptation of hand reaching movements transferred to manual tracking, and vice versa. To address these, 30 right-handed participants were asked to move a joystick so as to either track a target moving rather unpredictably (manual tracking task) or to point toward a static visual target (center-out reaching task). Visuomotor adaptation was elicited by introducing a 45◦ rotation between the joystick motion and the cursor motion. Half of the participants (n=15) adapted to the rotation first during discrete reaching movements, and then during the continuous manual tracking task, while the other half (n=15) performed both tasks in the reversed order.

Results
Group comparisons revealed asymmetrical transfer of adaptation between our two tasks. Namely participants that received prior training under reaching movements outperformed naïve participants (that did not receive prior training) during early tracking trials. In contrast participants that received prior training under manual tracking did not outperform naïve participants during initial reaching. Altogether our results showed that transfer of adaptation was possible when switching from the discrete reaching task to the continuous tracking task, but no transfer was found in the opposite direction.

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Conclusion
We interpret these findings of asymmetrical transfer as evidence that the neural processes driving the adaptation of continuous (tracking) and discrete (reaching) hand movements are partly shared, even though the adaptation of discrete movements seems to encompass a wider range of actions.

Keywords: visuomotor rotation, manual tracking, reaching movements, transfer of adaptation

How the way we move impacts the way we perceive others' actions

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The coordination of our own actions with those of others requires the ability to read and anticipate what and how our partner is about to do. Indeed, when observing someone else moving, we can extract useful information such as future bodily displacements or infer higher-order cognitive processes hiding behind those actions. In principle, knowledge about the invariant properties of movement control could support inferences about the unfolding of other's actions. In this regard, it has been proposed that these inferences may be based on a direct match between actor's sensorimotor activations during Action Execution (AE) and observer's sensorimotor activations triggered by Action Observation (AO). Indeed, using TMS-evoked corticospinal excitability (CSE), motor recruitment during AO was shown to automatically mirror the sequence of motor commands implemented by the actor.
For this to happen it is necessary that a stable one-to-one mapping exists between observed kinematics and underlying motor commands. However, due to the inherent redundancy of the human musculoskeletal system, this is hardly the case for multi-joint actions where everyone has his own moving style (individual motor signature - IMS).
Here we investigated the influence of participant's IMS on participants' motor excitability during the observation of an actor achieving the same goal by adopting two different IMSs. We asked 20 naive participants to first perform and then observe a whole-body reaching action executed with two different IMSs. Despite a clear dissociation in kinematic and electromyographic patterns between the two observed actions, group-level analysis did not reveal any significant difference in CSE modulation, due to intersubject variability. This result indicate that CSE-based measures of sensorimotor activations during others' (complex) AO are subject-dependent and cannot be summarized into a common standard pattern. CSE was instead modulated at the single-subject level according to the "distance" between actors' and observer's IMS: larger CSE modulations are associated with the observation of a more different IMS. The IMS distance was defined as the root mean squared error (RMSE) between intersegmental angular trajectories of the actor and each of the subjects.
Thus, sensorimotor activity during action observation does not slavishly replicate the motor plan implemented by the actor, but rather reflects the distance between what is canonical according to one's own motor template and the observed movements performed by other individuals. This agrees with the predictive coding framework, in which prior motor knowledge provides critical top-down signals that are integrated with bottom-up sensory-based processing to generate a prediction error signal (used to update the representation of other's action).
Keywords: action observation, motor resonance, corticospinal excitability, individual motor signature

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Human working in interaction with a cobot: what do its gesture, posture and gaze tell us?

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Introduction

Industry is currently subjected to a new revolution, moving from Industry 3.0 to Industry 4.0. Industry 4.0 is more digital, more ecological, more economical and more flexible. Its production is relied on the digital revolution and artificial intelligence [1]. Collaborative robots, or cobots, are a pillar of this new industry [2] and are characterised by the possibility to interact directly with a human [3,4].

With this work we want to study the nature of the interaction with a cobot. The collaboration between the human and the cobot is analysed during an activity such as the assembly of several products requiring co-manipulation of the product. This new form of collaboration requires an adaptation of the operator, since the introduction of the cobot transforms the relationship between his task and him, but also his motor activity, his work performance as well as potentially his health (in addition to the risks of traumas, musculoskeletal disorders can occur or move due to the adaptation of the operator to the cobot [5]) and his safety. The objective of this work is therefore to analyse the characteristics of human motor performance, through multimodal measurements, of the introduction of the cobot into the collaborative work situation in comparison with the same performance when faced with a human.

To this end, we have constructed an experiment in which participants are asked to put together several components in order to constitute a series of semi-finished products, either with a cobot or with a person. We hypothesize that the presence of the cobot shifts the participant's motor (posture and gesture) and oculomotor (gaze areas) behaviours, compared to the presence of a human.

Methods

A population of forty people, aged between 18 and 40 years, participated in the experiment. The participants were equipped with seventeen wireless inertial motion sensors (Xsens), which, with the help of a biomechanical model integrated into the software, estimate the joint angles, position, speed and acceleration of the participants' body segments. These data allow the study of

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biomechanical behaviour. The participants are also equipped with an eye tracker (Tobii) which records the position of the gaze, as well as the dilation of the pupils. The sessions are recorded and then analysed with the Captiv software in order to study the activity and inactivity time of the cobot and the human. The different measurement tools are synchronized with a Matlab program.
The motor task of the participant, standing in front of the working plan, consists in manufacturing a maximum of products in four minutes, in collaboration either with a YuMi cobot (ABB Group, Zurich, Switzerland) or with another human.

Results and discussion
Currently, the experiments are ongoing (20 participants have passed). The experiments will continue over the next few weeks. Results will be presented at the ACAPS'2021 conference.

Conclusion
The introduction of cobots in industries modifies the relations between the operator and his task, as well as his performance, health and safety. With this study, we hope to gather information that will allow us to better characterise these new relationships, which are still little studied in the literature, and thus to distinguish, upstream of the introduction of the cobot, the situations at risk from those that will benefit from it. A demonstrator is also being designed and our data will be used to enrich it.

Keywords: Cobot, Industry 4.0, Motion capture, Eye, tracking.

Impact of fasting and practicing sports on the response time and the selective attentional ability in preteen and teenage boys

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Introduction
Ramadan fasting concerns every Muslim in good health starting from puberty. During Ramadan, several disruptions affect the sleep/wake cycle, food and fluid intake. Cognitive processes seem to be influenced by the lack of sleep (Beebe et al., 2009), dehydration and food intake (Farooq et al., 2015). Importantly, physical activity, through its beneficial neurophysiological effects (Audiffren, 2009) could moderate the magnitude of these disruptions on cognitive processes. The objective of this study was to evaluate the impact of fasting and sports practicing on the reaction time and on selective attention in preteen and teenage boys.

Methods
Twenty-three healthy boys volunteered to participate in this study [(eleven basketball players (age: 12.5±0,5 years; height: 163±9 cm; weight: 53±10 kg) thirteen sedentary (age: 13±0.3 years; height: 163±7 cm; weight: 55±11 kg)]. The experimental protocol included two sessions:
- Before Ramadan (Control session)
- Mid-Ramadan (Experimental session).
During each session, simple (SRT), choice (CRT) reaction time and selective attention (negative priming- NP) were evaluated using validated software "Superlab 4.5".

Results and discussion
Following table I resume the performance of the two groups: Reaction time and attention constitute important tasks in academic success since they allow adolescents to respond adequately to stimuli while learning. The evaluation of these processes provides valuable information about the perceptual-motor function (SRT), decision-making (CRT), inhibitory control (NP) which constitute necessary skills for academic success. Importantly, Ramadan fasting and physical activity could have profound effects on these processes.
Here we found that neither Ramadan nor the participation in sports had significantly affected cognitive tasks obtained through the various tests (SRT, CRT, NP) (see Table I).

Conclusion
Ramadan fasting and the participation in sports do not affect cognitive processes of preteen and teenage boys.

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Keywords: Ramadan intermittent Fasting, cognitive functions, physical activity, preteen and teenage boys

Individual Motor and Perceptual Signatures

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Introduction

Despite anatomical constraints and dynamic laws, every individual moves differently from everyone else. Recent studies have proposed individual motor signatures to define these singular time-invariant motor strategies (Hilt et al, 2016 ; Slowinski et al, 2016).

A well-documented motor law is the integration of gravity within vertical arm movements. Indeed, experimental data demonstrated finger invariant kinematic during vertical upward and downward arm pointing. More precisely, in contrast to analogous horizontal pointing movements, velocity profiles of vertical movements are asymmetric: upward displacement has a shorter acceleration phase than a downward movement of the same duration (Berret at al, 2011). However, a law by definition is context-independent and universal, and thus should not be affected by important individual variations.

This study will examine the presence of putative motor signatures within vertical arm movement planning in 3D space. Secondly, we will verify whether these motor signatures predict participant's perceptual performances while observing vertical arm movements.

Methods

Forty right-handed voluntary subjects will participate to the two phases of the experiment (1- motor task, 2- perceptive task).

The motor task

Subjects will perform vertical upward and downward arm movements at three different speeds: Natural (N), Fast (F) and Slow (S). One trial will be carried out as follows : A first marker will appear, indicating the participant to point it with his right arm. Then it will disappear, and after a delay (0, 1 or 2 seconds) indicating movement speed, another marker will briefly appear, which will be the signal to start the movement. Arm movements will be recorded with a Vicon motion capture camera system.

The perceptive task

The same participants will view different stimuli on the screen. Each stimulus will consist in a white dot (twenty pixels in diameter) moving either upwards or downwards. The trajectory and timing of this point will be similar to the one recorded in the motor task for the finger marker. The motion displayed will correspond to the first part of the movement (acceleration phase + the 50 milliseconds of deceleration phase). For all conditions, the stimuli durations

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and dynamics will be equal for upward and downward direction. The task will consist in a first pressing of a button to initiate the movement, and a second pressing (after the disappearance of the stimulus), to estimate when the motion would have stopped if it were completely displayed. Stimuli will be displayed and answers will be recorded using Psychtoolbox on Matlab.

Data analysis
From the motor task several kinematic parameters will be computed: Movement Duration (MD), Maximum Speed (Vmax), Symmetry Ratio (SR), and Amplitude (Amp). From the perceptive task, we will extract the estimated movement duration, and we will compare this duration with the subject's kinematic parameters extracted from the motor task.
We will use aggregative tools to analyze our data, which we will complete with classification tools such as persistent homology and machine learning-based classifiers (KNN, hierarchical classification, etc.) to prevent the erasure of individual subject features, which is a drawback of aggregative statistical tools.
We expect low intra and large inter-subject variability, with groups based on the variables, matching different strategies in the task.

Keywords: Individual Motor Signatures, IMS, Persistant Homology, Prediction Models

Influence of physical exercise on inhibition of return

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Inhibition of return (IOR) classically refers to a bias against orienting attention to a previously investigated location. IOR is generally thought to have an adaptive role of optimizing visual search by inhibiting the exploration of previously attended locations, and thus enhancing the ability to notice a new relevant information elsewhere in environment. IOR can be observed in a peripheral cueing task (Posner & Cohen, 1984). In this kind of task, participants first have to focus their gaze on a central cross. A visual cue then briefly appears either on the right or left of this cross. After a variable temporal interval, a target is presented either on the right or left side of the cross: participants have to respond as fast as possible as a function of the target location. The cue location is not predictive of the target's position. Generally, when the Stimulus Onset Asynchrony (SOA: time between the start of the cue and the start of the target) is short (less than 300ms), response times (RTs) are shorter when cue and target have compatible locations (e.g., cue on the right and target on the right), than when they have incompatible locations (e.g., cue on the right and target on the left). This suggests that attention has been involuntary oriented as a function of the peripheral cue. At longer SOAs (more than 300 ms), the reverse pattern is observed : RTs are shorter when cue and target have incompatible locations than when they have compatible locations. This pattern suggests that attention has been initially involuntarily captured by the cue, then disengaged, and finally inhibited to return to the cue position (i.e., IOR). Even if IOR is a robust effect, it can be modulated by factors like the target emotional properties. For instance, IOR can disappear or be delayed when the targets are fearful faces to be discriminated (Sivert & Funes, 2016).
In the current study we tested whether IOR might be influenced by practicing a physical exercise. Forty participants had to perform a classical peripheral cueing task during three phases. During the pretest and the posttest phases, they performed the cueing task sitting on a chair. During the test phase, they performed the cueing task while performing an isometric wall-sit posture exercise. In the cueing task, the SOA were either 100ms or 500ms, and the participants had to respond as a function of the target's location (i.e., geometric stimulus).
Results showed in the three phases a classical facilitation effect for 100ms SOAs : RTs were shorter when locations of cue and target were compatible than when they were not. For 500ms SOAs, we observed the reversed pattern in pretest and test, revealing a classical IOR. Interestingly in posttest, no IOR was not observed for 500ms SOAs. A plausible interpretation for this absence of IOR in posttest is that during the test phase, the effort perception related to the wall-sit posture may have become associated to the targets. Therefore, our targets were no more emotionally neutral during the posttest. In line with the study of Silvert and Funes (2016)

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in which emotional targets disrupted IOR, no IOR was thus observed in posttest. The adaptive interest of such a dynamic will be discussed in our presentation.

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Keywords: inhibition of return, attention, physical exercise, perception of effort, emotion

Information throughput in healthy individuals who are comparable in age and gender with persons with stroke.

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Introduction
About two-thirds of stroke victims suffer from persistent functional limitations of their paretic upper limb. Stroke limits the capacity of the central nervous system to integrate sensory inputs for the execution of specific voluntary movement in response to task demands. Functional limitations are usually quantified with clinical scales, but it is unclear how clinical scores relate to the integration of sensory feedback into motor control loops. Here, we use a circular steering task to probe the efficacy continuous visuomotor feedbacks in goal-oriented behaviours, with the goal of providing baseline values in a population of healthy individuals who are comparable in age and gender with persons with stroke.
Method: 19 healthy volunteers were recruited into 2 groups: [> 75 years old]; [≤75 years old]. Their task was to follow a circular path as fast as possible with 2 to 6% of errors. Each participant performed a total of 20 trials (20s each), organized into 2 blocks x 2 hands x 5 repetitions. The outcome measured is the index of effective performance (IPe, in bit/s), which quantifies the throughput of the sensorimotor system as a whole.

Results
An analysis of variance revealed that the dominant hand had significantly higher IPe than the non-dominant hand, regardless of age and gender. In addition, the under 75 group had significantly higher IPe values.

Discussion
We replicated the expected results of a higher information throughput on the dominant side and for younger persons, independent participant gender. However, these preliminary results need to be supplemented with a larger number of participants to define age- and gender- specific norms for comparison with individuals with stroke.

Conclusion
The index of effective performance in a circular steering task quantifies the information throughput, which is a probe into the effectiveness of the individual's visuo-manual feedbacks. Therefore, reference values in healthy people indicate the possibilities for improvement for each patient, to guide therapists in the rehabilitation strategy of upper limb motor control after stroke.

Keywords: motor control, stroke, information throughput, feedback, steering task

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Proprioceptive contribution to learning an elbow flexion-extension task

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Introduction
Proprioception has been suggested to be a key component of motor learning, *i.e.* the ability to adjust motor performance based on feedback relative to prior execution (Krakauer et al. 1999). However, proprioceptive influence on motor learning has been mostly investigated in short-term ($<$ 2h) adaptations, limiting the understanding of possible long-term ($\geq$24h) effects (Vidoni & Boyd 2008). Our objective was to identify whether proprioceptive feedback contribute to long-term motor learning. We hypothesized that vibrating muscle tendons would be detrimental to a long-term motor learning performance.

Method
Ten healthy young adults (4 women, 22 years old) reproduced a continuous motion of elbow flexion-extension (70∘ maximum amplitude, duration of 3.5 s), with their right arm secured in a mechanical device and hidden underneath a blanket. Five participants were equipped with tendinous vibrators on the biceps and triceps distal tendons (VIB group) and five were not (control, CTL group). In the VIB group, tendons were vibrated at 5 different frequencies (from 50 to 90 Hz), randomly presented. All participants performed an acquisition phase of 10 blocks with 10 trials each, and a retention block of 10 trials 24h later. The elbow angle time history was recorded and, along with the reference angle time history, was displayed to participants at the end of each trial, for 5s. No visual feedback was provided during the trial. RMSE computed between the two time histories were compared using a two-way ANOVA ("Group" and "Block" as factors). Cohen d-tests were used as post-hoc.

Results
Mean RMSE decreased of about 5 to 15∘ between block 1 and block 10, in both groups. Statistical analysis revealed a significant effect of both factors and a significant interaction (all $p < 0.01$). Post-hoc comparisons revealed that RMSE in block 1 was superior to all other blocks, in both groups. Only in block 1, the RMSE in the CTL group was superior to the RMSE in the VIB group ($p < 0.05$). RMSE in the retention blocks were both inferior to the RMSE measured in block 1, but were not different between groups ($p > 0.05$).

Conclusion
Motor learning occurred despite alteration of a proprioceptive feedback. Contrary to our hypothesis, participants of the VIB group adapted better to the task than the CTL group but in

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the 1st block only. This suggests the task may have been too easy to learn and/or that presence of the vibration may have increased participants' attentional focus towards proprioceptive feedback. Another hypothesis would be to focus on dynamic feedback disruption instead of kinematic feedback (Krakauer et al. 1999). Further research is necessary to disentangle whether proprioceptive feedback contribute to long-term motor learning.

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Keywords: Appentissage, proprioception, vibration

Restoring arm complexity of stroke patient through arm dyadic synchronization

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Introduction

Stroke patient suffer a reduced ability to use their paretic upper limb and the complexity of this part, and they need rehabilitation programs that require different methods and this is a challenge for therapists1, 2. We hypothesized that the reduced ability and loss of complexity could be restored based on the complexity matching3 effect that has been proposed for accounting for synchronization processes and minimize trunk movement 4. Then our aim was to study to rehabilitate the upper limb, through an experiment that requires prolonged interaction of two systems of different complexities5, a healthy system, and a system lacking in complexity, by arm synchronization in duo.

Methods

The research variables were determined by the number of repetitions of the arm flexion and extension, the degree of pain, and the degree of the angle of the arm through synchronizing with the movement of a healthy companion arm to improve the range of motion of the arm as indicators of restoring complexity in the arm for stroke patients within a long training program. 11 participants (10 patients and 1 young healthy companion) were involved in the experiment. They have composed 10 dyads. The experiment lasted eight weeks, with three sessions per week, and three arms synchronize duo sequences of 15 minutes per session and solo sequence.

Duo sequences consisted that the participant synchrony their arm with a young arm and healthy companion by bending and extending the arm, along with picking up a cup and the trunk was restricted from the up to reduce its motion. Per and post-test (solo sequence) were performed before and after the end of the experiment.

Results and discussion

During duo sequences, the effect appeared through an improvement and increased participant's arm movement by increasing the number of repetitions of flexion and extension of the arm, as well as a decrease the degree of pain and reducing the pain angle of the arm.

The results show an improvement in the level of arm complexity of stroke patients represented by increased ability to perform a movement of the affected limb and range motion as a result of the complexity restoration.

These results were reinforced by the t-test, where the test showed significant differences between the results of the pre-test and the post-test. The restoration of arm complexity was preserved during the post-test, after the end of the experiment.

This experiment shows that the synchronization experience of complexity, with a healthy system, could allow restoring the complexity of deficient systems. Additionally, this effect seems persistent over time, at least within the time scale used in this experiment.

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Conclusions

- Synchronized arm, between the stroke patient and the experimenter, is dominated by a complexity effect.
- Complexity results in the attunement of complexities between the two participants, and an attraction of the complexity of the stroke patient towards that of the younger by increasing arm motion range.

Keywords: Complexity, Stroke patient, Restoration, Synchronization

The Effects of 2 minutes of breathing relaxation on the balance of 4th graders when they are carrying, or not carrying, a school bag.

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Introduction
Schoolbags have been the subject of controversy on many occasions. Sometimes targeted as the source of students' back pain, and at other times considered as innocent in it. It seemed interesting to question the real impact of the schoolbag on the posture of the students.
The purpose of our research will be to show that the schoolbag has a direct impact on the static and dynamic balance of our students. We will also try to show that physical education (PE), through respiratory relaxation, can correct these impacts.

Methodology
60 subjects aged 13 to 15 years (31F, 29G) were tested on their static balance using a Ouaknine cyber-sabot platform (40 Hz, 25.6 seconds) which allows the collection of standard parameters classically used in stabilometry (Gagey and Weber, 1999) without or with the same 6kgs schoolbag for all, on two shoulders or one shoulder chosen by the student with and without relaxation. We will only compare the results with eyes closed, analyzed by repeated measures Anova fact. 2 on Statistica 13 software and Bonferroni Post Hoc test.
To also measure dynamic balance, we used in parallel the Fukuda stomping test standardized for adolescents regardless of sex (Bourgeois, 2020) which measures a degree of deviation. Subjects, with their eyes closed, were asked to perform 50 barefoot, on-the-spot strides in 40s, in rhythm with a metronome. The angle of deviation formed by the direction of the two feet with respect to the starting point constitutes the spin.

Results
Analyzing the results of the Fukuda test, we observed a trend with a spin of 8 degrees less deviation during relaxation, with and without schoolbag ($p = 0.053$).
On the force platform, in static equilibrium, we did not observe a significant difference with the binder on both shoulders, with or without relaxation. On the other hand, when on one shoulder, we observed a trend of contralateral deviation (X parameter) of 3.5 cm, as well as an increase in surface area ($p < 0.001$) and length ($p < 0.001$). A decrease in energy (LFS) was significant when performing relaxation and binder wearing for two shoulders ($p=0.001$) and with one shoulder ($p=0.001$) respectively.

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Conclusion
Wearing a schoolbag has a significant impact on static balance only when worn on one shoulder. Relaxation increases body oscillations and decreases energy with and without a schoolbag, but does not increase deviations in the Fukuda dynamic balance test. These results on 60 subjects deserve to be pursued.

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Keywords: Relaxation, Equilibre statique, Equilibre dynamique, Posture, Cartable

Toward an individual emotional motor signature

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Introduction

Emotions produce transient changes at cognitive, physiological and behavioral levels for individuals who experience it (Scherer, 2001). Emotional behavioral responses are highly detailed in literature but a great inter-individual variability persists and methods of motion analysis are very varied. In order to generalize motion-emotion analysis and visualization, we applied a new method onto emotional field: the Individual Motor Signature (IMS), combining mathematical modelling to complex affective processes. IMS allows to capture the subtle differences in the way each of us moves, seen as a kinematic fingerprint (Slowiński et al., 2016). We hypothesized that the individual motor signature would be different depending on the induced emotional state and that an emotional motor signature of joy and sadness common to all participants would emerge.

Method

We elicited two different emotions (joy, sadness and a neutral control emotion) in 26 individuals, using an autobiographical memory paradigm, before they performed a motor improvisation task (e.g., the Mirror Game). We extracted the IMS of all participants under each emotional condition. Participants completed a self-report emotion before and after each motor task. The variables of interest were, for all participants, the intensity of the felt emotions and the similarity indexes of intra and inter emotional condition signatures for joy and sadness.

Result and discussion

The result of intensity scores of felt emotions indicated that participants felt the target emotions (joy and sadness) in the corresponding condition from the beginning to the end of the motor task ($p < .001$). Comparing the similarity indexes of intra and inter emotional condition signatures, results revealed that joy, sadness and neutral intra similarity indexes were significantly lower than neutral/joy, neutral/sad and joy/sad similarity indexes ($p < .05$). These results showed low similarity in trials from different emotions and high similarity in trials of the same emotion, showing the existence of a specific motor signature for joy and sadness, allowing us to introduce the notion of Individual Emotional Motor Signature (IEMS).

Conclusion

The evidence of IEMS of joy and sadness allows to deepen the understanding of emotion expression and reinforce emotion discrimination and quantification. It provides a starting point to connect research in psychology and in biometrics, allowing the possible detection of different

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emotional states of moving individuals. Our study can be applied to different pathologies, such as Autistic Spectrum Disorder, where impaired facial and bodily emotional expression contributes to the observed core social-communication disability. Extraction of Individual Emotional Motor Signatures from patients' motor behavior could be a novel pathway for indexing Autism in diagnostics and outcome measures of rehabilitation programs.

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Keywords: emotion, movement, individual motor signature, mirror game

What level of analysis to detect expertise during basketball shooting in a virtual reality ?

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Introduction
Although virtual reality allows detailed analysis of sports movements, how interesting each level of analysis is to coaches and scientists? In basketball shooting, body kinematics and the ball success rate are at the ends of the complexity continuum. We investigated these variables to explore players' expertise during shooting with a basketball simulator.

Methods
12 experienced (8 females) and 10 novice (5 females) basketball players were instructed to naturally throw an instrumented ball to swish in a stereoscopically rendered virtual basket. We randomly manipulated the distance of the basket relative to the player (3.225, 4.225, and 5.225 m), while keeping the surrounding environment unchanged. We measured the success rate and body kinematics during 3 shots performed at each distance.

Results
Concerning success rate, the two way-ANOVA (group × distance) with repeated measures on distance, revealed a significant main effect of expertise ($F(1, 21) = 22.934$, $p < 0.05$, $\eta^2p = 0.52$), a significant main effect of distance ($F(2, 42) = 31.252$, $p < 0.05$, $\eta^2p = 0.60$), and no significant expertise × distance interaction ($F(2, 42) = 1.73$, $p > 0.05$, $\eta^2p = 0.08$). Post-hoc tests showed that experienced players had significantly higher success rate than novice players (45.00 ± 3.44 vs. 23.07 ± 3.02 %, $p < 0.05$). Post-hoc tests also revealed significant different success rates across distances (58.46 ± 4.42, 40.32 ± 6.55, and 3.33 ± 1.93 % for the 3.225, 4.225, and 5.225 m distances; $ps < 0.05$). Concerning kinematics, multivariate tests showed that expertise affected movement patterns ($F(10, 45) = 4.02$, $p < 0.001$; Pillai's Trace = 0.47; $\eta^2p = 0.31$; [experienced vs. novice] movement duration: 1.13 ± 0.38 vs. 1.29 ± 0.47 s, hand angle: 148.61 ± 9.45 vs. 150.40 ± 8.78 ∘, elbow angle: 123.49 ± 16.55 vs. 125.29 ± 13.12∘, knee angle: 158.78 ± 6.47 vs. 160.18 ± 8.24∘, foot angle: 115.40 ± 11.18 vs. 121.54 ± 12.14∘, shoulder angle: 122.83 ± 12.98 vs. 113.63 ± 9.92∘, and trunk rotation: 93.65 ± 6.26 vs. 90.40 ± 4.55∘). However, distance did not affect the kinematic parameters statistically significantly ($p > 0.05$).

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Discussion
Both success rate and body kinematics allowed detecting the players' expertise. However, body kinematics failed to reflect any behavioral adjustments while adapting to the changes in distance. While advanced mathematical descriptions can help scientists in understanding how the whole-body kinematics are controlled when adapting to distance (Ibáñez-Gijón et al., 2016), one wonders about the cost of such complex procedures for coaches when the success rate offers sufficient sensitivity. the shot regulation observed in novice and experienced players as a function of egocentric basket distance manipulation suggest that the basket carries sufficient sources of visual information and nuances the role of visual information sources provided by other parts of the environment (Stöckel & Breslin, 2013).

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Keywords: Expertise detection, Kinematics, Level of Analysis, Basketball shooting, Virtual reality

Neural correlates of functional upper limb motor task performance using combined fNIRS-EEG

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Introduction

After a stroke, brain activation reorganisation and its evolution through rehabilitation is a subject of major interest (Jones, 2017). To evaluate the level of functional recovery of the upper limb (UL) after stroke, our team has developed functional motor tasks evaluating the i) use of the arm and trunk compensation during a reaching task, and ii) speed-accuracy trade-off with an index of performance (IP) in a circular steering task (Muller et al., in review). Two non-invasive neuroimaging methods allow for recording the task-related brain activation: i) functional near-infrared spectroscopy (fNIRS) based on haemodynamic response and ii) functional electroencephalography (fEEG) based on electrical activity. Simultaneous use of fNIRS-EEG could allow for a better spatiotemporal mapping of the brain activity during the task to unveil underlying mechanisms of functional UL recovery. Nevertheless, before studying stroke patients, we need first normative brain activation data during UL functional tasks in healthy adults. This study is being part of a larger project (ReArm, Muller et al., in review).

Objective. To depict the activation patterns of the motor cortex in both hemispheres using combined fNIRS-EEG methods and their association with the motor performance during UL functional tasks.

Methods

Sixteen (25.6 ± 5.3 years; 7 men) out of the twenty planned participants have already been recruited to participate in a single testing session of functional UL motor tasks. First, participants realize a reaching arm task with a target in front of them in a free then in a forced arm use (trunk restrained) condition for 3 blocks of 20s (20s of rest) for each arm/condition. Hand movement and trunk compensation while reaching in both conditions are assessed using a Kinect 3D motion capture device (LSL-Kinect; 10.5281/zenodo.4300182). Then, participants perform an electronic circular steering task (LSL-Mouse; 10.5281/zenodo.4297675) displacing a mouse as fast as possible on a tablet within fixed boundaries of a circle projected on a screen. Three blocks of 20s (20s of rest) are used for each arm and IP is assessed in terms of speed-accuracy trade-off. Meanwhile, brain activation over the motor cortex in both hemispheres is recorded using EEG (8 channels, around C3 and C4, 10-20 system) and NIRS (8 optodes, around C2 and C1). Laterality index (LI) and level of activation of the motor cortices are analysed with NIRS signals and the Mu (8-13Hz) and Beta (15-25Hz) rhythms through EEG signals.

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Preliminary Results
Preliminary data of 5 subjects showed i) the same arm use in free and forced conditions in the reaching task and ii) a similar IP in the circular steering task. NIRS-related LI results showed a greater contralateral brain activation to the active arm, in line with our previous work (Delorme et al., 2019). Regarding EEG results, Mu-Beta rhythm event-related desynchronization was seen mainly during active periods compared to the rest period, in agreement with Bartur et al. (2019).

Conclusion
We aim to describe the association between brain patterns and arm movements in functional tasks using easy to use and low-cost neuroimaging and kinematics methods. Based on this first healthy population data set, we will be able to compare values to those recorded in a stroke population (ReArm project).

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Keywords: Upper limb function, Motor task, fNIRS, EEG

The modulation of corticomuscular coherence reflects alteration of the central-peripheral network after stroke.

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Introduction

Stroke affects brain tissue, which leads to multiple rearrangements of both the central nervous and the peripheral neuromuscular systems, resulting in an alteration of motor network connectivity. By studying correlations between brain and muscle electrophysiological signals (EEG and EMG, respectively), also called corticomuscular coherence (CMC), previous studies have provided evidence of modifications in the brain-muscle communication for post-stroke subjects compared to controls. However, to date there is no consensus on whether CMC is lower or higher in stroke versus control subjects. Moreover, despite CMC provides information on the nature of the central command sent to synergistic muscles and reflects central-peripheral network alteration, it remains to investigate the functional role of CMC with respect to the loss of motor function after stroke. In view of increased spastic co-contraction occurring in post-stroke spastic paresis syndrome, this study investigates the effect of stroke on CMC computed between EEG and EMG from both agonist and antagonist muscles, concomitantly with the loss of motor function during active elbow extension. An alteration of CMC especially with antagonist muscles was expected in stroke subjects. Such finding would provide evidence for the involvement of CMC in the functional reorganization of the central-peripheral network, and could reflect an alteration of the central-peripheral network after stroke.

Method

10 chronic stroke subjects (Stroke: 8 M/2 F) and 9 healthy subjects (Control: 4 M/5 F) participated in this study. Kinematic, EEG and EMG data were recorded during 20 active elbow extension movements performed at a self-spontaneous speed with the paretic upper limb for Stroke and non-dominant for Control, to quantify i) the active range of motion, ii) spastic co-contraction and iii) CMC with agonist and antagonist muscle groups in the 'beta' frequency band (β, 13-31 Hz) (Fig 1). For statistical comparisons, effect size (ES) was calculated for each variable using Hedges'g. A significant difference was considered as an ES with confidence interval not including zero.

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Results

Compared to Control, Stroke showed a lower active range of motion (62.5 vs. 95.5 degrees, ES = 2.75 [2.10:4.48]) and a higher level of spastic co-contraction (10.9 vs. 2.4%, ES = -1.62 [-3.33:-1.19]). β-CMC with both the agonist and antagonist muscles was higher in Stroke than in Control (respectively: 0.56 vs. 0.18, ES = -0.91[0.17:1.92] and 0.52 vs. 0.19, ES = -1.05 [0.38:2.03]) (Fig 2).

Conclusions

This study highlighted an increased β-CMC during active elbow extension after stroke, suggesting a greater share of direct central drive sent to the synergistic muscles. This finding could reflect the functional reorganization of the central-peripheral network which contributes to the upper limb motor control. Contrary to our hypothesis, the observed modulation of CMC in stroke subjects occurred for both agonist and antagonist muscles. This may reflect a global reorganization of this central-peripheral network contributing to the muscular overactivity and to the loss of muscular selectivity after stroke. This work provides additional evidences of motor network reorganization after stroke, reinforcing the functional importance of CMC in the regulation of motor function.

Keywords: Brain Injury, Electromyography, Electroencephalography, Motor Control, Motor Network.

Functional Status Is Associated With Prefrontal Cortex Activation in Gait in Subacute Stroke Patients: A Functional Near-Infrared Spectroscopy Study

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Increasing cerebral oxygenation, more precisely the overactivation of the prefrontal cortex (PFC), reflects cortical control of gait in stroke disease (1,2). Studies about the relationship between brain activation and the functional status in stroke patients remain scarce. The aim of this study was to compare brain activation, gait parameters, and cognitive performances in single and dual tasks according to the functional status in subacute stroke patients.
Twenty-one subacute stroke patients were divided in two groups according to Barthel Index ("low Barthel" [61-90] and "high Barthel"[91-100]) and randomly performed ordered walking, cognitive task (n-back task), and dual tasks (walking + n-back task). Patients walked through an open space at a comfortable pace for 30 s, through an 8-m GAITRite walkway, which provided speed and stride variability. Cerebral oxygenation (ΔO2Hb) was measured using a functional near-infrared spectroscopy.
Patients with better functional status (high Barthel) showed a lower PFC activation (ΔO2Hb) and better gait parameters in single and dual tasks compared to low-Barthel patients, who exhibited decreased gait performances despite a higher PFC activation, especially in the unaffected side ($P < 0.001$).
This overactivation in PFC in patients with poor mobility confirms that basic motor tasks require most of their attention resources and could be interpreted as a neural inefficiency. Our results underline the interest of proposing rehabilitation programs focused on walking, especially for patients with low functional capacity.

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Keywords: functional near, infrared spectroscopy, prefrontal cortex, stroke, dual task, gait, cognition

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Effect of simultaneous physical and cognitive training on executive functions in aging people

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Context
Aging is characterized by a progressive loss of autonomy, partially explained by a cognitive decline in executive domain. Currently, cognitive and physical training seem to be effective to limit this decline. However, the scientific literature is not uniform concerning the superiority of the benefits of dual stimulation (cognitive-physical) in comparison to physical or cognitive training alone. In addition, there are very few studies in which double stimulation is performed simultaneously, which would be a major importance. Indeed, the hypothesis according to which physical activity potentiates cognitive activity when the two activities are practiced within a restricted time window has yet to be validated.

Objective
To compare the effect of simultaneous dual-task training on executive functions and cerebral oxygenation compared to physical training or cognitive training alone.

Methods
Twenty-four old (over 55 years old) healthy subjects participated in a 12-week training program. During this period, participants were invited to perform 30 minutes of training twice a week. Depending on their group, participants underwent physical, cognitive training alone or both training simultaneously. The executive functions measured by Stroop's task at rest and N-back in dual task walking, were evaluated before and after the training period. Cerebral oxygenation measurements (fNIRS) of the prefrontal cortex during these tasks were also evaluated.

Results
Repeated measures ANOVA revealed an interaction between group and time regarding inhibition performance during the Stroop ($p< 0.05$; d=0.86) and cerebral oxygenation during the N-back test ($p< 0.05$; d=0.74) but there is no effect on N-back performance. In both cases, this interaction favored simultaneous dual stimulation.

Conclusion
Simultaneous training would have a greater positive impact on inhibition capacities and cerebral

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oxygenation. These preliminary results tend to confirm the hypothesis that the dual physical and cognitive stimulation performed simultaneously potentiates the effects of the stimulations performed alone.

Keywords: Double tâche, Cognition, personnes âgées, activité physique

Neural plasticity induced by motor imagery strength-training

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Introduction

Motor imagery (MI) training is the repetition of a mentally simulated action without any corresponding overt movement. It is a promising therapeutic tool for rehabilitation. For examples, MI training promotes the relearning of impaired motor functions and prevents the loss of muscle strength following a long immobilization [1]. In heathy adults, MI training significantly leads to an increase of the maximal strength development, when compared to a control group [2]. However, the neural plasticity mechanisms supporting the increase of the voluntary contraction induced by MI training remain largely unknown. This lack of fundamental knowledge lowers the use such intervention in clinics. The overall objective of this study was to understand the neural mechanisms of plasticity induced by MI strength-training at all stages of the central nervous system (cortical, corticospinal and spinal).

Methods

Twenty healthy participants were randomly assigned into the MI training (n=10) or the Control (n=10) group. The MI training program consisted of 10 sessions, one per day, with each comprising four blocks of 20 imagined maximal voluntary wrist flexions. Before (Pre), immediately after (Post1) and 7 days after (Post2) the training program, maximal voluntary isometric contraction (MVIC) was measured to verify behavioral outcomes. Transcranial magnetic stimulation applied over the primary motor cortex was used to investigate cortical and corticospinal excitability modulations. Mean motor-evoked potential amplitudes and short-interval intracortical inhibition were measured in the trained flexor carpi radialis (FCR) muscle at different levels of muscle contraction: rest, 10%, 20% and 30% of the MVIC, with two Test stimulation intensities: 120% and 130% of the motor threshold [3]. To probe the changes of motoneurons excitability, electrical stimulations were applied over the median nerve to evoke H-reflex and maximal compound muscle action potentials in the FCR muscle.

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Preliminary results

Behavioral outcomes showed that gains in MVIC (normalized with Pre) were higher for the MI training group (+12.3 ± 14%) when compared to the Control group (-2.4 ±7%). Moreover, gains in MVIC were significantly greater at Post1 (P = .016) and Post2 (P = .028) when compared to Pre for the MI training group but not for the Control group (all P > .05). Analyses are currently being conducted to determine how these behavioral outcomes are accompanied by neurophysiological changes at the cortical, corticospinal and spinal levels. Based on physical strength-training literature and a previous study, we hypothesize that the improvement in MVIC will be accompanied by a reduction of intracortical inhibition [4] and an increase of the H-reflex amplitude [5]. Such a result would demonstrate that MI strength-training would lead to supraspinal as well as spinal adaptations.

Conclusion

Neural plasticity induction is thought to be a crucial mechanism to facilitate motor recovery. Therefore, findings from this fundamental research that would highlight a reorganization at the cortical and spinal levels could support the use of MI training in neurorehabilitation programs.

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Keywords: Transcranial magnetic stimulation, mental training, strenght, plasticity

Unconscious reading of action verbs modulates corticospinal excitability during motor imagery

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Introduction

The comprehension of action language has been shown to automatically activate distributed semantic motor representations (Barsalou 1999, 2008; Fischer and Zwaan 2008), including unconscious activation in motor areas. This motor activation has been compared to motor imagery in an unconscious form (Tomasino et al. 2008). However, it remains unclear whether action language and motor imagery share the same cognitive process with varying levels of motor network involvement (Yang and Shu 2014), or if they constitute two distinct processes employing separate motor representations (Willems et al. 2010). The current study addressed this issue, employing transcranial magnetic stimulation (TMS) to probe the level of corticospinal excitability during the imagery of hand actions. Each imagined trial was preceded by the presentation of a subliminal action verb, congruent or not with the imagined action. If action language and motor imagery share motor representations, subliminal presentation of congruent action words should be able to increase corticospinal excitability during motor imagery whereas incongruent subliminal action words should decrease this excitability. If action language and motor imagery are distinct processes, corticospinal excitability during motor imagery should not be modulated by the presentation of subliminal action words.

Methods

20 participants were instructed to imagine hand flexion (fist) or extension (palm open) upon presentation of a visual cue. The cue was preceded either by a congruent or incongruent action verb, or a meaningless chain of consonants (Control condition) in a masked subliminal presentation (See Dehaene et al. (2001) for the subliminal word presentation design). For example, the action verbs "I squeeze" or "I extend" might be presented subliminally before the subject was asked to imagine making a fist, on a congruent and incongruent trial respectively. During motor imagery, we measured the peak-to-peak amplitude of motor-evoked potentials (MEPs) in the Extensor and Flexor Digitorum Superficialis, and Extensor and Flexor Radialis Carpi muscles of the right forearm. To ensure that the presentation of verbs was subliminal, we performed a behavioral verification task at the end of the experiment.

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Results and discussion
We observed verb-dependant modulations of corticospinal excitability, characterized by a greater MEP amplitude when imagined actions were preceded by congruent verbs than that when preceded by incongruent verbs. These results suggest that motor imagery and action verb reading indeed influence each other, and thus potentially share motor representations. Supplementary analyses will be conducted to determine whether subliminal action verbs facilitate or interfere with motor imagery and whether the individual level of excitability during motor imagery alone, i.e., without any preceding verbs, influences these modulations.

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Keywords: Action language, motor representation, motor imagery, Subliminal priming, transcranial magnetic stimulation.

Life Sciences - Physiology, Biomechanics

Soccer match activity during the menstrual cycle in elite French women soccer players

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Introduction

The menstrual cycle (MC) follows a biological rhythm with cyclic fluctuations in endogenous sex hormones. It is well-known that the different MC phases may specifically alter metabolic adaptations during exercise (Oosthuyse & Bosch, 2010). However, the impact of MC on elite female athletes' performance is still under debate (Larsen et al., 2020). Nevertheless, a systematic review indicates that exercise performance might be trivially reduced during the early follicular phase (menses) of the MC (McNulty et al., 2020). Thus, the purpose of our study was to investigate and determine the impact of three distinct phases of the MC, including menses, on player's movement activity during competition matches.

Methods

Matches were registered over 3 consecutive competitive seasons from the second French division (2018/19 – 2020/21). Player's movement activity was assessed via an accelerometer and gyroscope devices placed on player's ankle. The match performances outcomes were expressed, and for each velocity range, as distance covered per minute (m.min-1) and for sprints and accelerations the number of occurs per minute. All these outcomes are averaged for each participant and were compared considering menstrual cycle phase (menses, late-follicular, mid-luteal) and by half-time.

Results and discussion

Linear mixed model revealed that the total covered distance (DTOT), distances covered at moderate velocity (ModV), at high velocity (HighV), with the worst performance was observed during menses compared to late-follicular (DTOT), and both late-follicular and mid-luteal (ModV, HighV). The number of sprints performed per minute is significantly higher during late-follicular phase compared to other phases. Moreover, DTOT and distance covered at low velocity (LowV) significantly decreased in second half time compared with first half time.

Menses suggests to impaired player's movement activity during a competitive soccer game as previously reports (Armour et al., 2020) and can be explain by various psychological factors

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as motivation, fatigue (Chrisler et al., 2015). Energy deficiency, commonly observed during menses and mid-luteal phases (Williams et al., 2017), is correlated with a greater fatigue during multiple sprint exercise because of limitations in anaerobic metabolism (Billaut & Bishop, 2009).

Conclusion

Theses results demonstrate that MC can altered player's movement activity during a soccer match. In particular, menses can have a negative impact on moderate and high velocity activity while during late-follicular, the capacity to perform sprints tends to be enhanced.

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Keywords: menstrual cycle, soccer, match

Effect of 40 min nap opportunity on physiological responses and physical abilities in elite basketball players

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Sleep disturbances and a high prevalence of insomnia symptoms are current on training days, night(s) before and following competitions in elite athletes. It was showed that sleep deprivation deteriorates athletes' physical and cognitive performance, increases muscle damage, impairs the recovery from high-intensity exercise, and is associated with higher injury risk. According to Romdhani et al. (2020) and Souabni et al. (2021), napping is a safe and non-invasive intervention in athletes' schedules. However, studies investigating the effect of napping on physical performance showed inconclusive and contradictory results. Little is known about the effect of diurnal napping on physical and cognitive performance, and sports specific skills in elite athletes. In addition, no study investigated the effect of a diurnal nap opportunity on physiological response in team sport. This study investigates the effect of 40-min nap opportunity on physiological responses and specific abilities in elite basketball players. Diurnal napping may enhance physical outcomes of athletes and would have a positive effect on physiological responses allowing better performance of specific skills.

Twelve high-level professional basketball players accomplished randomly two conditions: 40-min nap opportunity (NAP) and control condition (CON). Wellness Hooper index, Epworth Sleepiness Scale (ESS) were measured before and after both conditions. At 15:00 h, participants completed the shooting skills test (SST) (10 shots from the free throw line) followed by a 15 min standardized warm-up. Then, defensive (MAT) and offensive (CDT) agility, and upper body strength (MBCP) were tested. Next, participants played a 10 min small sided game (SSG) followed by the shooting skills retest. RPE at the end of SST-test, SSG and SST-retest and heart rate (HR) during both nap and control conditions, SST-test, SSG and SST-retest were measured.

Better performance was obtained in NAP compared to CON condition for MAT and CDT ($p \leq 0.02$, $d \geq 0.74$, $\Delta \geq 2.7\%$). MBCP performance was higher in NAP ($p < 0.0005$, $d = 1.67$, $\Delta = 5.6\%$). Although no significant difference was reported in test session, SST performance was significantly higher in NAP compared to CON condition in retest session (74.2±12.4 %

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vs. 59.2±11.6 %, respectively) (p=0.003, Δ=20.2%). HRmean was significantly lower in NAP compared to CON condition during SSG (p=0.02, Δ=6.09%). HRpeak was significantly lower in NAP compared to CON condition during SSG (p=0.02, Δ=4.9%) and SST-retest (p=0.01, Δ=5.25%), however no significant difference was reported during SST-test. RPE score was significantly lower in NAP compared to CON condition for SSG (p=0.001) and SST-retest (p=0.003). ESS, Hooper's stress and fatigue score were significantly lower after nap compared to values before nap (p=0.03, p=0.009 and p=0.01, respectively), however no significant difference was reported in CON condition.
In agreement with our hypothesis, NAP had a positive effect on physiological response operationalized through lower HR values compared to CON condition. This resulted in lower RPE scores and could explain the improvement of shooting performance in retest session. In conclusion, NAP reduces sleepiness, stress and fatigue and enhances physical outcomes of specific skills in elite basketball players. It is also an effective strategy to overcome the deterioration in shooting performance caused by the fatigue induced during exhaustive gameplay situations.

Keywords: Nap, Athletic performance, Basketball, Sleepiness, Fatigue, Stress, Heart rate

Effects of video games on endurance performance and perceived exertion in team sport players

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Introduction

Pacing is defined as the ability to distribute energy in an appropriate way to prevent premature fatigue towards the end of competition (Skorski & Abbiss, 2017). Pacing is influenced not only by physical, physiological and environmental factors but also by psychological factors such as emotion. Videogame playing may increases mental health and positive emotions in moderate gamer athletes (Villani et al., 2018). Thus, the objective of this study was to determine the impact of prior video games on endurance performance, pacing as well as the perception of effort in team sports players. We hypothesized that prior video games could improve endurance performance while reducing the perception of exertion and improving of pacing in team sports players.

Materials and methods

Seventeen team sports players (20.2 ± 1.1 years, 74.6 ± 6.7 kg, 179.5 ± 5.1 cm) completed a 10 km cycling time trial (TT10km) following 2 experimental conditions: i) a 40-minute rest period consisting in reading books or magazines (A); ii) a 40-minute video game (FIFA 2020) period (B). Participants were asked to complete the TT10km as quickly as possible. Feedback was limited to distance updates every km only, at which point participants were asked to rate their perceived exertion (RPE) using the Borg 0-10 scale (Borg 1982). TT10km completion time was measured to assess the physical performance. Thus, pedaling cadence and average power-output were averaged for each covered km during TT10km in order to assess exercise intensity and to determine the optimal pacing strategy used to achieve the exercise endpoint as fast as possible.

Results

The results of this study showed (i) lower values of RPE after condition B compared to condition A ($F=11.06$; $p=0.004$; $p2=0.40$), (ii) better endurance performance after condition B compared to condition A (807.41±74,30 vs. 833.05±68.21 s, $t=4.71$, $p< 0.0005$, $d=1.14$) (iii) higher pedaling cadence ($F=20.49$; $p< 0.0005$; $p2=0.56$) and average power ($F=12.53$; $p=0.002$; $p2=0.43$) after condition B in comparison with condition A ($p < 0.05$).

Conclusion

A 40-minute period of video games preceding TT10km reduces the perception of exertion in the subjects of the present study, which could explain in part the improved endurance performance

*Speaker

as well as the improvement of pacing adopted by team sports players. Future studies are needed to examine whether playing more violent video games could negatively impact the physical performance in team sports and other sports players.

Keywords: Video games, pacing, endurance performance, perception of effort, team sports players

Reliability of a new in vivo neck-muscle loading measurement device: Cervistab

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Introduction
Neck extensor muscles reactivity is crucial to maintain neck stability and prevent catastrophic spinal injuries and concussion during sport impact practice. To date, literature deals with the role of neck strength and neck stiffness in decreasing head velocity and magnitude of head movement after an impact but there is clearly a lack of validated device to elicit such realistic loading conditions (1). Therefore, this study was designed to test the reliability of a new device (Cervistab) to explore the dynamics of neck loading and associated muscular reactivity in prevention of rugby head and neck injuries.

Methods
12 healthy volunteers participated to this study. The neck extensor muscle reactivity following neck loading was measured with an original dedicated device (Cervistab) during a test/retest protocol. Cervistab based on an electro-pneumatic system allows for producing a series of impacts posteriorly on the head of each participant in a rugby ecological position. Cervistab induced head impacts, via a pneumatic compressor, on the head of a participant in a rugbystic ecological position. During each session participants experienced impacts with preloading (PL) set at 50% and 20% of MVIS. The neck muscle reactivity was evaluated by the muscle activation latency and by the passive and active loading rates.

Results
The impact force directly applied on the occiput was ranging from 19.99 DaN to 31.58 DaN, across participants. The mean muscle latency was 62 ms and 76 ms at 50% and 20% PL conditions, respectively. The mean passive loading rate of neck extensor muscle [SP1] was respectively 805 DaN.s-1 (50% PL) and 757 DaN.s-1 (20% PL). The mean active loading rate of neck extensor muscle [SP2] ranged from 162.5 DaN.s-1 (50% PL) to 295.2 DaN.s-1 (20% PL). Day-to-day reliability of muscle activation latency assessed by Intra Class Correlation coefficients (ICC (2,1)) was good to excellent (left 50% PL= 0.73 / right 50% PL= 0.85 / left 20% PL= 0.91 / right 20% PL= 0.79). The coefficient of variation (CV) of the muscle latency was 5.7% (left) / 4.6% (right) for 50% PL and 2.9% (left) / 4.6% (right) for 20% PL. Measures of loading rates (both passive and active) exhibited excellent reliability with ICC ranging from 0.88 to 0.92 for 20% and 50% PL conditions, respectively. The coefficient of variation for 20% and 50% PL conditions was 6.67% and 7.35%, respectively.

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Discussion
These results demonstrate show the excellent repeatability of the measures of the neck extensors activation delay latency and neckmuscle loading rate [SP3] measures on this new device. By allowing an accurate quantification of neck muscle extensors activation delay latency and loading rates, Cervistab can contribute to improve our understanding of neuromechanical factors influencing neck stability.

Conclusion
By providing a reliable quantification of neck loading as a function of muscular activation, Cervistab has a twofold role in injury prevention. It is an innovative tool to identify risk factors and contribute to primary prevention. Its measures can also be used to guide a player toward a safe return to play after a severe neck or head injury.

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Keywords: Cervical, Head, Muscular response, Rugby, Injury

Validation of on-field ground reaction forces measured through force sensors embedded into a football shoe

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Introduction

Biomechanical parameters like ground reaction forces (GRFs) have been widely studied in football to prevent injuries and understand player/shoe/surface interactions. However, the lack of ecological tool led to contradictory results and limited efficiency of injury prevention programs (Ekstrand et al., 2013; Lacome et al., 2018). The purpose of this study was to assess the validity of a football shoe fitted with 6 instrumented studs to measure GRFs on a football turf. To this aim, data collected during sprints and counter-movement jumps (CMJs) have been compared to data obtained with force platforms, i.e. the reference tool to measure GRFs.

Method

Two amateur football players with two different running profiles participated to this study: a rearfoot striker and a midfoot striker. Each subject was required to run in a straight line at different velocities (3, 4, 5 and 6 m/s) and to perform five CMJs. They were fitted with a football shoe equipped with six instrumented studs (Phyling, France) capable of recording vertical GRFs in situ (freq = 1000 Hz). Data acquisition system was composed of a portable unit (weight = 230 g) worn by subjects in a custom lightweight sport vest. The shoe was connected to the data acquisition system thanks to a wire that passed inside subjects' joggers. Kinetic parameters, centre of pressure (CoP) coordinates and temporal parameters were computed for each step. Force data were normalized by body weight (BW) to allow inter-subjects comparison.

Results (preliminary)

Force-time patterns were comparable to previous data obtained through force platforms while running, showing a typical impact peak followed by a propulsive peak for the rearfoot striker, and an absence of impact peak for the midfoot striker. Propulsive peak increased (from 1,36 to 1,79 BW) with running velocity, as well as vertical instantaneous loading rate (from 3,45 to 8,56 BW.s-1). CMJs force patterns showed a double impact peak during landing with force values ranging from 1,45 to 1,65 BW.

*Speaker

Discussion
Despite average lower force values, current force patterns and their evolution with running velocity were in accordance with the literature (Hamill et al., 1983, Munro et al., 1987). Lower force values could be attributed to higher softness and damping properties of the real football turf environment, in comparison to hard surfaces of force platforms employed in previous studies.

Conclusion
This innovative way to measure GRFs could give new insights to quantify training load, detect stride imbalances and neuromuscular fatigue and have a better understanding of the player/shoe/surface interface. This instrumented football shoe could also give information about force distribution under the foot (medial vs lateral, CoP trajectories, etc.). More subjects will take part in this study in the upcoming months and the subsequent results will be presented during the ACAPS conference.

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Keywords: Ground reaction forces, football, stud, force platform

Physical and physiological responses to 10 km cycling time trial following video games in team sport players

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Introduction

It is well known that video games reduce sedentary behaviors. Moreover, video games have been shown not only to induce stress, which influences cardiovascular, respiratory and metabolic systems but also reduce or manage stress (Roy and Ferguson, 2016). Video games increase positive emotions (Villani et al., 2018). Therefore, it could improve physical performance. Thus, the objective of this study was to determine the impact of prior video games on endurance performance as well as the cardiorespiratory and the metabolic responses in team sports players. We hypothesized that prior video games could improve endurance performance without affecting metabolic and cardiorespiratory parameters.

Materials and methods

Seventeen team sports players (20.2 ± 1.1 years, 74.6 ± 6.7 kg, 179.5 ± 5.1 cm) completed a 10 km cycling time trial (TT10km) (Souissi et al. 2022) following 2 experimental conditions: i) a 40-minute rest period consisting in reading books or magazines (A); ii) a 40-minute video game period (B). Participants were asked to complete the TT10km as quickly as possible. Only the covered and the remained distance were allowed. TT10km completion time was measured to assess the physical performance. Cardiorespiratory (heart rate [HR], minute ventilation [VE] and oxygen consumption [VO2], carbon dioxide production [VCO2] and respiratory exchange ratio [RER]) were averaged for each covered km during TT10km. Metabolic parameters (blood lactate concentration [La] and blood glucose concentration [Glu]) were assessed at rest, at 5 km and immediately after the TT10km.

Results

The results of this study showed (i) a better endurance performance observed after the video games session compared to the control condition (807.41±74.30 vs. 833.05±68.21 s, t=4.71, p< 0.0005, d=1.14) (i) a significant effect of video games on HR (F=6.32; p=0.02; p2=28) (ii) no significant effect of video games on VE (F=0.01; p=0.89; p2=0.001), VO2 (F=1.19; p=0.29; p2=0.02), VCO2 (F=0.34; p=0.54; p2=0.02), RER (F=6.32; p=0.02; p2=28) and metabolic

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parameters ([Glu] (F=0.46; p=0.50; p2=0.02) and [La] (F=0.59; p=0.45; p2=0.03)), (iii) a significant increase in HR through TT10km (F=71.88; p< 0.0005; p2=0.81), VE (F=187.92; p< 0.0005; p2=0.92), VO2 (F=128.17; p< 0.0005; p2=0.88), VCO2 (F=57.04; p< 0.0005; p2=0.80), [Glu] (F=102.02; p< 0.0005; p2=0.86) and [La] (F=160.84; p< 0.0005; p2=0.90).

Conclusion
A 40-minute period of video games preceding TT10km improves endurance performance. However, cardiorespiratory parameters showed to be unchanged following the video game compared to the control condition. Future studies are needed to examine the effect of playing longer video games on physical and psychophysiological performance of team sports players.

Keywords: Video games, endurance performance, physiological responses, team sports players

Effet de l'entraînement en hypoxie et d'une supplémentation en nitrates sur le stress oxydant et le métabolisme du NO

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Introduction

Hypoxic exercise was shown to increase in the oxidative stress through overproduction of reactive oxygen species (ROS). On the contrary, chronic aerobic exercise training decrease the oxidative stress at rest and in response to exercise mainly in improving the antioxidant enzymatic efficiency. However, little is known regarding the effects of hypoxic high intensity interval training (HIIT) program on the oxidative stress and antioxidant systems.

In other hand, nitrates supplementation is a strategy used to improve exercise performance in particular when microvascular perfusion would be one of the limiting factors of the performance, which is likely the case of HIIT in hypoxia. The benefits of nitrates supplementation rest on its ability to increase nitric oxide (NO) bioavailability and related muscular microvascular perfusion. Moreover, NO has antioxidant properties and thus nitrates supplementation may modulate the oxidative stress resulting from hypoxic HIIT.

The goal of this study was therefore to test the effects of nitrates supplementation during repeated session of HIIT in normobaric hypoxia on oxidative stress and antioxidant systems.

Material and methods

30 subjects trained in endurance (36,2±6,3 years) were randomised in three groups : hypoxic training + nitrate supplementation (HNO) ; hypoxic training + placebo (HPL) ; normoxic training + placebo (NPL : control, CON). Participants completed 4 weeks of training, with 3 sessions of HIIT per week in hypoxia or in normoxia, depending on the group. Participants ingested nitrates or placebo 2h30/3h before the beginning of each HIIT session. Blood tests were done at rest in pre- and post-intervention (i.e., one week before the training period and one week after). Antioxidant enzymes activity (superoxide dismutase, SOD ; glutathione peroxidase, GPX ; and catalase), and plasma NO metabolites (NOx : nitrites and nitrates), ferric reducing antioxidant power, myeloperoxidase activity (MPO), advanced oxidation protein products (AOPP), Malondialdehyde (MDA), nitrotyrosine and uric acid were measured in plasma.

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Results
In post-training, nitrates (p=0.07) and NOx (p=0.06) are higher in HNO compared to CON group. In addition, HNO increases nitrates (p=0.1, +32%) and NOx (p=0.09, +33%) between pre- and post-training whereas HPL and NPL not. GPX increased during the training (time effect ANOVA: p=0.025) independently of the group. However only CON group significantly increase GPX (p=0.017, +20%), while HPL and HNO groups did not change. Similarly, MDA increased during the training (time effect ANOVA: p=0.0003). Both HNO (p=0.001, +60%) and CON groups increased (p=0.023, +30%) while HPL did not change.
The other markers are not affected neither by condition nor by time.

Discussion
Our results confirm that a normoxic HIIT increases GPX as it was already observed. The addition of hypoxia (with or without nitrates supplementation) blunts this increase maybe by a lower metabolic stimulus during hypoxic HIIT sessions. Hypoxia seems limit the MDA increase observed in CON group and could results to lower mitochondrial ROS generation in during hypoxic training sessions. The increase in MDA in HNO group is intriguing; however, nitrates supplementation could allow to develop higher power during hypoxic HIIT session. The modest effects of nitrates supplementation on oxidative stress markers could be explain by its very moderate circulating increase.

Keywords: intermittent hypoxic training, nitrate supplementation, oxidative stress, nitric oxide

Spirulina supplementation prevents exercise-induced lipid peroxidation, inflammation and skeletal muscle damage in elite rugby players.

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Introduction

Rugby is a team sport known to induce oxidative stress (OS), inflammation and skeletal muscle damage especially due to its high metabolical/physical demands, numerous collision and eccentric contractions (McLellan et al., 2011). To prevent and reduce these exercise-related alterations, dietary supplementation may be a promising strategy.

Amongst dietary supplements, spirulina (*Arthrospira*) is widely used by athletes. Spirulina is a blue-green microalga known for its complex chemical makeup including high protein content (50 to 70% of its dry weight), all the essential amino and fatty- acids, and most of the vitamins and minerals (Hosseini et al., 2013), which confers to it numerous interesting properties and health benefits such as antioxidant (AO), immunomodulatory, anti-inflammatory, insulin-sensitizing, anti-cancer and anti-viral activities (Wu et al., 2016). The high level of phycocyanin and β-carotene confers to spirulina, AO and anti-inflammatory properties which could be interesting since athletes do not typically provide enough antioxidant vitamins through their diet (Groussard et al., 2004). However, literature data is still rare and controversial about spirulina's effects on exercise-induced OS, inflammation and skeletal muscle damage.

This study aimed to examine the effects of spirulina supplementation on pro/antioxidant status, inflammation, and skeletal muscle damage markers immediately and 24h after exhaustive exercise in elite rugby players.

Material and methods

Seventeen elite male Rugby Union players were randomly assigned to a Spirulina (SPI: n=9), or a placebo group (PLA: n=8) in a double-blind design. Subjects were supplemented with Spirulina platensis (5.7 g/d) or placebo for 7 weeks. At baseline and after seven weeks of supplementation, blood samples were obtained before (T0), immediately after (T1), and 24h after

*Speaker

(T2) exhaustive exercise. The Yoyo Intermittent Recovery Test Level 2 was used as an exhaustive exercise to induce OS, inflammation, and skeletal muscle damage. The studied parameters included Pro/antioxidant status markers (SOD, GPX, GSH/GSSG ratio, ox-LDL, and F2-Isop), inflammation markers (MPO and CRP), and skeletal muscle damage markers (LDH and CK).

Results and discussion
Our results showed that F2-Isop, CRP, and CK levels significantly increased at T1 only in PLA group with no change in SPI group which reflects the effect of spirulina to prevent lipid peroxidation, inflammation, and skeletal muscle damage induced by exhaustive exercise. Moreover, spirulina supplementation accelerated the return to baseline values given that F2-Isop, CRP, and CK levels at T2 were significantly lower than at T0 in SPI group.

Conclusion
Seven weeks of Spirulina supplementation could effectively reduce exercise-induced lipid peroxidation, inflammation, and skeletal muscle damage in high-level rugby players. Based on our findings, we recommend spirulina supplementation especially for athletes who do not achieved the recommended AO dietary intake and who perform a high volume of training in order to reduce the magnitude of OS, inflammation, and skeletal muscle damage which could help to reduce performance losses and accelerate recovery after training/competitions throughout the season.

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Keywords: Spirulina, Antioxidant, Supplementation, Rugby

Does performance improvement following repeated sprints in hypoxia correlate with oxygen (de)saturation during training sessions?

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Introduction
Hypoxia has been used for several decades to improve exercise performance. Recently, addition of hypoxic stimulus to repeated sprints within training emerged as a new way to maximize performance in repeated sprint ability (RSA) as compared to normoxia (1). Repeated sprint training under hypoxia (RSH) is able to increase performance in moderately active students (2) as well as international rugby players (3) even with a very low number of training sessions. Decline in arterial oxygen saturation usually observed when inhaling hypoxic gas mixture presents great inter-individual variations during RSH. This suggests that the hypoxic stimulus can differ among athletes involved in a same training. Lastly, although most studies were performed at simulated altitudes near 3000m, there is no clear consensus about either the optimal altitude or pulse oxygen saturation (SpO2) level to set for getting the highest exercise performance. Within this context, the use of SpO2 to individualize the hypoxic dose is of particular importance. Therefore, this study aims to determine whether performance improvement following RSH depends upon the level of desaturation over the training sessions.

Methods
Twenty-one male students from the sport sciences faculty (age 21.7 ± 1.4; height 176.3 ± 7.8; weight 68.5 ± 6.3) voluntary participated to 6 sessions of RSH over two weeks at simulated altitude of 1500m (n=7), 2100m (n=7) or 3200m (n=7). Training sessions consisted of 3 sets of 8 repetitions of 6 s sprint interspersed by 24 s of passive recovery on a cycle ergometer. The subjects performed a Wingate test and an RSA test (10 sprints of 6 s interspersed by 24 s of passive recovery) on separated days before and after the training. Peak and mean power outputs were monitored for each test. Lactatemia was measured at rest and 2 and 3 min after the RSA tests, and 5 and 6 min after the Wingate tests (Lactate Scout+). SpO2 was continuously monitored at 1 Hz and the rate of perceived exertion (RPE) was recorded after each set during RSH sessions.

Results
Mean SpO2 during training sessions was significantly negatively correlated with altitude level and different between all the three groups, while RPE was not different between groups. RSH

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significantly increased mean and peak power outputs during the Wingate test in all the three groups. Lactatemia after the Wingate test was enhanced following RSH, an effect that was potentiated in the 3200m group. This increase in lactatemia was negatively correlated with SpO2 during RSH ($p=0.03$, $r^2=0.23$). Peak power across the RSA test was significantly improved by training without difference between groups. Mean power during the RSA test was increased after RSH in the 1500 and the 2100 groups, but not in the 3200 group. None of the variations in performance following training were correlated with SpO2 during RSH.

Discussion
RSH is effective for improving anaerobic power and capacity. However, there is no clear evidence that gains of performance depend upon the severity of hypoxia during training sessions. Our results are in line with recent data obtained on sprint interval training conducted at different altitudes (4).

Conclusion
Six sessions of RSH increased anaerobic performance, whatever the altitude level used.

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Keywords: hypoxia, anaerobic power, repeated sprints, oxygen saturation

Effects of hydroxyurea on force production and skeletal muscle energetics in thalassemia minor-like mice

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Introduction
β-thalassemia minor (Tm) is a hereditary anemia due to a reduced synthesis of beta globin chains. It leads to a decreased Hb content which could ultimately affect the oxygen-carrying capacity of blood, oxygen flow and utilization with a recognized impact on exercise capacity (Woodson *et al.*, 1978). Hydroxyurea (HU) is a ribonucleotide reductase inhibitor mostly used as a therapeutic agent in sickle cell disease (SCD) with the aim of increasing fetal hemoglobin production, alleviating anemia and restoring exercise capacity. In β-thalassemia major, it has been reported that HU can enhance fetal hemoglobin (HbF) production (Cokic *et al.*, 2003) thereby increasing total Hb level and reducing anemia (Fucharoen *et al.*, 1996; Singer *et al.*, 2005). It leads to a decreased disease severity in β-thalassemia major patients. However, the corresponding effects on skeletal muscle energetics and function have never been reported in β-thalassemia minor.

Methods
Seventeen HbAA Townes mice, a mild thalassemic-like model (Wu *et al.*, 2006; Muncie & Campbell, 2009), were subjected to a standardized rest-stimulation(transcutaneous electrostimulation)-protocol while muscle energetics, using 31Phosphorus magnetic resonance spectroscopy, and muscle force production were assessed. Eight mice were supplemented with hydroxyurea (HU) for 6 weeks while 9 were not. Statistical analyses (mainly LME and Student t test) were performed using R, on RStudio (4.0.2). The significance level was set $p < 0.05$.

Results
HU-supplemented mice displayed a higher total force production (+ 14,6%, $p < 0.05$, Cohen's $d = 1.01$) compared to the control non-supplemented mice. Neither the total rate of energy consumption nor the oxidative metabolic rate were significantly changed.

Discussion
The increased contractile force reported in the present study is supportive of a similar result reported *in vitro* in fast-twitch fibers from mice supplemented with nitrate, a circulating oxida-

*Speaker

tion product from endogenous nitric oxide (NO) production that can be recycled back to NO (Hernández *et al.*, 2012). Dietary nitrate has been shown to have a targeted effect on fast-twitch fibers (Jones *et al.*, 2003). Accordingly, the low O2 pressure next to fast-twitch fibers would enhance reduction of nitrite to NO thereby potentially improving local blood flow, fatigue resistance, fiber contractility and ultimately exercise capacity. HU supplementation has been shown to increase NO production and its bioavailability (Jiang *et al.*, 1997). One may hypothesize that the improvement of muscle function observed in the present study in HU-treated thalassemia minor-like mice is related to an NO-mediated effect of HU on RyR.

Conclusion

We observed a potential ergogenic effect of a chronic supplementation of hydroxyurea in a group of thalassemia minor-like mice. While these changes might be linked to the NO donor function of hydroxyurea and an expected increase of total Hb, we cannot exclude other accounting factors such as those resulting in a larger proportion of fast-twitch fibers.

Keywords: MRS, Hydroxyurea, Skeletal Muscle, Function, Bioenergetics

Physiological responses to a single session of repeated-sprint training in hypoxia combined with whole-body cryotherapy: a preliminary study.

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Background
Repeated-sprint training in hypoxia (RSH) leads to enhanced repeated-sprint ability (i.e., better resistance to fatigue during a repeated-sprint test) in normoxic condition [1]. This may be explained by improved behaviour of fast-twitch fibres via compensatory vasodilatation and better oxygen extraction [2]. Nevertheless, RSH is very intense, which may contribute to exacerbate athlete's fatigue. The whole-body cryotherapy (WBC), which has been shown to stimulate autonomic nervous system activity [3] and increase sleep quality [4], could be an interesting complementary strategy. The present study aims to investigate the effects of RSH combined with WBC on physiological responses during exercise and recovery. We tested the hypotheses that WBC would stimulate the parasympathetic activation leading to an improved sleep quality post-RSH; that the vasodilation and vasoconstriction mechanisms caused by the successive exposures to hypoxia and cold would change the muscle oxygenation, leading to larger RSH-induced adaptations.

Method
20 trained cyclists performed 3 training sessions in randomized order: RSH, WBC before RSH (WBC-RSH), and WBC after RSH (RSH-WBC). RSH consisted of 3 sets of 5 sprints (10-s all-out / 20-s recovery) at a simulated altitude of 3000 m. The RSH session was preceded or followed either by WBC (30-s at -25 ∘C and 3-min at -55 ∘C) or by neutral exposure (10-min at 20∘ C). Heart rate and heart rate variability (HRV), power output, blood lactate, arterial oxygen saturation, muscular oxygenation (NIRS) were analyzed. The quality of sleep was assessed with HRV, actimetry, and Spiegel questionnaire.

Results and discussion
The following preliminary results include the data of five participants who have currently completed the experimentation. Mean power output during sprints (RSH = 742 ± 51 W; WBC-RSH

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= 737 ± 53 W; RSH-WBC = 732 ± 60 W), and % decrement score (RSH = 16.5 ± 6.3%; WBC-RSH = 16.9 ± 4.0%; RSH-WBC = 16.6 ± 5.9%) were similar between conditions. The subjective sleep quality was positively affected by WBC-RSH (21.6 ± 2.5 A.U) and RSH-WBC (22.4 ± 4.3 A.U) compared to the RSH condition (20.6 ± 4.0 A.U). Finally, the recovery sensation seemed higher immediately after training for WBC-RSH and RSH-WBC than RSH condition (respectively 6.4 ± 1.3 A.U; 6.1 ± 2,0 A.U; 4.8 ± 1.6 A.U) but also the day after experimentation (7.6 ± 1.5 A.U; 8.2 ± 2.0 A.U; 6.8 ± 2.2 A.U).

Conclusion

The objective of this study was to determine if RSH combined with WBC may improve the psychophysiological responses and recovery following RSH. The present preliminary results are encouraging but required confirmation by further analysis and the completion of the study.

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Keywords: Hypoxia, Whole, body cryotherapy, Recovery, Performance

HIIT and flaxseed oil association promote n-3 PUFAs derivatives conversion and modulate gut microbiota composition

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Introduction
Physical activity is an effective strategy to counteract obesity. High-intensity interval training (HIIT) is a time-efficient modality for decreasing fat mass (FM), especially visceral adiposity, which is strongly related to cardiovascular diseases. N-3 polyunsaturated fatty acids (PUFAs n-3) can also be beneficial in obesity by limiting fat mass accumulation and decreasing low-grade inflammation. Our aim was to determine whether HIIT and/or α-linolenic acid supplementation (to equilibrate the n-6/n-3 PUFA ratio) might prevent obesity disorders, particularly by modulating the mucosa-associated microbiota.

Methods
Male Wistar rats (n=60, aged 8 weeks) were evenly divided into CONT (normal diet, n=12) and HFD-ind (high fat diet-induction, n=48) groups for a 16-week period to induce obesity. At the end of this period, the HFD-ind group was divided into 4 groups of 12 matched for body weight (BW) and total FM: HFD; HFD with LO supplementation included in the diet (LO); HFD with a HIIT program (HIIT); and HFD with LO supplementation and a HIIT program

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(HIIT+LO). Trained animals ran on a treadmill (0∘ slope), 4days/week for 12 weeks (3min at 10m.min-1 followed by 4min at 18m.min-1 for 42min). The diet difference between HFD and HFD+LO was only n-6/n-3 PUFAs ratio (30.2 and 2.93, respectively). Body composition was analyzed by EchoMRI. Erythrocyte n-3 PUFAs content, body composition, inflammation, and intestinal mucosa-associated microbiota composition were assessed after 12 weeks.

Results
After the obesity induction period, BW and FM were higher in the HFD-ind group than in the CONT group ($p< 0.05$). Net area under the curve (AUCnet) obtained from the oral glucose tolerance test showed higher values for the HFD-ind group vs. the CONT group meaning that HFD was effective in altering body composition and metabolic profile. The 12-week intervention (HIIT and/or LO supplementation) showed that training promoted lower weight gain and FM accumulation than in the groups without training, despite similar food intakes. LO supplementation alone was not able to induce the same effect. Erythrocytes n-3 PUFAs content increased in the LO and HIIT+LO groups. In the HIIT+LO group, the percentage of DHA from total n-3 PUFAs was significantly higher than in the other groups. Plasma myeloperoxidase (MPO) is reduced in groups with LO supplementation. HIIT had the main effect on mucosa-associated microbiota β-diversity, but the HIIT+LO association significantly increased Oscillospira relative abundance.

Conclusion
HIIT had a major effect on limiting weight and FM gain, whereas LO reduced systemic inflammation. Our study showed that HIIT associated with LO improved ALA conversion to DHA and increased the abundance of Oscillospira bacteria in the microbiota. Thus, the combination of HIIT and α-linolenic acid seems favorable and could be proposed in the management of metabolic diseases such as obesity.

Keywords: HIIT, flaxseed oil supplementation, body composition, microbiota

Whole Body Vibration: what about fatigue?

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For the two last decades, the use of Whole Body Vibration (WBV) has become very popular for a wide range of applications (e.g., fitness, athletic training, rehabilitation...). This interest is mainly due to the enhancements in neuromuscular function generally reported after WBV exposure compared to the same exercise without WBV (i.e., sham). Despite an exponential number of publications regarding the use of WBV exercise, little is known regarding its effects on fatigue.
Compared to sham, an earliest study indicated that WBV caused premature cessation of exercise and greater effort perception (Rittweger et al., 2003). It is well acknowledged that WBV increases cardiorespiratory responses, blood flow (Rittweger et al., 2000) and surface electromyographic activity (sEMG) of lower limb muscles (Lienhard et al., 2014). Consequently, based on these observations, greater fatigue might be expected after WBV exercise.

Although Jordan et al. (2010) observed significant differences between WBV and sham, less fatigue, assessed by means of maximal voluntary isometric contractions, was found after WBV. Moreover, and even though the heterogeneity of the experimental protocols (e.g., type of platform used, duration, static or dynamic exercise...) and/or the WBV parameters (i.e., frequency and amplitude) varied across studies, no fatigue difference was constantly reported between WBV and sham exercise in the literature (Colson, et al., 2009; Kalc et al., 2020; Maffiuletti et al., 2013; Zory et al., 2013). One of the possible reason explaining this absence of difference could be related to the effective workload imposed by the WBV stimulus to the neuromuscular system. Indeed, in our laboratory, we observed that, depending on both the platform and the WBV parameters used, there is an acceleration threshold (i.e., an optimal combination of frequency and amplitude) that produces significant enhancement of muscle activity.

Through a contemporary update of the underlying mechanisms induced by WBV exposure, the objectives of this communication are: i) to illustrate how the acceleration threshold could participate to the absence of fatigue differences between WBV and sham exercises, ii) to present original outcomes related to WBV exercise on fatigue.

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Keywords: fatigue, electromyography, acceleration, knee extensors

How can prolonged local vibration exposure influence central nervous system excitability?

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Introduction

In the last decade, local vibration (LV) has emerged as a training intervention. Growing evidence demonstrate that LV directly applied to a muscle or its tendon during several 30-60 min sessions may improve neuromuscular function [1]. Yet, despite consistency of reported benefits, the influence of training (e.g., duration, number of sessions) and vibration (e.g., frequency, amplitude, site of application) characteristics are not well understood [1], which prevents the establishment of practical recommendations. By imposing repetitive muscle length changes, LV is a powerful stimulus to activate muscle spindles Ia afferents that project their inputs at both alpha motoneurons and cortical levels. Our team found that corticospinal excitability is more increased during LV exposure when LV is applied to the patellar tendon vs. applied to the quadriceps muscle belly, suggesting that LV should be applied to the tendon to optimize the acute effects of LV on knee extensors neuromuscular function [2]. We also reported that motoneuron excitability was depressed whereas cortical excitability was increased after 30 min of LV to the quadriceps muscle belly [3]. Better characterizing the acute effects of a single LV session may help to better determine optimal training parameters. This study aimed to compare the effects of prolonged (i.e. 30 min) tendon vs. muscle LV to the quadriceps on vastus lateralis (VL) motoneuronal and cortical excitability.

Methods

Fourteen healthy young adults performed two randomly-ordered testing sessions during which LV was applied during 30 min to the patellar tendon or the quadriceps muscle belly. Before

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(PRE) and immediately after (POST) LV, thoracic electrical stimulation and transcranial magnetic stimulation were delivered to record the corresponding VL electromyographic responses during a low-level contraction (i.e. 10% of maximal force). Thoracic motor evoked potentials (TMEPs) and transcranial motor evoked potentials (MEPs) normalized to the maximal M-wave amplitude were used as a proxy of motoneuronal and corticospinal excitability, respectively. The intensity for both stimuli was set at PRE to match 10% of the maximal M-wave amplitude. MEP/TMEP ratios were further calculated to quantify changes in cortical excitability. Two-way repeated-measures ANOVAs were performed with the site of LV (muscle vs tendon) and time (PRE vs POST) as within-subject factors.

Results and discussion
No main effect of the LV site, nor interactions were observed for any measured parameter. There was a significant effect of time for TMEP amplitude, showing a 10 ± 22% decrease between PRE and POST (p=0.031), suggesting a LV-induced depression in motoneuron excitability. No effect of time was observed for MEP amplitude (p=0.27) but the MEP/TMEP ratio increased by 25 ± 55% at POST (p=0.034). This latter finding suggests cortical excitability priming (i.e. changes in cortical activity) after a prolonged exposure to LV.

Conclusion
Prolonged LV can lead to both motoneuronal and cortical acute modulations, without any difference whether LV is applied to the tendon or the muscle belly. Cortical excitability priming may be of interest for patients.

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Keywords: vibration, stimulation magnétique transcranienne, motoneurone, fuseaux neuromusculaires

Soft Tissue Vibrations Standards of measurement, physiological interpretation, and clinical use

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Introduction

It is recognized, in the professional field, that the vibrations transmitted to the body in a sitting or standing position can generate various pathologies at the level of the spine (low back pain - sciatica or cruralgia by herniated discs). In addition, it has been observed that the vibrations transmitted to the hand-arm system affect more particularly the sensory and motor functioning of the upper limb (Raynaud's phenomenon, less sensation of touch, hot and cold, pain in the arms and hands, functional discomfort of the wrist and elbow joints). For each mode of transmission, the Labor Code (Article R. 4441-2) defines a limit value of daily exposure not to be exceeded. Even though numerous studies have measured the vibrations transmitted to the body and to the soft tissues in sport (Boyer, 2006), a precise assessment of the exposure of athletes to these vibratory stresses is not yet established. The aim of the present study was to constitute a task force to propose a method to evaluate accurately and reliably the soft tissue vibrations (STV) whatever activities in order to calculate an exposure dose for the athletes.

Methods

STV are mostly quantified with skin-mounted accelerometers placed on the muscle belly. However no standardised guidelines have been published yet while it has been demonstrated that this placement influences the acceleration magnitude of STV (Boyer and Nigg, 2006). In the same way, the orientation of the accelerometer with the segment and/or the muscle can be of great importance, but this parameter is generally treated in an unstandardized way. The localization and the orientation of the accelerometer may differ between muscles and sport activities. In addition, the variables and type of analysis used in the literature to assess STV are very numerous, sometimes redundant and conversely sometimes impossible to compare from one article to another. Moreover, the use of inappropriate methods can lead to erroneous conclusions. From a physiological point of view, STV may depend on the morphology of the subjects and some measures and precautions must be taken to correctly interpret the results.

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Results & Discussion
Recognition of this problem should lead specialists from ACAPS society to create a task force whose responsibility is to develop quality standards for the measurement and analysis of STV. The objective is to propose an adapted nomenclature, to specify standardized methods of measurement and analysis, to propose physiological correlates, to define the limits of use of the method and to anticipate the future applications of this method.

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Keywords: Vibration measurement, exposure dose, sport, chronic diseases, fatigue

Intra-cycle analysis of the Vastus Lateralis muscle vibration during cycling.

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Introduction

Some cycling studies have evaluated the transmission of the vibrations through the handlebars to the hand-arm (e.g. Chiementin et al. 2012). Surprisingly, only two studies measured the transmission to the lower limbs through the pedals. However, all external power is produced by these limbs, and vibration they receive has a significant influence on musculoskeletal system (Wakeling et al. 2002). Munera et al. (2017) examined the dynamic responses of the human bones. They showed that the transmissibility (i) decreased along the lower limb with the distance from the pedal and (ii) changed significantly in term of the phase of the pedaling cycle. Hintzy et al. (2019) completed the analysis by investigating the soft-tissues of the *vastus lateralis* muscle (VL) during cycling without differentiating the pedaling phases. Based on the evolution of effective force (Kautz et al. 1991) and muscle activation patterns (Hug and Dorel 2009) throughout the pedaling cycle, the present study investigates the transmissibility of the vibration along the VL muscle according to the phase of the pedaling cycle.

Methods

Twelve healthy males performed a rectangular cycling test at moderate intensity composed of four randomized vibration frequencies (14.4, 18.3, 22.4, 26.3 Hz, i.e. cadence of 55, 70, 85, 100 rpm respectively) lasting 3 min each. A specifically designed vibrating cycloergometer was used. Two triaxial accelerometers were placed on the distal part of the VL, spaced 10 cm apart, to measure both input and output vibrations during the last 20 pedaling cycles of each bout. The low-frequency component was decoupled using sixth order butterworth low pass filter with a cut-off frequency of 5 Hz. The transmissibility was calculated as the ratio of the RMS values of the output and the input in order to quantify the percentage of vibration transmitted along the VL muscle (example: 89 means that 89% of the vibration is transmitted). The pedaling cycle is divided into 4 phases from goniometer data placed on the knee (top dead center 325-20○; anterior effective zone 20-145○; bottom dead center 145-215○; posterior zone 215-325○). Friedman non-parametric paired statistical test was used to evaluate the difference between the phases.

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Results and discussion
The transmissibility of the vibration along the VL muscle depends significantly ($p < 0.05$) on the phase of the pedaling cycle, for all cadences. It is higher in the phases of power output by the muscle, i.e. during top dead center and effective phases.

Table 1: Transmissibility vibration according to the pedaling cadence (rpm) and phase of the pedaling cycle (∘).

RPM 20-145∘ 145-215∘ 215-325∘ 325-20∘

55 89±17%* 53±32% 52±13% 76±19%*

70 75±22%* 40±13% 50±13% 57±14%

85 69±13%* 36±11% 57±10% 63±17%*

100 77±12%* 41±09% 61±08% 66±15%

The increased transmission of vibration along the muscle in these pushing phases could be explained by the associated higher effective forces. According to the Newton's principle of action - reaction, the vibration would be better transmitted when the lower limb strongly pushes on the crank. To conclude, the transmissibility of the vibration along the VL muscle differed according to the phase of the pedaling cycle.

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Keywords: Cadence, RMS, vibration transmissibility, soft, tissue

Acute effect of adding vibration exercise during recovery on performance during consecutive explosive resistance exercises

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Introduction

Previous studies have shown that adding a 30 s whole body vibration (WBV) exercise with high frequencies (30-50 Hz) immediately increases performance in squat (Rhea & Kenn, 2009) and bench press (Marin et al., 2011). Although the mechanisms are not fully understood, the positive effect of WBV could be due an increased motor cortex excitability and voluntary drive (Marin et al., 2011). At our knowledge, no study has investigated this potential advantage on repeated explosive movement during multiple sets. The aim of this preliminary study was to evaluate the acute effect of adding WBV exercise during recovery on power and kinetic variables during consecutive repeated explosive movement.

Method

Seven male active subjects (24,3 ± 7 years old; 77,3 ± 9,8 kg; 176,4 ± 4,2 cm; 1RM BP: 87,4 ± 18,7 kg – SQ: 117,2 ± 24,2 kg) performed 4 testing sessions on both bench press (BP) and squat (SQ). All the sessions were separated at least by 2 days (same time of day) and started by a 15 minutes standardized warm-up. During the first session, the 1RM and strength-velocity-power profile were determined on BP (or SQ) for each participant in order to identify the optimal load that ensure maximal power production. During the 3 other sessions, the subjects performed 10 sets of 6 repetitions with the optimal load (BP: 32,4 ± 5,7% 1RM; SQ: 31,6 ± 7,7%). They were asked to move the barbell as fast as possible during the concentric phase of each repetition. During the 3 min inter-set rest period, one of the 3 following recovery strategies was applied in a random order: 90 s rest – 15 squats or 15 push-ups with the legs kneeling (30 s) on a platform (Physioplate fit, Italy) with vibration (frequency: 40 Hz; peak-to-peak amplitude: 2 mm) – 60 s rest (VIB), 90 s rest – 15 squats or 15 push-ups with the legs kneeling (30 s) without vibration – 60 s rest (NoVIB), 180 s only rest (Passive).

Peak power (Ppeak) and mean power (Pmean) were measured during each repetition at a frequency of 50 Hz by a GymAware Power Tool (GymAware, Australia). The validity and reliability of this linear transducer has been shown by Dorrell et al. (2018). All the data were averaged for all the repetitions throughout each session. ANOVA repeated measures tests was carried out using Past software to analyze the data set. The level significance was set at $p \leq 0.05$.

Results

There were no significant differences in Ppeak and Pmean between the three different recovery strategies during BP and SQ.

*Speaker

Discussion
Unlike it was exepted, we did not find any improvement in power production in consecutives squat or bench press sets when a 30 s vibration exercise was included during the inter-set rest period. The use of non-optimal vibration exercise parameters (i.e., exercise modality, vibration frequency...) and/or the presence of residual fatigue due to the additional exercise could explain the lack of positive effect of WBV in this study.

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Keywords: vibration, power, squat, bench press

Effects of new method combining vibrations and gravity-facilited traction: Biomechanical, neurophysiological, health and performance aspects

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Introduction
Back pain affects workers, athletes and even the aging population. They are the second reason for consultation with the attending physician. Thus, within their lifetime, 80 to 90% of adults will suffer from pain in the lumbar region (Bigo, 1994). These spinal pathologies are a public health issue and have significant economic and social consequences. This study will be focused on the GravityWaves® device. It's an innovation developed by Bodyfeed company combining artificial intelligence, declivity, and vibrations. The objectives of this research protocol experiment are to determine the biomechanical, physiological, and psychological effects induced by a declivity (15 ∘) coupled with vibrations (25Hz) on an athlete population exposed to heavy physical stress.

Methods
The population will be made up of 15 men and 15 women practicing athletic strength, powerlifting, weightlifting or bodybuilding.
The control group will do the usual training. The experimental group will receive the GravityWaves® program in addition to their training. The subjects of the experimental group will participate in 16 sessions spread over 8 weeks. The use of the device will be induced by a vibratory frequency of 25Hz with a tilt angle of 15 ∘. Sessions will incorporate vibration exposure for a maximum of 10 minutes.
Variables measured will focus on the parameters most related to the performance and health of the athlete (spinal curvatures, flexibility of the trunk, heart rate, postural balance, arterial pressure, muscular oxygen saturation, propagation of vibrations at different locations of the body, feelings, quality of life, well-being...).
Statistical analyzes will be approached using an analysis of variance. We will perform a comparison at the beginning and at the end of the session. The p-value retained will consider the number of analyzes carried out (weighting). A principal component analysis will highlight the multiple correlations between the variables analyzed.

Results
The results will be described during the ACAPS Congress (delay due to the covid). A preliminary measurement shows that the vibration exposure offered by the GravityWaves® device

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complies with European Union directives concerning exposure to whole-body vibrations. For a vibration frequency set at 25Hz (100% of motor capacity), the daily exposure limit value (1.15 ms-2, based on an 8-hour working day) would be reached after 15 minutes at the level feet.

Discussion
GravityWaves® device could be an interesting solution to integrate into the training of the athlete to allow him to preserve a mobility, appropriate to his good health and his athletic performance. It should also improve the quality of life, well-being, and recovery by being part of a prevention approach. The studies addressing our research criteria remain very weak. Apart from the study by Wang (2014), none, study is focused on combining vibrations and gradient.

Conclusion
This innovative combination could improve the preventive and curative management of musculoskeletal disorders and current knowledge around this topic. It therefore appears interesting to carry out experiments on the GravityWaves® device, which seems to offer, in addition to great user-friendliness, a multivariate field of observation in connection with current health topics.

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Keywords: Whole, body vibration, Biomechanics, Musculoskeletal disorders, Lumbar traction, Health, Performance

Energy system contributions during a rowing ergometer performance in young competitive rowers

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Introduction
Rowers under 18-year-old (U18) compete over the 2,000 m Olympic distance. To progressively prepare young competitive rowers for these races highly demanding in energy, some rowing nations have chosen to limit exercise duration by reducing the competition distance to 1,500 m in rowers under 16-year-old (U16) and to 1,000 m in rowers under 14-year-old (U14). While relative energy contribution was well documented in adult rowers over the 2,000 m distance1, no data has still been reported for young competitive rowers over the 1,500 and 1,000 m races.

Purpose
The aim of this study was to compare the relative energy contributions derived from aerobic (%EAe) and anaerobic (%EAn) pathways between the three competition distances. Considering that (i) relative anaerobic contribution increases with distance reduction and intensity increase2 and (ii) relative aerobic contribution decreases during growth due to body mass gain3, we hypothesized that rowing competition distances of 1,500 m in U16 and 1,000 m in U14 would trigger a comparable relative energy contribution as the 2,000 m rowing race in U18.

Methods
Thirty-one 12- to 17-year-old male rowers completed, as fast as possible, a distance of 1,000 m, 1,500 m, or 2,000 m on a rowing ergometer according to their age category. Oxygen consumption was used to assess %EAe, while energy equivalents, based on blood lactate increase during exercise, were calculated to assess %EAn.

Results and discussion
%EAe was significantly lower in U16 than in U18 (84.7 vs 87.0%, $P < 0.01$), and significantly lower in U14 than U16 (80.6 vs 84.7%, $P < 0.001$). %EAn was significantly higher in U16 than in U18 (15.3 vs 13.0%, $P < 0.01$), and significantly higher in U14 compared to U16 (19.4 vs 15.3%, $P < 0.001$). Our hypothesis was not verified since the relative energy contributions were found to be significantly different between the age categories, and therefore the race distances. However, it is worth noting that the relative anaerobic contributions for U18, U16 and U14 rowers were in the range of contributions usually found in adult rowers over the 2,000 m Olympic distance (12-30%).

*Speaker

Conclusion
On a more practical level, these results seems to confirm the strategy implemented by some rowing nations to reduce the competition distances in young competitive rowers to progressively prepare them for the physiological requirements of the 2,000 m Olympic distance.

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Keywords: adolescent, body mass, rowing, aerobic, anaerobic

An in vitro electrical pulse stimulating protocol (EPS) mimicking exercise-induced myokines release to study myocytes - muscle resident progenitors crosstalk.

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Background
Muscle deconditionning (MD) is characterised by loss of muscle strenght, mass and Inter Muscular Adipose Tissues accumulations (IMATs), driving poor functional outcomes (Brioche et al., 2016). Severals studies have shown us that regular intensive exercise is able to avoid MD and especially IMATs development (Distefano & Goodpaster., 2018; Wroblewski et al., 2011). In the past decade, researchers began to consider muscle as a secretory organ capable to produce and release several factors (exosomes, interleukins, intermediate metabolites, growth factors) during contractions, having paracrine or systemic actions (Pourteymour et al., 2017; Huh et al., 2017). We believe that induced-muscle contracting factors named myokines are able to modulate muscle fibre microenvironment in favour of healthy resident actor's crosstalk preserving microenvironment. We postulate that theses factors could participate to muscle health, indirectly or directly inhibiting IMATs progenitors differentiation.

Methods
We used in vitro contraction model (ionoptix) and developed a high frequency electrical pulse stimulation (EPS) train (20V; 5ms pulse duration, 20Hz pulse frequency) to mimic high intensity exercice. Electrical stimulation was applied on day 5 of differentiation phase of primary mouse myotubes. Protein, ARNs and conditionned media (CM) were harvested directly after 3h of electrical stimulation. Protein concentration of Interleukine (IL)-15, IL-6, and growth factors (PDGFaa, IGF-1, FGF and VEGF) as well as L-lactate release concentration were evaluated in conditionned media. Protein and mRNA content of mechanistic actors was also assessed respectively by western blotting and qPCR directly after EPS.

Results
We first verified the non cytotoxicity of our stimulating protocol, using LDH release in CM. Compared to non stimulated primary myotubes, LDH release from contracting myotubes was not significantly increased (p=0.3). PGC1 (p> 0.001) protein content was increased after 3h of

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contraction validating our exercise-liked EPS protocol.
Interestingly, 3h of contraction was sufficient to increase IL-6 (+90% $p< 0.05$) and chemoattractant protein 1 (MCP-1) but not IL-15 ($p> 0.05$) release in the CM of contracting myotubes. Moreover L-Lactate concentration in CM increased by 115% ($p< 0.05$). Among growth factors previously described as myokines, PDGFaa, VEGF, FGF content in CM of contracting myotubes were significantly increased compared to non EPS condition. As many exercise-induced myokines are dependent on AMPK activation we verified its phosphorylation status and found a 83% increase compared to non EPS condition ($p< 0.02$).
Conclusions: Our goal was to develop an Electrical pulse stimulation protocol mimicking intensive exercise in order to quantify myokines/growth factors release . Owing to the AMPK phosphorylation status and lactate concentration found in the CM we conclude that the contraction protocol was sufficient to trigger both cytokine-based (IL-6, MCP-1 but not IL-15) and growth factor based (VEGF, IGF-1, PDGFaa) myokines release. The next step is to test whether the contracting-induced myokines release could alter the fate/behavior of skeletal muscle resident progenitor cell involved in fatty accumulation or fibrosis

Keywords: Electrical pulse stimulation, IMATs, crosstalk, myokines

An in vitro electrical pulse stimulating protocol (EPS) to study resistance exercise.

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Background
The use of in vitro model is becoming increasingly important in numerous domains including exercise physiology. The desire to limit animal experimentation and to conclude about myocyte involvment led us to develop several alternative models to study contracting muscle responses. For this purpose, Electrical Pulse Stimulation (EPS) delivered to muscle cells culture has been shown to induce voltage-induced muscle myotube contractions and mimick exercise-induced gene expression. Most of the EPS protocols described in the literature tend to look like prolonged but not "intense" aerobic exercise. We know from human studies, that a dose response exists between intensity/duration couple and health benefits of exercise. However few data exist about in vitro resistance-like exercises. Intense exercise could protect various pathological states as diabetes, obesity or sarcopenia and could have more potent positive effects than prolonged low intensity exercise especially regarding the control of muscle mass. Therefore we aim to develop an EPS exercise model mimicking intense in vivo exercise. We hypothesized that our intensive EPS protocol could produce similar effects to in vivo intense exercise, in relation to well known activated pathways, gene expression or metabolite release.

Methods
We used an in vitro contraction system (Ionoptix) and developed a high frequency electrical pulse stimulation (EPS) train (20V; 5ms pulse duration, 20Hz pulse frequency) applied continuously for 3h or 4h. EPS was applied on day 5 of differentiation phase of primary mouse myotubes seeded at 1,75x 105/well. Proteins, ARNs and conditionned media (CM) were harvested directly after EPS protocol. Cytotoxicity (LDH assay) was systematically assayed. L-lactate release concentration and protein levels of IL-6, PGC1, phosphorylation of mTOR, AMPK and puromycin profile as an index of protein systhesis were evaluated.

Results
Using LDH assay, stimulated myotubes' LDH release wasn't significantly higher compared to unstimulated conditions (p=0.3) whatever the duration (3h or 4h). Our results showed a decrease in puromycin incorporation traducing a decrease of protein synthesis (p< 0.01). mTOR

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phosphrylation level was also decreased in contracting conditions (p=0.03) suggesting a decrease mTOR-dependent protein synthesis during EPS. Phosphorylation of major metabolic sensor AMPK was significantly upregulated (+83% p=0.02) and PGC1 protein level , a common marker to evaluate exercice-like EPS protocols, was also increased compared to unstimulated myotubes. Our results also confirmed an increased in L-lactate production in CM (+115%, $p< 0.05$) as well as an upregulation of IL-6 secretion (+90%, $p< 0.001$).

Conclusions

Our goal was to develop an EPS protocol mimicking intense in vivo exercise in order to propose an alternative to animal model and to allow the study of muscle contractile and secretory mecanisms in vitro. The decrease in protein synthesis and the metabollic changes, sustained here by the upregulation of AMPK phosphorylation, are two major characteristic encountered during in vivo exercise. Moreover, the doubling of the concentration of L-lactate release reinforced the validation of our in vitro intense EPS protocol. Further experiments are now planned to characterize the EPS-induced myokines release.

Keywords: Electrical pulse stimulation, alternative model, Intense in vitro exercise, myokines, signaling

A new model of training load quantification in resistance training

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Introduction

Resistance training (RT) is a cornerstone of performance enhancement and injury prevention purposes. Located at various physiological levels, the complexity of underpinning adaptations to RT challenges the capture of the objective exercise demand in a monitoring process.
Training monitoring for resistance exercises usually relies on objective and subjective training load (TL) indexes, calculated from intensity and volume training parameters (Scott et al., 2016). The "Volume-Load" (VL), the product of the number of repetitions and the intensity lifted has several limitations. First, it admits a reciprocal implication between volume and intensity, neglecting the multiple effects of intensity on physiological changes (Fry et al., 2004). Then, it does not differentiate exercises since the load traveling is not accounted for and it neglects the key effects of inter-set recovery duration and time under tension.
On this basis, we investigated the validity of usual TL quantification methods (VL and session rating of perceived exertion, RPE) in typical sub-maximal RT bouts and provided a new model of TL quantification regarding physiological responses.

Methods

Fifteen trained adults (eleven male age: 26.9 ± 3.4 y, height: 178.4 ± 4.1 cm, body mass: 78.1 ± 7.6 kg, body fat: 11.4 ± 3.4 % and 4 female age: 21.7 ± 1.5 y, height: 169.2 ± 5 cm, body mass: 60.6 ± 3.9 kg, body fat: 21.1 ± 3.4 %) voluntarily participated in the study.
The study was comprised of four sessions of repeated isokinetic knee extensions. First, individual force-velocity profiles were assessed through seven points (from 0.524rad.sˆ-1 to 3.665rad.sˆ-1). According to the non-linear relationship between relative intensity and repetition maximum (Reynolds et al., 2006), three volume-equated testing sessions were performed at moderate, heavy, and severe intensity (about 58%, 77%, and 93% of maximal voluntary isometric contraction torque).
Cardiorespiratory changes were recorded through breath-by-breath gas exchange and electrocardiogram. Blood lactate concentrations ([Lact]) were analysed around exercise and hormonal acute responses to RT sessions were measured through concentrations in plasma cortisol. Locally, muscle oxygenation and blood volume were recorded on the vastus lateralis muscle (VL) using near-infrared spectroscopy. Neuromuscular changes were measured using surface electromyography on the VL, rectus femoris, and vastus medialis muscles.
A visual RPE was collected after each testing session using the 6-20 Borg scale.

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Results
Preliminary results indicated a significant effect of the F-V profile and the relative intensity on [Lact] among testing sessions ($p< 0.001$ and $p< 0.05$, respectively). In addition, [Lact] showed a significant effect on RPE measurements ($p< 0.05$), which were positively correlated with the relative intensity ($r=0.59$, $p< 0.001$).

Discussion
At this stage, the F-V profile seems to be a determining factor of acute responses to sub-maximal RT exercises. Our preliminary results indicate that a TL quantification based on VL only has a little physiological meaning. Alternatively, we may consider a TL quantification based on individual impulse characteristics, accounting for the F-V profile through torque estimate and time under tension.

Conclusion
The use of standard TL quantification methods has a limited physiological representation. An impulse-based model of TL quantification may be a valuable alternative and applicable to field situations.

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Keywords: Training load, resistance training, adaptations, force, velocity, quantification

Relationships between training load, subjective markers of recovery, salivary cortisol and physical capacity in professional offshore sailors.

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Introduction
Inadequate training load (TL) analysis can lead to insufficient recovery and, thus, provoke a decrease in performance and increased risks of overtraining injuries [1]. TL has been widely used as a monitoring marker to optimize training in many sports. However, for predominantly strategy-based sports, such as sailing, TL analysis data is still lacking [2]. Therefore, the purpose of this study was to examine the effects of 6 months of training on neuromuscular adaptations, subjective markers of recovery, mood state and salivary biomarker cortisol in an elite offshore sailing environment.

Methods
Ten professional offshore sailors (8 male and 2 female) participated in this study. Daily internal TL (ITL), strain (TS), monotony (TM), intensity (INT) and acute:chronic TL ratio (AC) as well as a weekly total score of fatigue (TSF) were quantified respectively by session-rating of perceived exertion (sRPE) and a 4-item wellness questionnaire (delayed onset muscle soreness, stress, fatigue and sleep quality). Salivary cortisol (C), countermovement jump height (CMJ), maximal strength on bench press (BP) and total mood disturbance (TMD) were evaluated at the start of each meso-cycle (4 week blocks).

Preliminary results
Significant correlations were found between testing parameters and the TL variables. Salivary cortisol was significantly correlated to CMJ performance ($r=-.86$, $p< 0.05$), ITL ($r=-.87$, $p< 0.05$), AC ($r=.66$, $p< 0.05$) and block INT ($r=-.58$, $p< 0.05$). CMJ performance was associated with ITL ($r=-.72$, $p< 0.05$), AC ($r=-.55$, $p< 0.05$) and weekly INT ($r=.55$, $p< 0.05$).

*Speaker

Subjective markers of recovery were significantly correlated to ITL (r=.54, p< 0.05) and AC (r=.61, p< 0.05). BP performance was strongly correlated to AC (r=-0.98, p< 0.01). TMD did not provide significant relations with training parameters.

Conclusion

The collected data suggests that subjective instruments, such as sRPE and a 4-item questionnaire, seem to be good means for assessing TL in offshore sailors. In terms of planning and programming, the use of AC analysis provides interesting insights for managing physical and physiological readiness.

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Keywords: Sailing, Training Load, Performance, Monitoring

Impacts of real-time cardiac biofeedback on anticipatory stress

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Introduction
Many stressful situations can be identified before the real stressor occurs. Preparing a sport competition might thus lead athletes and coaches to an anticipatory stress response (1). Although high levels of anticipatory stress have been reported to affect well-being, sleep, and performance, there is no standardised tool designed to specifically investigate this phenomenon, and corresponding psychophysiological responses remain underexplored (2). The present study aimed at *(i)* characterizing these anticipatory stress responses using a new induction protocol, and *(ii)* determining how to manage the deleterious consequences of stress. While cardiac biofeedback (BFB) training routines have been shown to reduce anxiety (3), we explored whether a short and acute BFB session might contribute to specifically manage the anticipatory stress.

Methods
Twenty-nine healthy participants were exposed to a 15-min period of anticipatory stress induced by the Trier Social Anticipatory Stress protocol (TSAS, anticipation of a following social event where individual performance would be evaluated). In the meantime, participants either practiced BFB (STRESS + BFB, n = 15) or watched a neutral video (STRESS + VIDEO, n = 14). A group of control participants, without any anticipatory stress, practiced the BFB for equivalent time (CTRL + BFB, n = 15). Heart rate variability (cardiac coherence, standard deviation of R-R intervals) and changes in perceived psychological state were measured during the anticipation period (VAS stress, AD-ACL relaxation). Finally, participants were asked to self-report whether the intervention (BFB vs VIDEO) helped them to reduce their perceived stress (VAS coping).

Results and discussion
(i) Compared to the CTRL, the STRESS groups had an increased stress (VAS stress), a decreased relaxation (AD-ACL), and displayed lower cardiac coherence. These psychophysiological responses demonstrated that we were able to induce anticipatory stress by means of the TSAS which has the advantage to be less resource-intensive (in terms of time, human resources, or materials) than other stress protocols. *(ii)* Compared to the STRESS + VIDEO group, participants who practiced STRESS + BFB achieved higher cardiac coherence scores ($p < 0.001$).

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Subjective assessment revealed that, compared to the VIDEO, BFB further reduced psychological stress (VAS coping, $p < 0.05$). Both psychological and physiological responses provided evidence that BFB is an effective method for coping anticipatory stress. As cardiac biofeedback is easy to implement, inexpensive, and ambulatory, it may offer an interesting alternative to reduce anticipatory stress in ecological situations, such as before sport competition.

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Keywords: Stress, biofeedback, Anxiety, Heart rate variability, TSAS

Effects of acute and chronic exercise in sickle cell anemia

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Introduction

Sickle cell anemia (SCA) is the most frequent genetic disease in the world. SCA is caused by a single mutation in the b-globin gene, leading to the production of an abnormal hemoglobin (i.e., HbS). HbS is able to polymerize when deoxygenated, resulting in a mechanical distortion of red blood cells (RBC) into a crescent like shape; a phenomenon called sickling. Sickled RBCs are fragile and poorly deformable. Indeed, patients are characterized by chronic hemolytic anemia and may experience frequent painful vaso-occlusive crises. Although SCA is the prototype of a hemorheological disease, it is now admitted that vascular function is also severely impaired (Nader et al, 2021). Training programs (TP) improve vascular function and health condition in several chronic diseases but their effects in SCA population are incompletely understood. The aim of this presentation is to discuss the recent findings in this topic.

Methods

Acute exercise effects in SCA patients: The first set of protocols looked at the effects of acute exercises of mild-to-moderate intensity on different biomarkers involved in the pathophysiology of SCA (Waltz et al., 2012; Grau et al; 2019; Balayssac-Syransy et al., 2011; Faes et al., 2014). Blood was sampled at rest and at the end of exercise.

Regular physical activity and SCA patients: We also performed a study where children with SCA followed a 6 weeks TP with two sessions per week of 15-30 min at 70% of the first ventilatory threshold. Several biomarkers, as well as ventilatory responses during acute exercise, were compared before and after the TP (Grau et al, 2019).

Results

SCA patients may perform mild-to-moderate exercises of 15-20 min duration at an intensity corresponding to VT1, without any risks of medical complication. Neither the pre-existing hemorheological alterations, nor oxidative stress, were worsened in SCA patients after this kind of acute physical effort, supporting the safety of this intervention. We also demonstrated that

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both nitrositative stress and free hemoglobin were reduced after training compared to before. In addition, ventilatory efficiency during acute exercise improved after training.

Discussion
1) SCA patients may practice mild-to moderate exercises ($<$ 20 minutes) with limited risks and 2) regular physical activity has some beneficial biological and physiological effects. Long term clinical impacts need to be tested.

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Keywords: Sickle cell disease, Exercise, Blood rheology, Oxidative stress

Feasibility of an acute physical exercise before immunotherapy and chemotherapy infusion for metastatic non-small-cell lung cancer patients: ERICA study

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Background
Because of metastatic Non-Small Cell Lung Cancer (mNSCLC) and its treatment, patients suffer from numerous symptoms such as dyspnea, muscle atrophy, pain, fatigue, loss of appetite, altered physical condition and lung function, which may further impair the patient's overall condition. These adverse effects frequently impair the patient's general condition. Several studies in lung cancer patients have reported that these adverse effects induced by lung cancer may be reversible through physical activity (PA) which helps improve sleep quality, PA level,

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fatigue, aerobic capacity (VO2peak and strength), functional capacity, anxiety level and emotional well-being(1). While regular PA is recommended in patients with cancer, no specific recommendations exist for patients with lung cancer or metastatic disease(2). Nevertheless, it has been suggested that physical exercise could improve response to treatment at the clinical level due to its known effects on the immune system(3). Moreover, preclinical studies have shown that exercise performed during chemotherapy administration could result in physiological benefits such as improved intra-tumoral infusion and drug delivery(4). The ERICA study's primary objective is to assess the feasibility of an acute physical exercise immediately before immunotherapy and chemotherapy administration in patients with mNSCLC. The secondary objectives aim to evaluate the impact of the intervention on patients' clinical, physical, psychological and biological parameters.

Methods
ERICA is a randomized controlled, single-center feasibility study conducted at the Centre Léon Bérard (CLB). 30 patients with mNSCLC will be randomized (2:1 ratio) in one of two groups: "exercise" or "control". Participants in both groups will receive Physical Activity and nutrition recommendations at baseline and two nutritional assessments, at baseline and during the last treatment cycle. In the exercise group, participants will receive a 3-months program consisting in an acute exercise prior to immuno-chemotherapy administration and a home walking programm using an activity tracker to improve their exercise capacity. The acute exercise will be intermittent, at submaximal intensity and perform on a cyclo-ergomter for 35 minutes. A cardiorespiratory fitness test will be carried out to evaluate the submaximal oxygen consumption condition.

Results and discussion
All results should be available by the end of 2022.

Conclusion
ERICA is the first study to test an acute physical exercise prior to immunotherapy and chemotherapy in patients with mNSCLC. This study will provide preliminary data on acute physical exercise effects to optimize treatment efficacy in NSCLCm patients treated with chemotherapy and immunotherapy.

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Keywords: Non, small, cell lung cancer, Metastatic, Exercise, Immunotherapy, Chemotherapy, Immunology, activity tracker

Impact of endurance exercises on blood rheology and red blood cell physiology

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Introduction

Hemorheology plays an important role in the regulation of tissue perfusion and oxygenation both at rest and during exercise. For instance, red blood cells (RBC) need to be highly deformable to easily flow through small capillaries and transport oxygen to the tissues. RBC aggregation properties as well as hematocrit also modulate blood flow properties (1). However, the changes in cellular and metabolic environment during acute endurance exercise may affect red blood cell physiology and blood rheology, which in turn would influence exercise performance and/or recovery. Indeed, ROS and inflammatory molecules have been shown to modulate red blood cells and blood properties in *in vitro* studies. They could promote eryptosis (i.e., erythrocyte senescence process) that leads to erythrocyte phagocytosis. Eryptosis is also accompanied by RBC dehydration and shrinking, which reduce RBC deformability (2). Furthermore, RBC senescence process promotes the release of RBC microparticles that could have pro-thrombotic and pro-inflammatory effects through their phosphatidylserine exposure and their content in heme and oxidized hemoglobin (2). The modifications of blood rheology and RBC physiology induced by exercise could be highly dependent on the physical status of the athletes, the intensity and the modality of exercise and the environmental conditions of the exercise, such as altitude. Indeed, we tested several exercise modalities in different conditions on RBC physiology and rheology.

Material and methods

Blood rheology (RBC deformability and aggregation, blood viscosity, hematocrit), RBC eryptosis markers (phosphatidylserine exposure, Calcium and reactive oxygen species levels, CD47), RBC microparticles release and inflammatory markers were evaluated in several endurance exercise modalities : 8 endurance-trained athletes performed a 10km running trial at sea level, 8 well-trained cyclists performed a 30min submaximal cycling exercise at sea level and 17 trained cyclists performed a maximal cycling test at altitude (2400m).

*Speaker

Results
A short and intense running exercise at sea level in trained athletes increased RBC deformability and decreased blood viscosity without affecting RBC eryptosis, microparticles release and hemolysis. In contrast, a short and intense cycling exercise at sea level decreased RBC deformability and promoted RBC microparticles production because of increased oxidative stress. Cycling exercise performed in hypoxia increased blood viscosity and RBC aggregation properties which contributed to a rise in pulmonary vascular resistance.

Conclusion
Endurance exercises modulate blood rheology and RBC physiology, which could have potential consequences on vascular function and on performance. These modulations are dependent on exercise modality, intensity, duration and environmental context.

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Keywords: Hemorheology, exercise, red blood cells, altitude, cycling, running, trail inflammation

Effects of two modalities of physical activity on pancreatic cancer induced cachexia

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Introduction

While evidence for the benefits of physical activity in cancer patients is accumulating, its impact on advanced cancers remains poorly studied. 50 to 80% of patients with aggressive cancer experience cachexia. A loss of body weight with a progressive muscle wasting is observed in these patients and is recognized as a predictive factor of mortality. By limiting these symptoms, we hypothesize that physical activity could improve survival. Our project aims to study the impact of two modalities of physical activity on body weight, skeletal muscle mass and alterations as well as tumor growth in an immunocompetent mouse model of pancreatic cancer.

Methods

Six-week-old C57BL/6J mice were subjected to a subcutaneous injection of 1 million UN-KC-6141 pancreatic tumor cells. After tumor formation, mice were divided into 3 groups: no treatment (CaCTL, n=15), voluntary wheel running (CaVWR, n=14) and treadmill training (CaTT, n=14). Healthy mice (Sa, n=9) completed these groups. Body weight and food consumption were daily recorded, tumor size was measured every two days, and a strength test was performed at the end of the protocol. 33 days after tumor cell inoculation, various organs and fluid were collected (muscles, tumor, epididymal adipose tissue, liver and blood) for further investigations.

Results and discussion

Subcutaneous inoculation of UN-KC-6141 cells in mice induced pancreatic tumor formation and weight loss without anorexia. A significant decrease in mass of gastrocnemius, anterior tibialis and cardiac muscle as well as in strength was also found. No difference between the mass of soleus, epididymal adipose tissue and liver was observed. Wheel running appears to limit the severity of cancer cachexia whereas treadmill training seems to accelerate this syndrome. CaWR mice exhibited an increase in food intake and in gastrocnemius and soleus mass compared to the CaCTL group. In contrast, a decrease in body weight (non-significant) and liver mass was observed in the CaTT group compared to the CaCTL group. Other analyses are in progress in order to identify the molecular mechanisms associated with these findings.

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Conclusion
These preliminary results suggest that the modalities of physical activity induce a differential response in a context of pancreatic cancer induced cachexia: While voluntary wheel running seems to limit cancer-induced muscle wasting, treadmill training tends to aggravate body weight loss. These results, in combination with future studies, will help to precise physical activity recommendations for patients with advanced cancer.

Keywords: physical activity, pancreatic cancer, cancer cachexia, skeletal muscle

Dysregulation of mitochondria-related oxidative stress in breast cancer patients during chemotherapy: the first step to decipher the mechanisms of muscle deconditioning

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Introduction

Previous studies showed that chemotherapy (CT) in breast cancer patients (BCP) lead to skeletal muscle deconditioning. Indeed, a reduction in the *vastus lateralis* cross sectional area (CSA) and mitochondria number were found [1]. However, little is known about the cellular processes implicated and mitochondrial function analysis has not been done yet. Our study aims to decipher the underlying mechanisms of muscle deconditioning during (neo)adjuvant CT in BCP.

Method

Newly diagnosed BCP (N=12) undergoing treatment with epirubicin and paclitaxel were included and measurements were made before and after the CT (18.8 ± 2.1 weeks). Vastus lateralis architecture and echogenicity (ultrasonography) and body composition (bioelectrical impedance analysis device) were measured. Through vastus lateralis muscle biopsies, we determined mitochondrial activity by in situ respiration of permeabilised fibres. Appropriate substrates were added to obtain complexes respiratory capacity: CI linked substrate state, oxidative phosphorylation (OXPHOS) by CI, OXPHOS by CI&CII and OXPHOS by CII. Reactive oxygen species (ROS) were measured via hydrogen peroxide production (H2O2) during mitochondrial respiration by real-time monitoring of amplex red oxidation.

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Results and discussion

We found a significant skeletal muscle deconditioning in BCP as evidenced by a decrease in total muscle mass (-1.9 ± 2.4%; p=0.02), as well as a reduction in fascicle length (-13.8 ± 8.4%; p=0.003) suggesting a reduction in sarcomeres in series. We also found a tendency of decrease in muscle thickness (-8.0 ± 14.3%; p=0.08). Our results also shown no changes in mitochondrial respiratory capacity corroborating another study highlighting no variations in protein levels of oxphos complexes [2]. However, H2O2 production clearly increased for CI linked substrate state (+26.8 ± 23.1%; p=0.0009), OXPHOS by CI (+16.7 ± 17.6%; p=0.009), OXPHOS by CI&CII (+23.9 ± 20.9%; p=0.002) and OXPHOS by CII (+21.8 ± 25.6%; p=0.02), demonstrating an increased mitochondria ROS production. H2O2-mediated ROS production was previously associated with an overexpression of p53 and an impaired mTORC1 assembly, probably leading to protein turnover deregulation [3]. H2O2 is also known to induce mitochondrial fragmentation as well as increase IL-6 expression levels, therefore impacting mitochondrial function and inflammation-mediated muscle wasting.

Conclusion

Our results demonstrate substantial mitochondrial adaptations in BCP, particularly in mitochondrial quality, with an increase in H2O2-mediated oxidative stress impacting the muscle deconditioning characterizing this population. Further analyses are in progress to investigate more deeply the underlying mechanisms of this muscle deconditioning (e.g. protein turnover) in order to finally improve its management.

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Keywords: Muscle wasting, Cancer cachexia, Mitochondria, Muscle architecture, Reactive Oxygen Species, H2O2

Central and peripheral fatigue during exercise in breast cancer patients following (neo)adjuvant chemotherapy

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Introduction
A hallmark of breast cancer patients (BCP) is exacerbated fatigue, evidenced in the scientific literature via subjective questionnaires1. However, if the perceived component of cancer-related fatigue (CRF) is insightful in clinical practice, it is equally important to understand its underlying mechanisms to develop counteracting strategies. Therefore, the purpose of this study was to determine central and peripheral fatigue induced by exercise in BC compared to their healthy counterparts.

Methods
Fifteen BCP were tested within two weeks after completion of (neo)adjuvant chemotherapy and were compared to 15 healthy women (CTRL) matched for age, BMI and physical activity level. Participants performed 60 maximal voluntary isometric quadriceps contractions (MVC) over a 5-min period (3 s contraction, 2 s relaxation). Critical force (CF) was determined as the mean force output of the last 6 contractions, whereas W' was calculated as the area above CF. Peripheral and central fatigue levels were quantified via changes in preexercise- to postexercise-potentiated quadriceps twitch force (Qtw), as evoked by supramaximal electrical stimulation of the femoral nerve (immediately through 10 min recovery), and quadriceps voluntary activation (VA), respectively. Corticospinal excitability before and after exercise was assessed by changes in motor evoked potentials triggered by transcranial magnetic stimulation. Perceived fatigue was collected using the FACIT-F questionnaire.

Results
Preliminary results (n=7 in both groups) evidenced lower pre-exercise MVC in BCP compared to CTRL (295.4 ± 50.0 N *vs* 382.2 ± 78.7 N, $P< 0.05$). When normalized from baseline, we observed greater MVC fatigability in BCP compared to CTRL ($P< 0.05$). More specifically, peripheral fatigue was not different between groups (BCP: -61.2 ± 13.8%; CTRL: -48.4 ± 17.8%, $P=0.15$) while central fatigue was exacerbated in BCP (-26.2 ± 14.8%) compared to CTRL (-13.6 ± 8.3%). There was no impact of exercise ($P=0.3$) or the disease ($P=0.2$) on corticospinal excitability. These discrepancies between groups affected key parameters of the force-duration

*Speaker

relationship. Indeed, CF was lower in BCP compared to CTRL when expressed in absolute units (133 ± 26 *vs* 213 ± 46 N, $P< 0.01$) while W' was not different (BCP: 5.1 ± 3.6 kJ; CTRL: 6.4 ± 3.4 kJ, $P=0.5$). Recovery of neuromuscular indices were not impacted by BCP ($P> 0.05$). Higher perceived fatigue was observed in BCP compared to CTRL (32.7 ± 13.0 *vs* 46.0 ± 4.9, $P< 0.05$). No correlation was found between subjective (perceived) and objective (neuromuscular) indices of fatigue, emphasizing a dissociation between these parameters.

Conclusion

These preliminary results suggested that, in addition to a reduction in maximal voluntary force, fatigability was exacerbated in BCP, consecutive to central, but not peripheral, alterations. As a result, exercise capacity was impaired. However, there was no association between perceived and neuromuscular fatigue, suggesting that CRF is complex and multifactorial, and highlighting the need of future comprehensive and mechanistic studies.

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Keywords: central fatigue, peripheral fatigue, breast cancer, exercise tolerance, critical torque

Time-course of functional and morphological muscle adaptations during downhill running training

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Introduction

Muscle strength is a major contributor to quality of life and physical performance in both clinical and sporting contexts. In this regard, eccentric-based interventions have been shown to be effective in enhancing muscle strength through neural and morphological muscle-tendon adaptations, with minor *in-situ* metabolic cost and cardiorespiratory stress. Although eccentric cycling training has been preferentially used in laboratory contexts, downhill walking and/or running (DR) may be an interesting alternative (e.g., easier to implement in daily life settings, and accessible to most individuals regardless of their age and physical condition) to promote chronic adaptations to locomotor muscles. However, to date, DR training-induced functional and morphological adaptations and their respective time-course are poorly understood. This study aimed to fill this gap by investigating the kinetics of changes in strength and potential morphological muscle adaptations following short-term DR training in healthy adults.

Methods

Twelve untrained adults (5 women, 7 men) volunteered to take part in a 4-week DR training program. Training was performed 3 times/week, using three negative slopes (-5%, -10% and -15%). Running speed was set to 60-65% VO2max, and training load raised throughout the training period by increasing total running duration and/or time spent at steeper slopes (i.e., -10% and -15%) per session. Changes in functional capacities (knee-extensor maximal isometric and isokinetic voluntary torque, MVT; neuromuscular fatigue following a 15-min controlled DR bout) and *vastus lateralis* (VL) muscle morphology (cross sectional area (CSA) from 25% to 75% of muscle length; CSAmean; physiological CSA, PCSA; muscle volume; fascicle length, Lf; pennation angle, PA) were assessed before (i.e., 0 week), and at 2 and 4 weeks of consecutive DR training.

Results and discussion

When presented as percentage changes from baseline, MVT increased at 4 weeks by 14.9%, 14.6% and 12.9% for eccentric, isometric and concentric modalities, respectively ($p < 0.01$). Although a

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main effect of *training* was reported ($p< 0.001$) for VL muscle CSA, no *training*×*location* effect was observed ($p=0.13$) suggesting non-regional-specific VL hypertrophy. Detectable changes for VL CSAmean (2.7%) and volume (2.5%) were observed at 2 weeks ($p< 0.05$), whereas PCSA (3.3%), PA (5.8%) and *Lf* (3.2%) increased at 4 weeks only ($p< 0.01$). Voluntary activation measured in the non-fatigued state did not differ between week 0, 2 or 4 ($p> 0.05$). Furthermore, it did not change pre-to-post the controlled DR bout at any time point ($p> 0.05$). In contrast, isometric MVT and indicators of peripheral fatigue (e.g., amplitudes of potentiated single twitches and high-low frequency doublets) were significantly altered post-15 min controlled DR bout at 0, 2 and 4 weeks, with no difference between time points ($p> 0.05$).

Conclusion
Rapid functional and morphological locomotor muscle adaptations were observed following just 2-4 weeks' DR training in previously untrained, healthy adults. Notably, changes in VL volume and CSAmean were identified as early as 2 weeks. These were followed by architectural VL adaptations at 4 weeks. As voluntary activation capacity did not change during the 4 weeks' DR training, the observed morphological adaptations appear to explain most of the improvements in isometric and isokinetic strength. Finally, acute DR appears to elicit peripheral and not central fatigue, but this acute response is not affected by chronic DR training in this population.

Keywords: eccentric training, muscle strength, muscle volume, neuromuscular fatigue

Energy Cost of Running in Highly Trained Athletes: towards slope-dependent factors

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Purpose
The purpose of this study was to determine the contribution of metabolic, cardiorespiratory, neuromuscular and biomechanical factors to the oxygen and energy costs of downhill, level and uphill running in highly trained runners.

Methods
Eight highly-trained trail runners completed maximal isometric evaluations of lower limb extensor muscles and three 5-minutes randomized trials on treadmill to determine their metabolic and cardiovascular responses as well as running gait kinematics during downhill (-15% slope), level (0%) and uphill running (+15%) performed at similar O2 uptake (_˜60% level VO2 max).

Results
Despite similar O2 demand, downhill running, was characterized by higher running speed and heart rate (all $p< 0.05$), but lower oxygen and energy costs (all $p< 0.05$) and a more superficial ventilation pattern compared to both other conditions. Both O2 and energy costs were correlated between level and downhill running conditions (both $r> 0.79$; $p< 0.05$). Importantly, whereas uphill running O2 cost was correlated with respiratory exchange ratio, heart rate, cardiac output and arteriovenous difference (all $—r—> 0.71$; $p< 0.05$), downhill running economy indexes were correlated with lower limb vertical stiffness and spatiotemporal gait parameters, such as ground contact time, stride length and frequency (all $—r—> 0.70$; $p< 0.05$). Of note, lower limb isometric torques were not related to running economy indexes.

Conclusion
Despite similar O2 demand, O2 and energy costs of running are lower in downhill vs level vs uphill conditions. These data suggest that the determining physiological factors of running economy in highly-trained trail runners are slope-specific (i.e., metabolic and cardiovascular in uphill versus neuromuscular and biomechanics in downhill running), thereby highlighting possible directions to optimize both the physiological evaluations and training programs of competitive trail runners.

Keywords: cardiac output and heart rate, muscle torque, spatiotemporal gait parameters, vertical leg stiffness, trail running

*Speaker

Repeated bout effect: Neuromuscular and cardiorespiratory responses during downhill walking in relation to muscle function loss

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Introduction

It has been well established that performing a bout of unaccustomed, predominantly eccentric exercise may result in a long-lasting muscle function deficit (> 24 h) and in a set of symptoms (e.g., muscle soreness, increased levels of circulating proteins). It is also well established that repeating the same bout within few weeks results in reduced loss of muscle function and symptoms of muscle damage compared to the initial bout. It has been suggested that neural, mechanical and cellular adaptations may explain the protection conferred by a single bout of eccentric exercise, called the "repeated bout effect" (RBE).

Currently, there is no consensus about how the adaptations involved in the RBE could affect neural (muscle activation) and mechanical (muscle/tendon elongation) behavior during a second bout of eccentric-biased exercise. Moreover, while it is well known that neural/mechanical behavior could affect running/walking economy, no study investigated cardiorespiratory changes for a given running/walking speed in a RBE context. The aim of the present study was to: 1) quantify any mechanical, neural or cardiorespiratory changes that occur between two identical eccentric biased exercises separated by two weeks; 2) explore whether these parameters were associated with muscle function loss or any muscle damage markers.

Methods

12 participants performed two sessions of 45-min downhill walking (DW) separated by 2 weeks. DW was performed on a treadmill with a load 30% of the body mass, at a 25%-gradient and a velocity of 4.5 km.h-1. Oxygen consumption (VO2), heart rate (HR), rating of perceived exertion (RPE), fascicle elongation/pennation angle of the vastus lateralis (VL) and EMG activity of the VL, rectus femoris (RF), biceps femoris (BF), gastrocnemius medialis (GM), soleus (SOL) and tibialis anterior (TA) muscles were assessed during the downhill walking. Maximal voluntary contraction (MVC) torque, delayed-onset muscle damage (DOMS), knee range of motion (ROM), creatine kinase (CK), myoglobin (Mb), matrix metallopeptidase 9 (MMP-9) and shear modulus assessed by shear wave electrography were assessed before (PRE), within 1h (POST) and 4h after the exercises (POST), and the days after the two sessions (24h, 48h, 72h and 168h).

*Speaker

Results
MVC torque measured 24h after the DW was reduced by 22.8 ± 11.7 % and 7.4 ± 8.2 % for the first (DW1) and the second (DW2) DW. Relative DOMS, ROM and shear modulus values were also significantly reduced after DW2 compared to DW1 ($p < 0.01$). Biochemical analyses are in progress. Muscle activation (RF and SOL EMG activity), cardiorespiratory (HR and VO2) and subjective (RPE) responses were significantly decreased during DW2 compared to DW1 ($p < 0.05$). Fascicle elongation and pennation angle analyses are in progress.

Conclusion
As expected, we found a reduced loss of muscle function and symptoms of muscle damage after the second bout compared to the initial bout of downhill walking. Protective adaptations conferred by the first bout induce a lower perceived exertion and cardiorespiratory responses when the same exercise is repeated within few weeks. Neural and mechanical adaptations could partly explain the lower perceptual and physiological responses during a second bout of eccentric biased exercise.

Keywords: eccentric exercise, exercise, induced muscle damage, muscle function, shear, wave elastography, load carriage, muscle architecture.

Neuromuscular alterations induced by concentric versus eccentric cycling at the same workrate or effort perception

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Introduction

At same workrate eccentric and concentric cycling induced a decline in maximal voluntary contraction (MVC) torque of similar magnitude (1, 2). It is uncertain, however, whether the magnitude and etiology (neural and/or muscular) of MVC decline would differ if eccentric and concentric cycling exercises are matched for perception of effort (3). The aim of this study was to compare neuromuscular alterations induced by concentric and eccentric cycling performed at the same workrate or effort perception.

Methods

Fifteen participants completed three 30-min sessions: one in concentric at 60% peak power output (CON) and two, randomized, in eccentric, at the same workrate (ECCPOWER) or same perceived effort (ECCEFFORT). The knee extensors MVC torque, the torque evoked by single and double stimulations at 100 Hz and 10 Hz (Dt100; Dt10), and the voluntary activation level (VAL) were evaluated before and after exercise. Dt10/Dt100 ratio was used as marker of excitation-contraction coupling and EMG RMSMAX/MMAX used to estimated neural drive withMMAX corresponding to maximal amplitude of M-wave evoked by single twitch. ANOVAs were used to compare separately each eccentric condition with CON.

Results and discussion

Oxygen uptake and heart rate were lower during both ECCPOWER and ECCEFFORT than CON. Workrate was higher in ECCEFFORT (89.1 ± 23.3% peak power) than CON for a final perceived exertion of 51 ± 15 a.u. The VAL and MVC torque decreased without difference between CON and ECCPOWER while maximal vastus lateralis and rectus femoris EMG (EMG RMSMAX/MMAX) was unaltered, suggesting no difference in the neural impairment between the conditions. MVC decreased to a greater extent after ECCEFFORT (-30.2 ± 15.8%) compared with CON (-19.04 ± 6.5%) while VAL decreased similarly and maximal vastus lateralis and rectus femoris EMG (EMG RMSMAX/MMAX) were unaltered in these conditions. There was no difference in Dt100 or Dt10 between CON and the eccentric conditions. The Dt10/Dt100 ratio dropped more in ECCEFFORT than CON. Delayed-onset muscle soreness indicated that both eccentric sessions probably damaged the muscles more than concentric cycling.

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Conclusion
When performing eccentric and concentric cycling at the same workrate, participants showed a similar performance fatigability. In contrast, eccentric cycling perceived as difficult as concentric cycling induced more MVC torque decline, in relation with a more pronounced alteration of the excitation-contraction coupling. From a clinical perspective, the propensity of participants to exhibit more performance fatigability in eccentric than concentric cycling perceived as difficult should prompt to be cautious when setting eccentric cycling intensity based on perception of effort.

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Keywords: fatigue, fatigability, neural, muscular

Metabolic responses and adaptations to eccentric cycling training

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Introduction

Eccentric cycling is a novel and less explored training modality, in which eccentric training of the lower limb muscles is performed when resisting against a backward rotational movement of the cranks generated by an eccentric ergometer. We have shown that eccentric cycling imposes lesser cardiopulmonary, metabolically, and perceptually demand (i.e., lower oxygen consumption, dyspnea, lactate and blood pressure) and allowed a greater workload production for the same metabolic demand than concentric cycling. We have shown that the lower metabolic demand during eccentric cycling has been attributed to minimal usage of ATP during eccentric contractions (ATP-independency) and to a smaller and selective recruitment of type II muscle fibers. Interestingly, when eccentric cycling is used as a training modality, it has shown to induce greater gains in muscle mass and strength, and functional performance in several clinical populations. Among clinical populations, chronic obstructive pulmonary disease (COPD) patients have limited exercise tolerance due to bronchial inflammation and emphysema. This limits the intensity of exercise used in pulmonary rehabilitation. Furthermore, COPD patients loss muscle mass faster due to systemic inflammation, oxidative stress and disuse. Thus, it seems that eccentric cycling training is an ideal exercise modality for chronic obstructive pulmonary disease (COPD) patients.

Aim and methods

We compared the effects of eccentric cycling (ECC) and conventional concentric cycling (CONC) training on muscle function, body composition, functional performance, and quality of life (QOL) of patients with moderate COPD. We recruited 20 patients (age: 69.6±10.1 years, forced expiratory volume in 1-second: 73.2±11.4% of predicted) which were randomly allocated to ECC (n=10) or CONC (n=10) group. They performed 12 weeks of ECC or CONC training twice a week in the first two weeks, and three times a week thereafter at an intensity corresponding to fairly light – somewhat hard in the Borg's RPE scale. The workload, heart rate (HR), blood oxygen saturation (SpO2), and dyspnea were monitored during cycling. Outcomes measures included maximal voluntary isometric contraction (MVC) strength of the knee extensors, its rate of force development (RFD), lower-limb fat-free (LLFFM) and fat (LLFM) mass, timed up-and-go test (TUG), stair ascending and descending time, 6-minute walking test (6MWT) and QOL assessed by the Saint George's respiratory questionnaire. Two-way ANOVA was used to compare between ECC and CONC, and percentages of change from baseline were compared using independent Students-t-tests.

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Results
We found that ECC produced on average 3-fold greater (interaction effect: P< 0.001) workload (211.8±106.0 kJ) than CONC (78.1±62.6 kJ) over 34 training sessions. ECC showed 1.5±2.1% greater SpO2, 24.7±4.1% lower HR, and 64.4±29.6% lower dyspnea in average than CONC (interaction effect: P< 0.001). No interaction effect was observed for clinical outcomes. However, Percentage of change of LLFFM (4.5±6.2%; P=0.03) after ECC increased, while CONC decreased LLFM (3.3±6.4%; P=0.04) when compared with baseline values. Both ECC and CONC reduced (P< 0.05) stair ascending (-16.1±9.3% vs -10.1±14.4%) and descending time (-12.2±12.6% vs -14.4±14.7%), and improved (P< 0.05) QOL (33.4±38.8% vs 26.1±36.6%) similarly, but only ECC improved (P< 0.05) RFD (69-199%), TUG (13.6±13.6%) and 6MWT (25.3±27.7%) when compared to baseline.

Conclusion
In conclusion, our results suggest that ECC training with less cardio-pulmonary demands, was more effective in increasing functional performance and muscle mass for COPD patients than CONC training.

Keywords: COPD, patients, muscle function, cardio, pulmonary demand.

Differential effects of concentric and eccentric contractions on the primary motor cortex

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Introduction

Eccentric contractions generate greater force for a lower metabolic cost and lower cardio-respiratory constraint than concentric ones. In 2004, Fang et *al.* highlight that eccentric contractions lead to earlier preparation and greater magnitude of cortical activity for movement execution compared to concentric [derived from electroencephalography -EEG- analysis (1)]. Indeed, the amplitude of eccentric movement-related cortical potentials (MRCP) were greater than during concentric. Interestingly, this was observed either in sensory-motor area and others not directly implicated in the task. These results indicate that the use of eccentric could be highly relevant to fight against muscle weakness in COPD patients due to insufficient cortical activation (2). However, these results were obtained in young subjects upper limbs, while COPD (generally sharply over 50 years-old) cortico-muscle dysfunction mainly affects the lower limbs (3). Thus, the purpose of this study was to verify, in 55-65 years old individuals, if EEG activity between eccentric and concentric contractions of the quadriceps induce higher sensorimotor activation, as in younger individuals.

Method

22 male and female performed 40 voluntary eccentric and 40 voluntary concentric knee extension against 20% of their maximal voluntary contraction on a Biodex isokinetic ergometer. Surface EEG signals from seven scalp locations overlying sensorimotor-related cortical areas were recorded continuously as torque, join angle, and surface electromyographic (EMGs) signal on vastus lateralis (VL), vastus medialis (VM) and rectus femori (RF) of the dominant leg. MRCP were derived from the averaging of all EEG signals recorded during eccentric and concentric contractions, in order to analyze the negative peak (NP) related to movement planning and execution.

Results and discussion

Preliminary results show that although the muscle activity of the VL, VM and RF (assessed by RMSEMG) was lower during eccentric, the amplitude of the major MRCP component (NP) was greater. The greater cortical signal for lower limb eccentric contractions in older subjects suggests that the brain plans and executes eccentric movements differently from concentric, and this, regardless of the age and the limb. Our study tends to confirm in older persons the results found in literature. Thus, we could confirm that even in older persons, eccentric requires a specific planification, probably due to a superior complexity and difficulty of movement control [higher number of feedback signals from the peripheral systems (1)].

*Speaker

Conclusion
Our study confirms the interest of eccentric contractions to induce, during muscle strengthening, higher cortical activation. This is of prime importance because in COPD patients, a non-optimal activation of motor cortex during voluntary contractions is a prominent muscle weakness determinant. Because muscle weakness is associated with higher mortality rate, any increase in cortical activation during muscle contraction is a major goal, and eccentric contractions could be an efficient way to reach it.

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Keywords: Eccentric contraction, Movement related cortical potential, COPD, muscle weakness, EEG

Study of the choice of slope according to duration for a trail-running D+ record attempt

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With the cancellation of official trail-running events during the pandemic, runners turned to other challenges, one of which was rather atypical: the record of ascending elevation over a period of 1 to 24 hours. Other challenges, such as the Everesting, consist in achieving the ascending elevation corresponding to an ascent of Everest from sea level (i.e. 8848m) in the shortest possible time over a round trip.
Interest in this type of event is growing, with an increase in the number of 24-hour challenges carried out last year (12 attempts in 2020, 5 in 2019 and 3 between 2016 and 2018) and the creation of a specific event dedicated to this challenge in France (24H VERTICAL CHALLENGE, June 2021). The current record is 17217m held by Aurélien Dunand-Pallaz on a loop of 1.72 Km and 212.56 m D+ with an average gradient of 29.55 % while the 2nd world performance held by Patrick Bohard is 17130.3 m on a loop of 452 m and 95.7 m D+ with an average gradient of 46.74 %.

Hypothesis
On all the attempts recorded the choice of the loop is different on its length, the % of the slope in ascent and descent, the duration of the ascent and descent, the nature and the technicality of the terrain. Billat (2005) and Doucende and coll. (2017) were able to show that the ascent speed was different according to the slope for the same effort intensity and that the energy cost was different according to the % slope (Minetti and coll. 2002; Saibene and Minetti 2003). In addition, Billat (2019) shows that in a marathon-type effort on the road, it is preferable to split the effort rather than run at a constant pace. As the ascent during these attempts may correspond to the effort phase and the descent to a recovery phase, it is then interesting to ask what would be the best modality to optimise performance and recover sufficiently according to the duration of the desired challenge.

Methods
The data is being processed into a database of 150 to 200 races with D+ challenges ranging from one hour to 24 hours from all those who have already completed such challenges. The data collected will be as follows: time of effort, distance covered, ascending elevation, characteristics

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of the slope (%, nature of the terrain, length) and the .gpx file of the race in order to transpose all the routes onto the same base map and topographical references.

Expected results
As the highest ascent speeds are achieved on steep slopes, for sub-6 hour attempts we feel it is best to go for a short slope of at least 30-35%.. However, beyond 6 hours of effort, a slope with a lower % could be preferable in order to benefit from the return of elastic energy from the Achilles tendon (Billat, 2005) and to reduce muscle damage during the descent. The slope should still be greater than 20% because below this, the horizontal distance to be covered is too great in relation to the difference in level. Furthermore, the equations developed by Carlsson et al (2020) have shown that for the same energy cost, the ascent speed is lower at 10% than at 25%, hence the choice of a slope close to 20-25%.

Keywords: Trail, running, ascending elevation, slope, ascencionnal speed, record

Effects of shoe longitudinal bending stiffness on running economy and biomechanics during graded running

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Introduction
All major running shoe manufacturers added a carbon plate to their high-end competition model, which is known to increase the longitudinal bending stiffness (LBS) of the shoe. Increasing LBS has been shown to improve biomechanics and energy cost of running (Cr) in level running, even though Cr changes were found to be from +3% and -3% compared to a less stiff shoe (Ortega & al., 2021). Importantly, its influence on uphill running remains unknown. As the first trail-running specific shoe with carbon plate has recently been announced, the aim of our study was to identify the effect of LBS on Cr and biomechanics on level and graded running.

Methods
Twenty well-trained men (28 ± 8 yr; 65 ± 4 kg, 175 ± 5 cm, having recently run 10-km in less than 38 min) participated in this study performed over two separate visits. On day 1, Cr was determined using gas exchange at the mouth (measured by Metamax 3B (Cortex, Leipzig, Germany) during nine, 4-min bouts performed using three different LBS shoe conditions (Kalenji prototypes) at 8 and 16 km/h on level, and 8 km/h uphill (+15%). On day 2, running kinetics and kinematics were measured using motion capture, ground reaction forces (instrumented treadmill) and EMG (VL, GM, SOL, TA) using the same shoes, at three inclines (0%, +15% and -15%), and three speeds (8, 12, 16 km/h). All variables were compared using three-way ANOVA (shoe × speed × slope effects). Kinematics and kinetics curves were analyzed with Statistical Parametric Mapping (SPM).

Results and discussion
Cr were in average 4.69 ± 0.44 J/kg/m for FLAT_8, 4.17 ± 0.23 J/kg/m for FLAT_16, 8.85 ± 0.47 J/kg/m for UP_8. There was a significant effect of condition (FLAT_8 VS FLAT_16 VS UP_8, $F=2845.78$, $p< 0.001$) on CR, but no significant effects of LBS ($F=2.88$; $p=0.068$) or interaction LBS condition ($F=0.68$, $p=0.58$). Results were characterized by a very large inter-individual variability in response to different LBS. Results will thus be presented between responders and no responders to LBS, to highlight whether similar biomechanical strategies can explain these differences. The current study contributes to a growing body of literature reporting no effect of LBS on flat, and show that increasing LBS does not improve Cr during uphill either. Considering the differences in footwear construction to increase LBS, the results

*Speaker

of this study are applicable to the specific shoe construction used regarding carbon plate shape, location, and thickness.

Conclusion
Increasing LBS does not significantly increase running economy either uphill or level running. Yet the very large inter-individual differences in response to changes in LBS suggest that it may be beneficial for some runners.

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Keywords: footwear, energy cost of running, metatarsophalangeal joint, carbon plate

Two weeks of running sprint interval training (R-SIT) improve sprint mechanics, power and jump performance in young male basketball players.

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Introduction
Basketball is an intermittent sport were the fast actions such as sprints, jumps or changes of direction are key physical features. Typically, it is in the preseason that these, and the main physical components are emphasized during training to ensure the highest levels of performance in the following competitive period (1). Given that the technical-tactical content must be also addressed in the preseason, the optimal choice between the different physical training methods is crucial for coaches. In this regard, sprint interval training is a time-efficient and very effective approach to rapidly increase performance (2). However, little is known about its field-application. This study aimed to determine the effects of a running sprint interval training protocol (R-SIT) on the sprint acceleration mechanical properties and jump performance. The novelty of this experiment lies in the use of the force-velocity relationship (3) to assess changes in both sprint performance and underlying mechanical factors.

Methods
Eleven young male basketball players performed six all-out sprint sessions in addition to their habitual-basketball training routine. Participants performed 30-s running bouts interspersed by four minutes of recovery. The number of all-out repetitions increased from 4 to 7 throughout the protocol as initially proposed by Burgomaster *et al* (2). Sprint time, power and other mechanical outputs over a 20-m sprint and a countermovement jump were assessed at baseline (PRE) and after two weeks of training (POST). Since the first and the last session consisted of four sprints, the maximal and mean distances covered during the sprints was recorded to analyze the repeated sprint ability during long efforts.

Results and discussion
On average, maximal force and power outputs increased by 5 and 4% respectively ($p < 0.05$), with no changes in maximal speed ($p = 0.26$) over the 20-m sprint. Despite the lack of improvement in maximal speed, the time at short sprint distances (i.e. 5 and 10 m) was improved by 2% approximatively ($p < 0.01$). Jump height and power also increased after training (5 and 3%;

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$p < 0.05$). Overall, our results show that the inclusion of six all-out sessions spread over two weeks is enough to improve sprint and jump abilities in young basketball players. Rather than maximal sprint speed, R-SIT influenced positively the explosive force and acceleration capacities which, in turn, are more game-related and relevant for basketball. In addition, players improved their maximal sprint distance covered during the 30-s bouts and became more fatigue-resistant to long sprint events.

Conclusions

Six sessions of R-SIT enhanced short sprint time and mechanical sprint force and power outputs. Repeated sprint ability and jump height were also positively influenced by the training.

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Keywords: Sprint interval training, force, velocity profile, basketball, sprint performance.

Biomechanical analysis of curve sprinting in male and female track athletes

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Introduction

In track and field, the distance ran on the curve represents 57 % of the total distance covered during the 200-m dash [1]. Within the acceleration phase [2] and maximal speed phase [3] of curve sprinting, the speed decreases in comparison to linear sprinting due to longer left step ground contact time and a reduction in the right step length than on the straight. In addition, kinematic modifications occur on the bend, such as a greater left hip adduction, a greater touch-down distance and a greater inward lean, which are related to slower sprint performance and could also be linked to force production alteration.

Although it is known that the amount of horizontal force produced regarding the total amount of force produced is key in straight line sprinting, this parameter is slightly reduced during the acceleration phase of curve sprinting [2]. Further, propulsive impulse, also considered as a mechanical determinant of performance is reduced on the bend as well. On the other hand, mediolateral forces are greater on the bend at maximal speed and during the acceleration phase than in linear sprinting which is a mandatory adjustment of curve sprinting, where athletes must produce centripetal force in order to maintain their path on the curve. Since sprinting velocity and force production are both altered on the bend compared to linear sprinting, the force-velocity-power (F-V-P) profile must be modified as well and requires further investigation. Therefore, the aim of this study will be to assess and compare the F-V-P relationship in curve and straight-line sprinting.

It is hypothesized that the F-V-P profile will be shifted to the left. Specifically, we think that the maximal power output and the maximal anteroposterior velocity reached when the anteroposterior force is equal to zero will be the most disrupted parameters in comparison to linear sprinting.

Methods

16 track and field athletes (8 female) with a regional or national level, specialized in either the 200 or 400-m dash will be recruited for this experimentation. Data will be collected on a flat indoor track with a reconstructed bend replicating lane 5 of a standard outdoor track (41.41 m radius). After a self-selected warm-up of at least 45 minutes, athletes will begin with two 40-m linear sprints. Thereafter, they will realize two 10-m, two 20-m and two 40-m sprints on the bend. Between each 40-m, 20-m and 10-m sprints, athletes will be given respectively 6, 5 and 4 minutes of rest.

*Speaker

Ground reaction forces (GRF) will be computed with 6 in-series force plates (Kistler, Wintherthur, Switzerland, operating at 1 000 Hz). Kinematic analysis will be assessed with the MVN Biomech link system (Xsens Technologies BV, Enschede, The Netherlands, operating at 240 Hz) composed out of 17 inertial measurement units. During the linear sprints, the athlete's velocity will be computed with a radar (Stalker ATS II, USA, 46 Hz). F-V-P profiles, GRF, as well as joints and segments' kinematics will be compared between linear and curve sprints.

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Keywords: curve sprinting, track athletes, force, velocity profile, athletics, 3D kinematics

Impact of cold and heat on skin temperature on manual performance during maneuverability exercises in powerchair soccer players.

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Introduction

Power wheelchair users have functional limitations that do not allow them to use a manual wheelchair or power assisted devices. In general, the wheelchair users are either older and/or presenting neurologic pathology (myopathy, muscular dystrophy, spinal cord injury...) . Depending on the functional capabilities, they could usually use their hand, foot or chin to drive the power wheelchair thanks to a joystick [1].

The powerchair soccer is a collective opposition sport that allows people with heavy motor disabilities to play in competition. During powerchair competitions, many players used hand warming techniques [2]. On healthy subjects, Brajkovic & al [3] defined digital thermal comfort at a temperature of 23∘C. The cold has been shown in able-bodied subjects to reduce manual performance, particularly during fine dexterity tasks [4]. The evaluation of manual dexterity was performed with ergonomic tests are not suitable for our population.

The purpose of this study was to evaluate the impact of cold on the accuracy and the speed using joystick simulator in powerchair players. We assume that the cold will negatively impact the performance and the application of heat will positively improve the performance while using the joystick.

Method

Ten volunteers with heterogeneous pathologies engaged in international FIPFA competitions (9 men, 1 woman) aged 23.3 ± 3.7 participated in the study. The assessments consisted of carrying out a computer maneuverability path before and after immersion of upper limb in cold water (8∘C)(cold condition; CC), before and after exposure to heat with a hair-dryer (heat condition; HC). The maneuverability course consisted of boxes counted after each pass before and after for each experimental condition (CC or HC). All participants performed the CC and HC on two different days, with a control condition performed before each condition. Randomization was performed to determine the day of the CC and HC. The skin temperature of the hand and

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forearm, perceptive scales of thermal sensation, thermal comfort, effort and pain perception were also performed. All data were checked for normality using Shapiro-Wilk tests. The Wilcoxon and Mann-Whitney tests were used to compare the different conditions (before vs after test and HC vs CC).

Results
Cold and heat did not significantly impact performance (before HC = 143.1 ± 32.0 boxes, after HC = 149.3 ± 33.5 boxes ; before CC = 144 ± 33.7 boxes, after CC = 138.7 ± 39.5 boxes, $p < 0.05$). However a slight downward trend was observed for the cold and a slight upward for the heat. The cold and heat influenced the skin temperature of the hand and forearm, the thermal sensation and the thermal comfort of the players in contrast to the perception of effort and pain (hand after HC = +5.9∘±3.9∘C, hand after CC = -11∘±1.4∘C ; forearm after HC = +1.9∘±1.0∘C , forearm after CC = -0.6∘±0.7∘C ; $p < 0.05$).

Discussion
This study aimed to measure the impact of cold and hot weather on performance during joystick handling exercises in high-level players. Our hypothesis that the impact of cold was negative for performance was not tested, despite the large individual variations obtained, which can be explained by the heterogeneity of the pathologies and the small number of subjects. At the perceptual level, cold affected perceptions of thermal sensations and thermal comfort, leading to discomfort, while heat improved perceptions of thermal sensations and thermal comfort.

Conclusion
Based on our results, we can assume that wheelchair soccer players need to play in warm environments in order to train in optimal conditions.

Keywords: powerchair soccer, skin temperature, cold, heat, performance.

Breathing-related stability among 10 meter air pistol shooters

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Introduction

In 10 meter air pistol, the aiming phase requires athletes to stabilize their posture, i.e. maintain a low displacement of the center of pressure (CoP). Stability while aiming varies accordingly to the shooter expertise: the displacement of the CoP is lower among elite athletes than among untrained participants (Chadefaux et al., 2020). Further, natural breathing perturbs balance by inducing specific minimal oscillations of the CoP. A modulation of the posturo-respiratory coupling can then impact respiratory-induced postural perturbation and modify stability.
We hypothesized that posturo-respiratory coupling during natural breathing differed in athletes with the highest expertise.

Materials and methods

Twenty participants were recruited and grouped according to their expertise: 4 *Elite* participants from the French national team, 6 *Intermediate* participants with a national championship level, and 10 *Novice* participants. A stabilometric trial was performed: participants were asked to maintain a natural standing position during one minute, eyes open, with a natural breathing. Ground reaction forces were measured using force plates and their application point was used to compute the CoP. The stability profile was then evaluated by the medio-lateral (ML) and anterior-posterior (AP) components of the CoP displacement.
The chest wall volume (and subsequently breathing frequency) was obtained with optoelectronic plethysmography (Clavel et al., 2020). The posturo-respiratory coupling was estimated by the CoP respiratory emergence parameter (REm) (Hamaoui et al., 2010): a fast Fourier transformation was performed on the CoP displacement, the REm was computed in the frequency domain

*Speaker

as the ratio of the average power of a band of 0.08 Hz centered on the mean breathing frequency over the average power of the whole CoP signal.

Results and discussion

The lowest CoP displacements in both AP and ML directions were observed for *Elite* shooters, corresponding to a more stable postural balance (Fig. 1). This conclusion is in line with previous research on pistol shooting (Mon et al., 2014).

Moreover, the REm was higher among *Elite* athletes (Fig. 2, for the AP component). This could indicate that *Elite* participants have a better ability to synchronize their posture with their breathing, allowing them to reduce the respiratory-induced CoP displacements during aiming.

Conclusions

Athletes with more expertise in pistol shooting displayed a greater stability, potentially related to an increased posturo-respiratory coupling.

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Keywords: 10m pistol shooting, performance, stability, breathing

Psychology - Education sciences

Health-related lifestyle and behaviors in French elite athletes: A qualitative study

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Introduction
Elite sport performance requires athletes to constantly push their body limits, which can be a threat to their health. Although numerous studies have focused on the psychosocial determinants of health risk behaviors (e.g., burnout, doping), the literature on elite athletes' health-related lifestyle is scarce (e.g., Burns et al, 2019). Furthermore, the plurality of factors related to specific athletes' health behaviors, and their perceived relationships with performance are not documented.The purpose of this study was (a) to explore health-related lifestyle of elite athletes as well as the perception of its role in sport performance, and (b) to characterize elite athletes' specific health-related behaviors, and their related intrapersonal, interpersonal and organizational factors.

Methods
16 French elite athletes, 3 females, 13 males (22,2 ±4,1 years), from different sports (swimming, n=3, gymnastics, n=8; trampoline, n=5), participated to individual semi-directive interviews. Interviews were transcribed *verbatim*. A thematic content analysis was carried out, and trustworthiness of the analyses was tested through investigator triangulation.

Results and discussion
Preliminary analyses resulted in the identification of 288 meaning units related to the three following main themes: (a) health-related lifestyle and its perceived role in performance; (b) characteristics of health-related behaviors adopted by athletes; (c) factors (intrapersonal, interpersonal, organizational) of health-related behaviors. Athletes consider health-related lifestyle as a major determinant of their sport performance, which may even be more important than training. This is related to health behaviors such as a balanced diet, regular sleep, physical recovery, and stress management. However, these perceptions are not consistent with the behaviors reported by some athletes (e.g., "junk-food", lack of recovery protocol or mental preparation). Favorable factors of health-related behaviors include: personal factors, social influences, and organizational factors.The perceptions of elite athletes giving an important place to a healthy lifestyle in their performance, are in line with emerging studies on the subject (Burns et al., 2019). Our results also provide support to previous literature on the role of specific health

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behaviors in athletic performance such as food choice or recovery. While the favorable intrapersonal and interpersonal factors are consistent with the study by Burns et al. (2019), our study is the first to our knowledge to highlight the role of organizational factors.

Conclusion

Although elite athletes consider health-related lifestyle as a major determinant of their sport performance, their reported behaviors are not always in line with their beliefs. These results call for the development of health promotion strategies based on a multilevel approach as proposed by socioecological models (Mountjoy et al., 2019).

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Keywords: health, related lifestyle, health, related behaviors, health promotion, elite sport

Stress and coping dynamics during the qualification phase for the Tokyo 2021 Olympic Games: Relationships with performance and burnout among elite artistic swimmers

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Introduction
The Olympic Games are often considered by many elite athletes to be the pinnacle of their athletic career. The phase of qualification then becomes a particularly stressful period for the athletes (Nicholls & Levy, 2015), that may expose athletes to chronic stress and have negative effects on their performance and health. The Tokyo Olympics also take place in an unprecedented context due to the COVID-19 pandemic with increased risk of exposure to multiple stressors (i.e., disruptions of training conditions and qualifying processes, delay of the Olympic Games). Better understanding of how athletes appraise and manage this particular stressful period is therefore important in light of its exceptional nature and potential detrimental effects on athletes' performance and health. Thus, this study aims to explore the dynamics of stress and coping processes and their consequences on performance and burnout among elite artistic swimmers during the Olympic Games qualification phase.

Method
Fifteen elite artistic swimmers (Mage = 21 years, SDage = 2.85 years) participated in this study and completed an online questionnaire once a week during the Olympic Games qualification phase (January-May 2021). The questionnaire, using a single-item definitional approach (e.g., Doron & Martinent, 2016), measured individual and collective stress appraisals, individual and collective coping strategies, burnout, and individual and collective performance satisfaction. The simple items were rated on visual analogue scales ranging from 0 to 5, except for the stress interpretation ranging from -3 to +3.

Results and discussion
Data collection is still in progress. Multilevel growth curve analyses (MGCAs) will be conducted to examine the trajectories of stress appraisals, coping, burnout, and performance during the Olympic Games qualification phase. According to previous studies (Doron & Martinent, 2016; Madigan et al., 2020), we expect that this particular stressful period will be characterized by distinct longitudinal patterns of stress appraisals and coping, and that they will be differently related to athletes' burnout and performance.

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Conclusion

This study may provide new knowledge on the dynamics of stress appraisals, coping, burnout, and performance processes among elite athletes during the stressful period of the qualification phase for Olympic Games, that takes place in the particular context of COVID-19 pandemic. The results of this study may inform the development of more adequate care, support, and intervention, in particular through the use of technological tools such as applications on phones in order to prevent the potentially deleterious effects of stressful situations on performance and health of elite athletes.

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Keywords: Stress appraisals, Coping, Elite performance, Burnout, COVID19 pandemic, Olympic Games, Process oriented method

When being an elite athlete conflicts or enriches with being a student and vice versa: Psychometric validation of inter-role interactions and consequences on well-being.

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Introduction
The mental health of student-athletes is an important condition for their success in their Sport-School Dual Career (SSDC). Resources consumed in meeting the demands of one role (e.g., athlete) are likely to be lacking in overcoming the demands of another role (e.g., student). In contrast, taking on one role can develop resources that can be used in the other role. These Sport -> School or School -> Sport *conflict* or *enrichment* and *balance* may impair (conflict) or improve (enrichment and balance) well-being. While there is considerable work on inter-role interactions (Carlson et al., 2000, 2006, 2009) and well-being in the work-family context, there is less research on the SSDC context. Moreover, most of this research has focused on the negative aspects (*conflict*), ignoring the potentially positive aspects of the SSDC. In addition, there are no validated tools for measuring the different variables of the interactions. The purpose of this study is to investigate (1) the validity of inter-role interactions concepts in SSDC context (conflict, enrichment, and balance), and (2) the links between inter-role interactions and sport related well-being.

Method
French university student-athletes completed, twice, a questionnaire (October, N = 371, and December 2020, N = 127) measuring Sport-School Interactions, Athlete Burnout and Engagement. Contextual and demographic variables and role identity were also measured. Exploratory Structural Equation Modelling (ESEM) and Correlations were performed.

Results and discussion
The psychometric validity of Sport-Study Interactions Scale (SSIS) was confirmed (i.e., ESEM: CFI = .960, TLI = .912, RMSEA = .045 [90% CI - .039-.050]; and Cronbach's alpha estimates ranging from 0.78 to 0.89). Moreover, correlations revealed that athlete burnout was positively correlated to both Sport -> School and School -> Sport *conflict* ($r = .22$, $p < .01$, and $r = .27$, $p < .01$ respectively). Athlete burnout was negatively, and engagement was positively

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correlated to Sport à Study *enrichment* (r = -.17, p < .01, and r = .22, p < .01 respectively) and *balance* (r = -.16, p < .01, and r = .15, p < .01 respectively). Finally, we assume that the results of latent profile analyses (currently in progress) will reveal that student-athletes' well-being will be higher for participants with a positive profile (i.e., high enrichment, low conflict, and balance) in comparison to participants with a negative profile (i.e., low enrichment, high conflict, and unbalanced).

Conclusion

Student-athletes must manage many demands to be successful in their SSDC. The SSIS appears relevant for studying the inter-role interactions in SSDC. Preliminary analysis confirms the links between inter-role interactions in SSDC and well-being of student-athletes.

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Keywords: Dual career, Student Athletes, Engagement, Burnout, Exploratory Structural Equation Modelling, Mental Health

Interventions and programs for doping prevention in sport: a systematic review.

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Introduction
The 2021 Testing Figures Report from the World Anti-Doping Agency indicates that doping remains a major problem in sport. According to the antidoping policy set by the French Sports Ministry, French sports federations need to develop modern and multifaceted prevention programs. These programs would benefit from up-dated scientific knowledge about the efficacy of prevention strategies. This review systematically recorded, categorized, and assessed studies on the development and/or evaluation of doping prevention programs in sport.

Method
The methodology followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (Shamseer et al., 2015), including protocol registration in the International Register of Prospective Systematic Reviews. A committee approach was adopted, and several screenings (i.e., title/abstract, full text) were run independently until consensus was reached. Screening and data extraction steps were conducted with Covidence software. The quality assessment of the review will be performed using the JBI Critical Appraisal Checklist for Systematic Reviews and Research Syntheses (Aromataris et al., 2015). The main outcomes will be classified on the basis of the usual success factors for interventions: (a) type and setting, (b) components and approaches, (c) delivery modalities (e.g., interactive *versus* passive), and (d) results/impact.

Results and discussion
Data on interventional studies promoting doping prevention in sport were collected from seven databases (e.g., PubMed, PsycNET). We included studies in the human and social science fields that involved actors from different sports and examined the effects of doping prevention programs on doping attitudes and behaviours. We excluded studies on doping prevalence and detection. At this point, 4824 papers in both English and French have been included for initial screening and 115 for full-text inspection. Results are still in progress.
The interventions will be classified according to the five categories of Gatterer et al. (2020): (a) knowledge focused, (b) affective focused, (c) social skills, (d) life skills, and (e) ethic and value-based. We expect that the knowledge focused category will be the most implemented. We also hypothesize that integrative programs including all five approaches will be scarce.

*Speaker

Conclusion
This systematic review should help to identify the success factors of doping prevention programs and perspectives for future research in the field of doping prevention. Valuable implications for the anti-doping policies of French sports federations may also be deduced from this study.

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Keywords: Systematic review, doping, sport, prevention, intervention, education, health

Psychological and attentional effects of a short online mindfulness meditation intervention in university students during the remote learning period imposed by the COVID-19 pandemic

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Introduction

The COVID-19 pandemic and its related restrictions has caused psychological distress in the general population and especially so in young adults [1]. In this context, we were interested in the mental health and cognitive performance of French University students who, in addition to the general lockdown restrictions, were submitted to a remote learning obligation. We investigated the extent of the reported pandemic-related psychological distress, with additionally, the eventual presence of repercussions on their attentional abilities, and tested whether these negative impacts can be countered through a short online mindfulness meditation intervention (MMI). Indeed, this mental practice aiming at developing the self-awareness of the present experience [2] has been shown, outside the pandemic, to improve attentional abilities [3] and mental health [4].

Method

Ninety-six university students (22.13±3.34 years) pursuing their academic learning remotely during the second Covid-19 lockdown in France took voluntarily part of the study. They were randomly assigned to either a control group with no specific intervention, or an experimental group who followed a daily online MMI (17 sessions of 20 min on weekdays and 10 min on weekends). Pre- and post-tests were done to assess attentional abilities (D2-R) and mental health (WEMWBS for psychological well-being, and DASS-21 for depression, anxiety, and stress). In addition, the MMI group had a daily assessment of their emotions (SAM for pleasure, dominance, and arousal) and anxiety (MRF-L for cognitive and somatic anxiety).

Results

The baseline scores in the D2-R test were in the expected average range, which indicates no substantial attentional impairment in our cohort. However, the psychological scores were alarming with a high prevalence of stress, depression, and anxiety (extreme to extremely severe categories) and low well-being scores. After controlling for between groups baseline differences, we found no group differences in attentional performance changes between pre and post-tests, but

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a significant reduction in depression, anxiety, and stress scores, as well as improvement in the well-being score only in the experimental group. The reductions in depression and anxiety were especially observed for participants with, respectively, high baseline anxiety or depression levels. Throughout the intervention, the MMI group showed a continuous reduction of arousal, somatic and cognitive anxiety, and an enhancement of pleasure, with no effect on dominance.

Conclusion

In conclusion, although the investigated short online MMI did not enhance attentional abilities in seemingly good performing university students, it did significantly improve different aspects of their psychological health that was alarmingly poor during the second lockdown and the remote learning period imposed by the Covid-19 pandemic. These findings are encouraging and support mindfulness meditation practice as an efficient and feasible interventional, and potentially preventive, strategy to cope with the psychological distress experienced by university students during the Covid-19 (or any similar future) sanitary crisis.

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Keywords: mindfulness meditation, online intervention, mental health, attentional abilities, Covid, 19, university students

Emergence of online sports coaching videos in pandemic period

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Sports coaching practices are developing massively (Williams, 2009) and have been spreading over the last ten years via the Internet (Neumann and Krzytaniak, 2007). The epidemic episode of Covid-19 which confines the population seems to amplify the phenomenon with the emergence of the abundant offer of videos broadcasting physical activity sessions on social networks. This very varied offer seems to be motivated by a hygienic and social vocation which would make it possible to soften the confinement of fellow citizens, improve physical health and stimulate the morale of practitioners, grouped together in virtual communities (Rheingold, 1995).
These videos are very different in content and form. The simplest ones are improvised using a cell phone, while others are made in the studio with great professionalism. Sometimes it is the atmosphere and the exchanges with the members that are at the heart of the content. Others highlight a coach/animator with a sculpted aesthetic or the technical exemplarity of proven physical exercises. This observation leads us to investigate the processes that encourage these different actors to produce and broadcast physical activity sessions online. The motivation of people who have developed a certain celebrity status through the dissemination of online physical activity videos seems to fall under the role of mentor, or even model or example to follow (Armour and Duncombe, 2012).

The scientific literature separates the role of model, which refers to a relationship between an individual and a group, from that of mentor, which refers to a relationship between an individual and another person (Boulard, 2000; Armour and Duncombe, 2012). Mentors seek to develop ongoing personal relationships with their learners in order to positively influence their physical and moral life. Celebrities are more likely to inspire others through their personal achievements by acting on the desire to imitate them (Almour and Duncombe, 2012).

The research phase proceeds by case studies and uses the video content analysis method. We opted for a method of matching video content by considering semantic and temporal aspects (Desoyer et al., 2016). The observation tool is linked to the theories of representation and social scene. We have viewed a significant selection of the online physical activity session offer (n=29). The analysis is carried out with a film analysis grid (Bourgatte and Thabourey, 2018) and allows us to propose a model.

A first category of videos seems to simply promote physical exercise in a seemingly disinterested way. It is animated by individual actors who seem motivated by health, sharing and communication with communities of practitioners. A second category of video places aesthetics

*Speaker

and celebrity at the heart of the content. It comes from celebrities and well-known personalities involved in the movement, probably driven by the search for visibility and notoriety. These videos of fitness activities are characterized by a high quality of audiovisual production. Finally, a last category of video proposes a more technical content of physical conditioning. This is the offer coming from sports and health institutions. These videos are distinguished by the exemplarity and precision of the proposed exercises and by the sobriety of the contents.

What do you want to do ?
New mailCopy

Keywords: Physical activity, internet, social networks, video

Staying at home during the COVID-19 pandemic: Well-being and physical activity in overweight or obese women under lockdown in France

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Introduction

Following the first cases of SARS-CoV-2, governments have taken exceptional lockdown measures and health organizations placed people suffering from chronic diseases, including obesity, on the list of so-called "at risk" people. Psychologically, it has been shown that obesity has negative consequences such as low levels of well-being (Wardle & Cooke, 2005), and the period of lockdown may have worsened these. Moreover, physical activities (PA) are essential in the management of obesity, due to its beneficial effects on weight loss and reduction of co-morbidities (Jakicic et al., 2019) or psychological well-being (PWB, Lubans et al., 2012), and as before, lockdown may have impacted level of PA realized. So, and during lockdown in France, from march to may 2020, objectives of the present study was to analyze the differences in well-being and physical activity level between overweight or obese French female adults and those with a healthy weight.

Methods

250 adult women, all registered in weight loss programs, agreed to take part in this study. During April 2020, they were contacted by email and asked to provide information about their own perceptions of well-being using the French versions of (1) the Ryff's Psychological Well-Being questionnaire, and (2) the international Positive and Negative Affect Schedule - and level of PA using the Ricci-Gagnon questionnaire, before (January-February, Time 1) and during (April, Time 2) lockdown period.

Results

Whatever the weight, lockdown had significant effect on decrease of PWB ($p = .003$), positive affects ($p < .0001$) and PA level ($p = .03$) between Times 1 and 2 (figure 1). Post-hoc analyses revealed no effect in healthy weight women on PWB and positive affects, but an increasingly strong effect on PWB depending on the degree of obesity (overweight, $p = .09$; obesity I and II, $p = .06$; obesity III, $p < .001$), and a sharp decrease in positive affects in women with obesity ($p < .0001$ for all degree of obesity). Concerning PA level, post-hoc analyses showed an almost significant increase during the lockdown period in healthy weight women ($p = .06$), while a significant decrease in obese women (Obesity I, $p = .03$; Obesity II, $p = .02$ and Obesity III, $p = .01$). Finally, at Time 2, BMI was the main predictor of psychological well-being, positive affect and physical activity level (β = -.17, $p < .001$ for PWB; β = -.15, $p < .01$ for

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positive affect; β = -.15, p < .01 for PA Level), accounting for 18% to 25% of the variance. During lockdown, the more a woman's weight increased, the less she experienced high levels of psychological well-being, positive emotions or active behavior.

Conclusions
This study highlights the importance of taking account of well-being and active vs. inactive behavior of overweight and obese women during the lockdown period. Our results complemented the studies on evolution of well-being and PA level during lockdown in France, taking account of individual weight.

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Keywords: COVID, 19, Lockdown, Obesity, Well, being, Physical activity

Personality traits and onset of COVID-19 disease's symptoms

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The relationship between personality and mental or chronic disease is well documented (Strickhouser et al. 2017), but little is known about the relation between personality and infectious diseases. According to recent health models, personality is linked with health state through health behavior (Fergusson, 2013; Smith, 2006).
Since a link exists between personality traits of the Five Factor Model (Mc Crae & Costa, 2003 ; Digman,1990 ; Goldberg, 1990) and compliance with behavioral guidelines to contain COVID-19 transmission (*e.g.* social distancing) (Blagov, 2020; Götz et al., 2020), this study examines the relation between personality and the risk of onset of COVID-19's symptoms.

Participants were drawn from the English Longitudinal Study of Aging (ELSA; N = 4539) and United Kingdom Household Longitudinal Study (UKHLS ; N = 1309). Symptoms were self-reported between April and July 2020.

The English sample shows a significant relationship, for three personality traits : conscientiousness and extraversion are linked with less risk of symptoms (Odd Ratio (OR)-C = 0.72 ; Confidence Interval (CI)-C : 0.62-0.84 ; $p < 0.001$ et OR-E = 0.75 ; CI-E : 0.64-0.88 ; $p < 0.001$) whereas neuroticism is associated with more risk (OR-N = 1.49 ; CI-N : 1.28-1.73 ; $p < 0.001$).

This study shows the existence of a relationship between three personality traits and risk of infectious disease's symptoms.

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Keywords: Personality, COVID, 19, risk of symptoms, Health Behavior Model of Personality

Self-control resources and past physical activity as predictors of the evolution of physical activity during COVID-19 lockdown

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Introduction

COVID-19 lockdown measures have led to decreases in physical activity (PA) worldwide. Some authors have shown that this decrease might depend on the habitual PA profile. Nevertheless, few studies have examined this relationship on a weekly time scale during and after the lockdown, and what may explain it. Past research (Forestier et al., 2018) has shown the relevance of self-control resources as a potential predictor of weekly PA. Based on the aforementioned literature, we established two hypotheses:

- Self-control resources interacts with the past PA profile (e.g., inactive, some PA) to predict PA during and after lockdown. More particularly, we predicted that inactive individuals would need more self-control resources to do PA than active individuals, because the former have developed less PA habits than the latter.
- Self-control resources x past PA interaction effect on PA depends on measurement time. More particularly, we expected this interaction to be stronger as the lockdown progressed, because the break in habits imposed at the beginning of the lockdown required to have sufficient self-control resources to implement new habits.

Method

Two-hundred-fifty-three participants (66.2% women; Mage = 34.02) living in France were recruited using social media and answered seven questionnaires: five during the five last weeks of the lockdown (once a week) and two after the lockdown (i.e., two weeks and two months after the end of the lockdown). Participants reported their weekly PA, self-control resources, and their PA before the lockdown. Linear mixed-effect models were used to analyse our data.

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Results

At the within-person level, the subjective vitality x past PA interaction was significant (β = -1.31 [-2.32; -0.31], p = .010]). The slope of subjective vitality for inactive individuals was the largest (β = 2.36, p = $<$ .001, $t(949)$=4.56) showing that the association between subjective vitality and past PA behavior was stronger for inactive individuals. In addition, this interaction depended on time measurement (β = 0.25 [0.02; 0.47], p = .030]), meaning that the interaction between subjective vitality and past PA varied according to measurement time. Specifically, the inactive individuals reported the largest slope during the first time-measurement (β = 2.92, p = $<$ .001, $t(949)$=3.05)and, this slope decreased with the passage of the weeks. This pattern was inversed for the other profiles (e.g., the most active individuals increased their slopes and achieved the largest one during the last time-measurement β = 2.90, p = $<$ .001, $t(949)$=5.45).

Discussion

Our study corroborates the key role of self-control resources in adapting healthy behaviors and habits during changing contexts. Notably, we demonstrated that the inactive individuals needed more self-control resources than the other past PA profiles. Besides, we distinguished different patterns of the association between subjective vitality and past PA depending on time-measurement. The subjective vitality x past PA was stronger for inactive individuals during the first time-measurement and it decreased thereafter. This pattern was inversed for the other profiles.

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Keywords: physical activity, self, control, COVID, 19 lockdown, subjective vitality

Video games and physical health : what does the litterature actually say ?

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Introduction
Video games are played in more than 75% of North American households and revenues of this industry now equal or even outpace those of the movies or streaming industries1. This growing popularity is reflected in a fast-growing professional scene that offer salaries and challenges similar to traditional sports. Esports are now so well established that they could be included in the next Olympic Games. Although video gaming has seen a massive growth in popularity, studies suggest that it may have several negative impacts on psychological and physical health. Another often-raised problem is that many video game enthusiasts devote a large number of hours to gaming; gaming addiction was considered serious enough for the American Psychiatric Association to add video game addiction as a pathology in the DSM-52 Moreover, screen time is a major concern for public health organisations, as it has several negative effects3,4. Given the growing popularity of gaming and the growing concerns about its effects on health, we conducted a scoping review that focused on how playing video game impact the physical health indicators and behaviours of players.

Methods
A scoping review was conducted to identify observational and experimental studies pertaining to our research question. Retrieved papers were screened using a two-phase method first involving a selection based on titles and abstracts. Then, potentially relevant studies were read and triaged by our team. The final set of included studies was analysed, and data were subsequently extracted. Studies were assessed using the appropriate Cochrane Risk of Bias Tool and data were synthetized according to specific physical health and related health behaviours.

Results
Twelve peer-reviewed articles were retained for further analyses. Our results suggest preliminary evidence that time spent playing video games is associated with a lower self-reported health and a higher body mass index. However, there is insufficient evidence to conclude on a possible association between gaming time and other physical health indicators.

Discussion
The results of this sopping review suggest an association between increased video game playing time and a deterioration in some physical health indicators, but available evidence is scarce, preventing us from any strong conclusion.

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Conclusion
Proposals to reduce the possible negative effects of video game play on physical health, such as integrating it into school curricula or training qualified practitioners, will be proposed to optimize the gamer experience and make it sustainable in the long run.

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Keywords: Jeux vidéo, santé, habitudes de vie, sports électroniques

How the development of students' emotional competences can enable them to learn to cope with difficulties: an exploratory and comparative study

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Introduction
The links between stress and health have been the subject of much research on health education. Indeed, in addition to academic stress, students are confronted with additional stresses during their internship. However, there is little training content that teaches them how to cope with this stress. It is essential to integrate tools that enable students to learn to cope with the difficulties of the profession. Furthermore, psychological determinants such as emotional intelligence (EI) are negatively correlated with stress [1] and positively correlated with well-being, physical health, performance and social relationships [2]. Regular physical activity (PA) also has an impact on these areas. In addition, it has been shown that physically active students are more emotionally competent [3]. This raises the question of whether physical activity could be an interesting tool for developing EI. As active pedagogies seem to be more effective for students' learning [4], it is questionable whether a PA-oriented program would be more effective than an exclusively theoretical one. The aim of this study will be to compare the effectiveness of these two intervention programs.

Method
An experimental study was conducted with 98 students. Three groups were formed : a control group without intervention (n = 34), a lecture group (n = 30) and an PA group (n = 34). The lecture group attended 3 theoretical contents on stress and EC. The PA group participated in a program combining theory and practical exercises on the different EC. The Trait Emotional Intelligence Questionnaire (153 items) was administered in pre and post-test. It measures a total of 13 facets grouped into 4 major factors (i.e., well-being, sociability, emotionality and self-control) and 2 auxiliary facets (i.e., adaptability and self-motivation).

Results
A repeated-measures ANOVA was conducted and showed a significant effect of time in the overall EI level ($F(3,108 = 10.609)$; $p < 0.01$ and $\eta^2 = 0.031$). Post hoc t-tests were conducted for each dimension of the TEique. Significant differences are observed for some sub-dimensions of the EI

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between passation for the PA group (expression, social skills, perception, stress management, optimism, well-being, sociability and emotionality) and conference (optimism, relational skills, adaptability, well-being). No difference are observed in control group. Significant differences are also observed for some sub-dimension of the EI between PA group and lecturer group in expression (MPA = 4.985 ; SDPA = 0.896 ; MConf = 4.186 ; SDConf = 0.845 ; p = 0.014), perception (MPA = 5.272 ; SDPA = 0.716 ; MConf = 4.285 ; SDConf = 0.787 ; p= 0.01), stress management (MPA = 5.348; SDPA = 1.034 ; MConf = 3.855 ; SDConf = 1.362 ; p= 0.01 and emotional abilities (MPAP = 5.217 ; SDPA = 0.580 ; MConf = 4.169 ; SDConf = 0.638 p< 0.01).

Conclusion

These results suggest that PA can be used to improve students' EI level. In addition, an AP program appears to be more effective than an exclusively theoretical program. Further studies are needed to confirm these results.

Keywords: Emotional competences, students, training, physical activity

"Workplace Physical Activity Program" (WOPAP) study: A four-arm randomized controlled trial intended to prevent burnout and promote vigor

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The survey "Great Place to Work" (2015) indicated that 17% of French employees self-rated them as burned-out. Burnout corresponds to "the gradual depletion over time of individuals' intrinsic energetic resources, including the expression of emotional exhaustion, physical fatigue, and cognitive weariness" (Shirom, 1989). Alternatively, vigor is a second construct assessing work-related well-being which refers to "one's feelings of possessing physical strength, emotional energy, and cognitive liveliness" (Shirom, 2003). Previous research has shown that physical activity (PA) was efficient to promote Work-Related Well-Being (WRWB, i.e., vigor and burnout) (Gerber, 2013; Lindwall, 2014). Some workplace PA interventions have reported a main beneficial effect of PA on work-related well-being indicators (Bretland, 2015; de Vries, 2017, Nazcenski, 2017). Adding to methodological concerns (no control group, no randomization, various parameters of PA, heterogeneity of well-being indicators), these studies did not compare PA with expressive activities such as theatre, which have been identified as potentially relevant to promote recovery from work (Demerouti, 2009). Then, these intervention studies have used pre-and post-intervention measures while weekly measures could have brought more information about evolution patterns of burnout over the course of the intervention. Research has shown that recovery experiences may explain the effects of PA interventions, but few of them assessed them in their protocol (Sonnentag et al., 2017). In the light of the above elements, the WOPAP intervention intends to address these limits examining whether a 10-week PA intervention promotes vigor and reduces burnout, compared to theatre, and paying particular attention to recovery experiences that could meditate on this effect.
In a four-arm parallel trial, 72 participants were randomized into two PA groups, a theatre group, and a waiting-list group. Intervention groups took part in PA or theatre sessions. In addition, one of the PA groups beneficiated from a supportive climate, with an instructor trained to support psychological basics needs (Deci & Ryan, 2001). The other PA group will experience the same PA program with a non-trained supervisor. Each week, two sessions have been headed by instructors, during lunch or after-work periods. Primary outcomes were burnout and vigor. These variables were assessed before and after the intervention, and at three and six months after the intervention. Moreover, WRWB variables and recovery experiences have been assessed weekly through the intervention period. More information about the rationale and the protocol

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of this study are available in the published protocol paper (see Ginoux et al., 2019, BMC Public Health).
We expect (1) an intervention effect, intervention groups reporting better WRWB than waiting list group; (2) an activity effect, PA groups reporting better WRWB than theater group; (3) climate effect, need-supportive PA group reporting better WRWB than traditional climate PA group; (4) and that recovery experiences explain WRWB trajectories of participants over the intervention.
Statistical analyses are still in progress and will be presented at the congress. Results will bring insights about the most efficient activity type, the potential additive effects of the motivational climate, and should indicate which psychological mechanisms explain the beneficial effects of the intervention.

Keywords: Burnout, vigor, physical activity intervention, motivational climate, recovery experiences, randomized controlled trial.

Physical activity prescription: report on 3 seasons of the Occitan program.

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Introduction
According to the World Health Organization, chronic diseases would be responsible for 52 million deaths by 2030 (OMS, 2014). Sedentary behaviour and physical inactivity are modifiable risk factors at the forefront of prevention and health promotion strategies (OMS, 2018). The health benefits of physical activity (PA) are widely demonstrated in chronic diseases (INSERM, 2019) and have leading to the prescription of adapted physical activities (APA). Despite encouraging international data (Knobé, 2019; Pedersen & Saltin, 2006) french scientific data are insufficient to evaluate the effectiveness of programs relating to APA prescription. Our study aims to evaluate the "Bougez sur ordonnance® " program with two objectives: 1. to measure the effectiveness of the program based, 2. to identify the patient profiles for whom the program would be most beneficial.

Methods
Our sample was composed of 113 participants with a chronic disease (83.18% women) with a mean age of 55.4 ± 13.9 years. The participants benefited from an 8-week PA program that could include Nordic walking, aqua fitness, gymnastic or stretching. All participants were evaluated at the beginning and end of the program including anthropometric measurements (e.g weight and waist circumference) and subjective measure of physical activity. Physical fitness was also assessed in three key areas such as aerobic fitness (e.g 2 or 6 minutes walking test); muscular strength and endurance (e.g 30 Second Sit to Stand Test) and flexibility (e.g Fingertip-to-Floor distance).

Results and discussion
Nearly 86% of participants were overweight with a body mass index (BMI) greater than 25 kg/m^2 and two thirds had a BMI up to 30 kg/m^2. Statistical analyses showed a significant improvement in the physical condition of the participants, expressed by a better cardiorespiratory endurance, a better flexibility, and an increase in the muscular strength of the lower limbs. The level of PA increased significantly for all participants.

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Conclusion
The significant improvement at the end of the APA prescription is encouraging. These results corroborate those obtained in the international literature and allow us to add to the few studies that still exist in France. Yet, these results need to be confirmed by a long-term evaluation of the effectiveness of the APA prescription.

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Keywords: Physical activity prescription, chronic diseases

The impact of the physical activity level of master athletes on executive and memory processes: a study using virtual reality.

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Introduction
Several studies demonstrated the benefits of physical activity on cognition, especially on attention, executive functions, and episodic memory (Blanchet et al., 2018). However, only a few of them studied the master athlete model (Lepers & Stapley, 2016), and none of them used an ecological task to assess cognitive functioning (Dupuy et al., 2019). This issue was addressed with the present study by investigating the effect of a high level of physical activity on the ability to manage interferences on episodic encoding, and especially on the binding features involved in episodic memory. A virtual reality task performed under full or divided attention in encoding was completed by master athletes.

Methods
Thirty-seven participants (15 women and 22 men) were recruited and divided into two groups: 19 elderly subjects with a moderate physical activity level (mean age 72.1 yrs ± 5.2) or 18 master-athletes (mean age 69.4 yrs ± 5.3). Both groups carried out a computer-based virtual reality task. Participants had to memorize twelve lively events along with their contextual details under full or divided attention while traveling through the virtual environment. The secondary task in divided attention was to classify sounds as living or non-living. After a filled delay with a cognitive test which lasted fifteen minutes, participants were asked to proceed to a free recall followed by a cued recall. Scores were calculated taking into account spatio-temporal and perceptive details given by the participants for each recalled event.

Results
To examine the effect of physical activity level on the binding score according to the attentional level in encoding, an ANOVA with Groups (master athletes, control subjects) as between-subjects factor was conducted for each memory indices, followed by post-hoc analyses for decomposing significant interaction (Scheffé test and Bonferroni correction). The binding score obtained on the cued recall after an encoding under full attention was higher for Master-athletes than control subjects (respectively, 44 ± 4.6 vs. 33.37 ± 7.63, $p < 0.01$). Master athletes also

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dealt better with interference when encoding under divided attention. Indeed, master athletes classified more sounds than control subjects during encoding (respectively, 13.67 ± 4.03 vs 11.68 ± 2.94, p = .003).

Discussion

An intensive and regular physical activity would have a protective effect against the age-related neurocognitive decline. Our findings could help promote the master athletes' model as a successful aging model on physical and cognitive levels, preventing the deleterious effects of aging.

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Keywords: physical activity, master athlete, cognition, virtual reality

Effet du pic, de la pente et de l'autorégulation de l'intensité sur la réponse affective à l'exercice chez les femmes âgées

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Introduction
La pratique d'une AP permet d'atténuer certains effets délétères du vieillissement (e.g., perte d'équilibre et des fonctions exécutives **;** Smith et al., 2010). Mais seulement 30% des plus de 55 ans pratiquent régulièrement de l'AP (Eurobarometer, 2014). Afin de promouvoir l'engagement durable dans l'AP de la personne âgée, la littérature révèle l'importance cruciale du plaisir ressenti pendant la pratique (Stevens et al., 2020). Trois paramètres principaux influencent la réponse affective à l'exercice (Zenko et al. 2017) : son intensité, l'évolution de la pente de l'intensité au cours de l'exercice, et le fait de pourvoir autoréguler cette intensité. L'objectif de cette étude est de comparer l'effet de quatre conditions d'exercice (i.e., pic d'intensité au début – DEB –, au milieu– MIL –, et à la fin – FIN – de l'exercice, et autorégulation de l'intensité ; AUTO) sur la réponse affective à l'exercice chez la femme âgée.

Méthode
34 femmes âgées de 55 à 85 ans (Mage = 70 ans) étaient volontaires pour participer à cette étude. Elle a consisté à proposer 4 séances d'AP – de 45 minutes – variant les conditions d'exercice (i.e., DEB, MIL, FIN et AUTO). Chaque séance comprenait 5 min d'échauffement, 3 séquences de 6 min d'exercice intermittent, et 5 min de retour au calme. Afin d'éviter un effet d'ordre, les participantes étaient réparties en 4 groupes expérimentant les conditions dans un ordre différent. Dans les conditions DEB, MIL, et FIN, l'intensité de l'exercice était prescrite par l'intervenant et le pic d'intensité correspondait à 85% de la fréquence cardiaque maximum (évaluée par un test navette). Chaque participante était équipée d'un cardiofréquencemètre (i.e., Polar A360) permettant de vérifier le respect des intensités d'exercice. A chaque séance, la réponse affective et l'intensité de l'effort perçu étaient mesurées 4 fois (i.e., après échauffement et après chacune des 3 séquences) avec la Feeling Scale (FS; Hardy & Rejeski, 1989), et la Rated Perceived Exertion (RPE; Borg, 1970), respectivement.

Résultats
Des analyses multiniveaux ont examiné l'effet d'interaction Temps × Condition sur FS et RPE. Elles ont révélé que le score de FS diminuait au cours de la séance de la même manière dans les

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conditions DEB, MIL and AUTO, et que cette diminution était plus forte dans la condition FIN : Tps × Condition MIL vs FIN (b = -0.50, p = .03), Tps × FIN vs MIL-DEB-AUTO (b = -0.27, p = .006), et Tps × FIN vs DEB-AUTO *(*b = -0.35, p = .008). Le score de RPE augmentait au cours de la séance de manière équivalente dans les conditions DEB, MIL and AUTO, et cette augmentation était plus forte dans la condition FIN : Tps × MIL vs FIN (b = 0.82, p = .02), Tps × FIN vs MIL-DEB-AUTO (b = 0.36, p = .01), Tps × FIN vs DEB-AUTO (b = 0.44, p = .03).

Discussion

Dans cette étude, la réponse affective est la plus dégradée lorsque le pic d'intensité de l'AP est situé en fin de séance, c'est-à-dire que la pente d'intensité de l'exercice augmente. Afin d'optimiser le plaisir ressenti par la personne âgée, il semble préférable de proposer des séances dans lesquelles l'intensité de l'exercice diminue progressivement au cours de la séance, ou bien de laisser la possibilité aux pratiquants de réguler l'intensité de leur exercice.

Référence

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Keywords: Plaisir, activité physique, personne âgée

Relation between eating disorders, physical activity and psychological disturbances in sport sciences students

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Introduction

Eating disorders (ED), such as anorexia nervosa or bulimia nervosa, affect 1-4% of the population and are more common among young female. Students can be considered at higher risk of ED than general population, especially during 1st year of study which is a transition period likely to affect the most vulnerable among them [1, 2]. Athletes can also constitute a population at risk of ED, especially those practicing disciplines within which weight and body shapes have an important influence on performance [3]. According to these findings, it can be assumed that 1st year sport sciences students could specifically have a higher risk of developing an ED, than other students.

To our knowledge, no study investigated the risk of ED in this population which combines several risk factors. Therefore, the present study aims to verify if 1st year sport sciences students of the University of Caen are more at risk of ED than general population, and to examine psychological profile and sleep quality of high-risk students.

Method

An online survey has been sent to all students registered in 1st year of sport sciences at Caen in 2018-2019. This survey combined questions focused on practice of physical activity (PA), as well as questionnaires assessing ED, sleep quality and various psychological variables (i.e. binge drinking, impulsivity, exercise dependence, depression, anxiety, body dissatisfaction, physical self-esteem).

Results

207 students completed the survey. They were divided into 3 groups according to their score at the EAT-26 questionnaire, measuring ED risk (Table 1). Results revealed that 16.9% of students obtained a high risk of ED with an EAT-26 score above 20 (GR3), and that these last ones showed a higher frequency of PA than GR1 and GR2, with a sur-representation of body-building (31%) and running (22%). In addition, scores of binge-eating and most sub-scores of exercise dependence were significantly higher in GR2 and GR3 than GR1, revealing a higher risk of binge-eating and higher exercise dependence behaviors in both groups. Scores of physical self-esteem were significantly lower (meaning a lower esteem) in GR3 than GR1, and in GR3 than GR2. Finally, GR3 showed a poorer sleep quality with a significantly higher score of PSQI

*Speaker

than GR1, a score above 21 indicates major sleep difficulties (Table 2).

Discussion

Despite the small sample, our results revealed that 16.9% of students were at high risk of ED (GR3), which is more important than in general population (i.e. 8 to 12%). Compared to GR1 and GR2 these students (GR3) appeared to have more binge eating behaviours, a stronger PA dependency, as well as a lower physical self-esteem and a poorer quality of sleep. The differences were significant between GR3 and GR1. These results highlight a psychological profile for students at risk of ED and to promote early detection of ED. Further investigations are required including larger students' populations.

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Keywords: anorexia, students, physical activity, disorders

Adapted physical activity as complementary treatment to alleviate the symptoms of endometriosis? The CRESCENDO program (inCRease physical Exercise and Sport to Combat ENDOmetriosis)

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Introduction

Endometriosis is a chronic disease characterized by growth of endometrial tissue outside the uterine cavity which affects 200 million women worldwide. One of the most common symptoms of endometriosis is pelvic chronic pain. This pain can cause psychological distress and interpersonal difficulties.

The beneficial effects of regular physical activity (PA) and particularly adapted PA (APA) on chronic diseases were highlighted (INSERM, 2019). PA appears to reduce pain severity and improve physical functioning and to enhance psychological and social health (Eime et al., 2013). However, studies questioning the link between PA and endometriosis are rare, cross-sectional,

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and their results are inconsistent (Bonocher et al., 2014). It worth noticing that, in the context of endometriosis the barriers and facilitators to the practice of PA are not clearly identified. Otherwise, a RCT is needed to test the effects of PA on the symptoms and consequences of endometriosis.
Our ambition is to allow a comprehensive view of the phenomena at play in the relation between PA and endometriosis. First, we will lead a cross-sectional study which will aim to examine the reasons why patients are or are not physically active. Based on these first results a RCT will investigate leverages and effects of an APA program which include motivational interviewing (MI) on perceived pain, quality of life, on PA and sedentary behaviors (SED), and on patients' physical, psychosocial health. On a subsample, the effects on inflammatory status and oxidative stress will also be examined.
This program could (H1) complement current treatments for endometriosis by reducing pain and SED, increasing quality of life and PA, (H2) have beneficial effects on patients' physical, psychological and social health as well as physiological factors. Finally, a program combining APA and MI will be more effective than one that offers these interventions separately (H3).

Methods
150 patients will be randomly assigned to 4 groups: (1) control group, (2) MI group, (3) APA group, and (4) MI and APA group. The study will last 13 months (4 months=recruitment & 6 months=intervention). There will be four times of measurement (indirect and direct measures) will be used. The intervention will consist of a total of 5 MI sessions on adopting or maintaining a physically active lifestyle and pain management and/or 3 sessions of APA per week (1 via videoconference and 2 via a personalized program to follow autonomously.

Results (Expected benefits)
We expect the results of this study lead to the generalization of the integration of APA and MI programs into endometriosis care protocols. These practices could be view as a complement or even an alternative to treatments that reduce healthcare costs. The use of videoconferencing to deliver APA programs would remove barriers to PA related to the availability and proximity of sports facilities as well as scheduling constraints, while allowing a collective, adapted and emotionally secure practice.

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Keywords: endometriosis, adapted physical activity, visioconference, motivational interviewing

Automatic processes associated with physical activity and sedentary behavior from a lifespan perspective

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Introduction
Dual-process theories of physical activity suggest that both automatic and reflective processes influence the engagement in physical activity and sedentary behavior (Cheval & Boisgontier, 2021). However, the effect of age on these automatic processes is still unclear. The main objective of this study is to improve our understanding of the mechanisms underlying the engagement in physical activity across the lifespan. The main research questions that will be addressed are whether age and self-control affect the automatic processes associated with physical activity and sedentary behaviors.

Methods
At least 190 adults 18 years of age or older will participate. This minimum sample size estimation results from an a priori power analysis based on a power = 90%, an alpha level of α =.05, and a smallest effect size of interest of f2 = .15. Automatic approach-avoidance tendencies will be assessed using the manikin task (Cheval et al., 2018a). Demographic data (age, sex, gender, country of residence, height, weight), self-control (Effortful Control Scale) and the level of physical activity (International Physical Activity Questionnaires; IPAQ) will be assessed using questionnaires. Data will be analyzed using multiple linear regressions and structural equation modelling.

Results and discussion
We hypothesize that age affects the automatic approach-avoidance tendencies associated with physical activity and sedentary behaviors and that this automatic process mediates the association between self-control and the level of physical activity, irrespective of age.

*Speaker

Conclusion
On the one hand, the age-related decline in physical activity and increase in sedentary behavior has been repeatedly demonstrated (e.g., Cheval et al., 2018b). On the other hand, automatic and self-control processes have been shown to be related to physical activity and sedentary behavior and to be affected by aging. However, whether these two mechanisms are related is still unclear. This study will provide new knowledge related to the theory of effort minimization in physical activity (TEMPA; Cheval & Boisgontier, 2021) from a lifespan perspective and will reveal whether self-control mediates the effect of aging on automatic tendencies toward physical activity and sedentary behavior. Such results could inform future interventions aimed at increasing physical activity and decreasing sedentary behavior.

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Keywords: aging, automatic processes, physical activity, self, control

Dynamics of approach/avoidance motivations during positive and negative series of feedback

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Introduction
Approach and avoidance have recently been conceptualized as two competing attractors, the landscape of which is determined by a control parameter, K, such as K = (C × Bs) – [Ts × (1 – C)], with C as competence expectancies, Bsas benefit for the self, and Ts as threat for the self [1]. To test potential nonlinear transitions across these attractors, we examined the effects of gradual variations of competence feedback [2] within conditions of high or low activation of the self.

Method
A sample of 106 sport sciences students were randomly assigned to the four experimental conditions of a 2 × 2 factorial design (Self activation: high vs. low × Feedback series: increasing vs. decreasing). They carried out 11 blocks of 10 trials of a perceptivo-motor task which consisted of placing a computer's mouse pointer as accurately and as quickly as possible on a point of a map of France they deemed to be as close as possible from a previously announced city. Following each of the first 10 blocks, participants were provided with the (manipulated) feedback of performance regarding that block and answered items regarding the next block and measuring C, Bs, and Ts-which enable the calculation of K-[3], as well as their intention to continue the task.

Results
Analyses of variance only revealed significant Block and Block × Feedback effects for both K and Intention. Whereas K increased and decreased quite gradually over the increasing and decreasing feedback scenarios, respectively, intention did not vary over the increasing scenario but abruptly decreased by the end of the descending scenario.

Discussion
The nonlinear changes in intention as K changes gradually are consistent with classical attractor dynamics according to which nonlinear changes in order parameters occur during gradual changes in control parameters [4]. The abrupt change in intention found only in the decreasing scenario supports previous findings that achievement motivation is more sensitive to negative momentum scenarios than positive ones [5].

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Conclusion
This study brings first evidences that properties of non-linearity and resistance to change, that are specific to attractor dynamics, can apply to approach-avoidance motivational states.

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Keywords: dynamical systems, achievement goals, motivation, nonlinearity

Ego Depletion: Criticisms & Perspectives for future investigation of its role on physical inactivity

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Physical inactivity is a leading cause of mortality with 5 million deaths per year1, and could be due to difficulties to overcome motivational conflicts which oppose goals toward physical activity to desires toward sedentary behaviors2. Self-control permits conflicts resolution, and self-control failures foster behaviors driven by desires2,3. Ego depletion, the impairment of self-control after an initial self-control act4, could explain these failures and promote a better understanding of physical inactivity. Ego depletion has been highly criticized after replication failures5. However, studies also supported it, and raised issues that fostered replication failures (e.g., low statistical power)6. This review stresses theoretical and practical limitations that contributed to replication failures, and perspectives to address them and investigate the role of ego depletion in physical inactivity. Theoretically, we discuss the omission of the original ego depletion components (i.e., self-control resources, willingness, and capacity changes)4 and the necessity to distinguish between ego depletion's core theory, and auxiliary hypotheses from a Lakatosian perspective7. Specifically, the literature focused mostly on two auxiliary hypotheses while other auxiliary hypotheses have been overlooked, thereby preventing the rejection of the theory as a whole, according with Lakatos7. Practically, we argue that the low replicability of past studies could be explained by the absence of a comprehensive and integrative definition of self-control, central to the concept of ego depletion; by an unclear distinction between ego depletion and mental fatigue; and by the low validity of the tasks used to induce it. Finally, we stress the necessity to consider the dynamic and multifactorial nature of ego depletion. To overcome these issues, we propose to get back to the original definition of ego depletion, and adopt an updated and falsifiable definition of self-control; to approach ego depletion as a self-control specific fatigue; to consider tasks pre-tests and affectively charged tasks; and to investigate the dynamics and the complexity of the phenomenon through within-person designs. These criticisms and perspectives aim to promote rigorous investigation of ego depletion, to better understand its role on the physical inactivity pandemic.

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Keywords: ego depletion, physical inactivity, self, control ressources, self, control motivation, self, control capacity

Enhancement of the Rubber Hand Illusion (RHI) by the touch-proprioceptive coupling: a self-initiated procedure of the RHI.

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Introduction

The body is the entity that allows human beings to act in their environment. Thus, it is essential for them to be able to be in control of their body and movements. The sense of being in control of one's own body and actions is named the sense of agency. This notion is coupled with the sense of ownership: our body is really ours and that we own it. Together, the sense of ownership and the sense of agency constitute body awareness (Gallagher, 2000). However, it is possible to experimentally manipulate body awareness, notably with the well-known Rubber Hand Illusion (Botvinick & Cohen, 1998) where the participants are under the impression that a false plastic hand has become a part of their body and that they own it.

The RHI induction is classically explained as the resolution of a multisensory discrepancy between the proprioceptive and tactile sensations from the participant's real hand and visual perception from the rubber hand stroking (Ehrsson, 2012). The resolution of this conflict induces the RHI and a sense of ownership towards the fake hand. However, in Gapenne's opinion (2014) in order for body awareness to emerge, a moto-proprioceptive coupling is required. For him, the moto-proprioceptive coupling is deeply linked to our capacity to distinguish signals from the body activity than those from the outside world. According to his proposal, it seems that something is missing in the RHI for the fake hand to be really considered as our own hand since the subjects are in a passive state during the RHI.

Thus, it is hypothesized that in an auto-initiated RHI (i.e., participants stroking the fake hand with their free hand) the coupling between self-initiated actions and felt sensation would enhance both sense of ownership and agency in comparison with a passive RHI.

Method

In order to test this hypothesis, an experimental design has been created where participants experienced a passive condition of the RHI and an active one. Proprioceptive drifts before and after the induction of the illusion were measured for each condition in order to implicitly investigate whether or not the illusion has been induced in the participant. Participants filled in a questionnaire after the illusion in each condition in order to investigate the sense of ownership and agency.

Results

Results are currently being acquired but we expect a greater proprioceptive drift and stronger senses of ownership and agency towards the rubber hand in the active condition than in the passive one.

*Speaker

Discussion
In line with Gapenne, the expected results seem to indicate that self-initiated action towards one's own body increases the sense of ownership and agency toward the fake hand. This touch-proprioceptive coupling seems to underlie one's differentiation from the outside environment. More generally this experiment led us to think that moto-proprioceptive coupling is a crucial factor for the "*enaction*" of body awareness.

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Keywords: rubber hand illusion, body awareness, sense of ownership, self, initiation, moto, proprioceptive coupling

Influence of physical activity intensity on students' level of well-being and emotional intelligence

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Introduction

The transition from high school to university requires a high level of commitment in order to cope with the increased workload and academic level. Furthermore, entering university usually coincides with a significant decrease in physical activity. Moreover, the workload generated by training is often responsible for the abandonment or reduction of sports activities due to a lack of time. This reduction in practice time in favor of sedentary and unhealthy behaviors can be detrimental to students' life quality. However, the level of emotional intelligence (EI) of students is thought to be positively correlated of their health behaviors [1] and their well-being (WB) [2]. Furthermore, it has been shown that students who practice regularly a physical activity are more emotionally competent than inactive students [3].
The aim of this study was to measure students' levels of WB, physical activity (PA) and EI in order to determine possible correlations between physical activity intensity and students' WB and EI levels.

Method

An email describing the study with a link to an online questionnaire assessing emotional intelligence, well-being and physical activity intensity was sent to a group of university directors. The questionnaire was then sent to students via their institutional email. This tool meant to question demographic data, the Trait Emotional Intelligence Questionnaire short version (30 items), the Short Multidimentional Well-Being Questionnaire (23 items) and the International Physical Activity Questionnaire short version (7 items). IPAQ classifies students according to their intensity of practice into 3 categories: low, moderate and vigorous. Each student was free to participate or not in this study. A total of 1250 students completed the questionnaire. Of this sample, 49% of the students were enrolled in their first year of university study. The majority of the students were between 18 and 25 years old (N= 1167).

Results

The results of ANOVA show that there are significant differences on three components of well-being (i.e, Physical Self-Perception ($F(2,1247,\ 66.987)$; $\eta^2 = 0.097$; $p < .\ 001$) ; Self-Esteem

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and Self-Efficacy (F(2,1247, 17.549); $\eta^2 = 0.028$; p < . 001), Socialization (F(2,1247, 40.516); $\eta^2 = 0.061$; p < . 001)); general Well-Being (F(2,1247, 73,526); $\eta^2 = 0.165$; p < . 001) and Emotional Intelligence (F(2,1247, 18.947); $\eta^2 = 0.028$; p < . 001) among students with different levels of physical activity. Post hoc t-tests were conducted for each dimension evaluated. Significant differences are observed between three groups. Vigorous group has a significantly higher level of PSP (MV = 3.705, SDv = 0.688 ; MM = 3.301, SDM = 0.759 ; ML = 3.001, SDL = 0.797), S (Mv = 3.786, SDv = 0.679 ; MM = 3.513 , SDM = 0.704 ; ML = 3.272, SDL = 0.747), WB (Mv = 3.510, SDv = 0.390 ; MM = 3.304, SDM = 0.421 ; ML = 3.105, SDL = 0.434) and EI (Mv = 4.747, SDv = 0.632 ; MM = 4.596 , SDM = 0.709 ; ML = 4.416, SDL = 0.722) than Low and Moderate Intensity group. It also has a significantly higher level of SESE than the low group (p < . 001) but not with the moderate group (MV = 3.392, SDV = 0.686 ; MM = 3.270, SDM = 0.693 ; ML = 3.068, SDL = 0.735). Except to emotional reaction, Moderate group has a significantly higher level for dimensions evaluated than Low intensity group.

Conclusion

Students who engage in intensive activity have higher scores on well-being and EI compared to other practice intensity groups. the delivery of PA interventions to students could be beneficial in improving their level of WB and EI.

Keywords: Emotional intelligence, students, physical activity, wellbeing

Motivation toward physical activity in patients with musculoskeletal disorders: two meta-analyses of the association with behaviour and the efficacy of behavioural interventions

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Introduction
Musculoskeletal disorders (MDs) - osteoarthritis, rheumatoid arthritis, low back or neck pain - are a widespread health issue worldwide, which can lead to temporary or permanent disability at work, causing high costs for global economy[1]. Pain is one of the major symptoms related to MDs. Physical activity (PA) reduces pain and increases function among these patients[2]. To promote behavioural changes, it seems important to focus on modifiable factors involved[3]. Thus, this review focused on motivation toward PA in patients with chronic MDs. Previous work assessing the association between motivation and behaviour, and/or the efficacy of behavioural interventions on PA motivation were included.

Method
The systematic review followed an established protocol, and was registered at PROSPERO (record #CRD42021234601). We used the following electronic databases: PubMed, PsychINFO, MEDLINE, EMBASE and Web of Science. Searches used terms referring to "physical activity", "motivation" and "chronic musculoskeletal disorders". Participants had to be adults aged 18 years and over, with chronic MDs (> 3 months). Both qualitative and quantitative studies were eligible. Quantitative studies assessing both measures of motivation toward PA and PA behaviour are eligible for inclusion. All intervention are eligible for inclusion regarding effects on behaviour change interventions on motivation. Risk of bias will be assessed with the Quality Assessment Tool for Studies with Diverse Designs (QATSDD).

Results
The literature search identified 6489 potentially eligible studies. After screening the titles and the abstracts of studies retrieved, there were 389 eligible studies. Pearson's r and Hedges' g will be used as effect size. Robust method of estimation of variance will be conduced to account for

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dependencies of having multiple effect sizes come from each study. We will test several moderators: motivational dimensions, disorder localisation and severity.

Discussion
This review could identify modifiable factors involved in PA among MDs patients, and will help practitioners to build effective interventions.

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Keywords: Systematic review, meta, analysis, motivation, chronic musculoskeletal disorders, physical activity

Psychological state and living conditions during and after the COVID-19 lockdown: A longitudinal study on active vs non-active French adults

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Introduction
In January 2020, the World Health Organization declared the global outbreak of the coronavirus disease 2019 a public health emergency and a pandemic in March 2020. As a response, the French government enforced an isolation period (" lockdown ") on March 17th 2020. Quarantine measures consisted of prohibition of unnecessary travels, mandatory stay at home measures, closure of " nonessential " stores and limited physical and sport activities [1]. One hour a day of physical activity away from home was allowed within a one-kilometer radius. Studies suggested an impact of lockdown on psychological distress, anxiety and depressive symptoms in various countries [2], in line with previous research on quarantined individuals [3]. The aim of the study was to analyze the effect of COVID-lockdown on trait and state anxiety in French adults.

Method
An online, national " Ex-COVID " survey was created to assess the impact of lockdown on health. Participants were recruited through nonprobability snowball sampling using social networks. The study design was longitudinal (repeated every 4 days), started 3 weeks after lockdown was initiated and ended one month after its end. Four time points were used: 2 scores during lockdown, 2 post lockdown immediate and post + 1month. Trait and state anxiety were respectively assessed with the Y-A and Y-B form of the State-Trait Anxiety Inventory [4]. Sociodemographic (sex, age, occupation, education level), physical and social living conditions data (accommodation type, outdoor area, alone vs co-habitation, frequency of Covid-19 information searching) were collected. Participants were grouped based on their previous (before lockdown) lifestyle (4 profiles regarding levels of sedentary and active behaviors, following WHO guidelines [5].

Results
122 participants (Mage = 43.43, SD = 15.80; n = 84 women) were included for analysis. Non-parametric Wilcoxon Signed Ranked tests and linear mixed effect models were performed to test the evolution of anxiety measures. Analysis revealed an overall decrease in anxiety state

*Speaker

measures overtime: the baseline measure was higher than all other measures; anxiety decreased between the 1st and 2nd part of lockdown (Z = -2.30, $p = 0.02$), increased slightly between the 2nd part of lockdown and post measure (Z = -2.04, $p = 0.04$) and decreased again one month post lockdown (Z = -2.91, $p = 0.004$). Our model revealed two factors that had a differential effect on anxiety measures: gender (women being more anxious) and professional activity (individuals without professional status having higher anxiety scores than other categories). The activity profile did not impact anxiety state ($F = 1.94$, $p = 0.13$).

Discussion

Our results did not identify a negative psychological impact of the lockdown. Participant's anxiety decreased during the isolation period and between the post and one month after isolation. The previous levels of sedentary and activity habits did not impact anxiety. Finally, it seems that being in a reliable professional situation had protective effects.

Conclusion

Our study suggests that participants had favorable physical and social living conditions (e.g., accommodation, social network, high SES) that could be protective factors in managing lockdown isolation.

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Keywords: lockdown, covid, 19, psychological impact, activity

Sensorimotor decrease by aging suit to study cognitive impairment in aging: an innovative experimental protocol

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Embodied view of cognition suggests that memory depends on motor and sensory systems, as well as the interaction between the body and the environment. Previous studies showed that a disturbance of the motor system alters memory of action concepts, such as action verbs or manipulable objects (e.g. Dutriaux & Gyselinck, 2016 ; Villatte et al., 2021), in young adults. According to this point of view, older adults would be an interesting population to examine because the mnemonic and motor changes observed during aging could be linked (Vallet, 2015). Inter-individual differences in aging are classically explained by physical activity level (Quigley et al., 2020) but these links between memory, motor skills and physical activity remain poorly studied in a context of embodied cognition.

Objectives were to: (1) introduce a new paradigm of motor disturbance (aging suit, simulating the physical declines of older adults in young adults, adding around 30 more years) in order to test the link between motor skills and cognitive processes of action verbs (2) identify the age-group most suitable for the use of the aging simulator in the study of aging changes, and (3) explain both the mnemonic changes and the positive effects of physical activity on these mnemonic changes observed during normal aging with an embodied view.

Different age-group were created: young adults (20/40 years old, with or without aging suit), adults (40/60 years old, with or without aging suit) and older adults (60/80 years old, without aging suit). Motor skills were assessed with the Short Physical Performance Battery (Guralnik el al., 1994) and pieces placement (inspired by Hole Peg Test, Mathiowetz et al., 1985 and Grooved Peg Board Test, Heaton et al., 1986), for respectively gross and fine motricity. Cognitive measures included executive function (updating, inhibition and flexibility) and a source memory task, involving actions (manual and foot) and non-action verbs. Daily activities, including physical activities, were assessed with PAPA (physical, social, cognitive, and sedentary activities, Chavoix et al., in prep), MAQ (estimate Kriska et al., 1990), and actimetry (1 week).

We expect: (1) lower performance in motor and cognitive skills in groups wearing the aging suit and older adults. Motor and memory performance would be correlated: the more motor skills are reduced, the more memory of action verbs will also be, and (2) a benefit from physical activity on memory, and especially concerning action verbs.

This communication focuses on the methodology of this study. If conditions are favorable preliminary results will be presented.

Keywords: aging, embodied cognition, episodic memory, aging simulator

*Speaker

Study of the effect of an unforeseen event in rugby on team adaptation and the adaptation process

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Introduction

Adaptation is a change in team performance that leads to a functional outcome for the whole team (Burke et al., 2006). It is the result of modifications made in response to the demands of a changing environment. Several mechanisms allow the teams to adapt, such as communication and coordination.

The objective of this study is to propose an experimental method adapted to rugby to measure team's adaptation after an unforeseen event, as well as the process through which the teams adapt.

Method

The study was carried out with 63 players from a rugby academia ($Mage$ = 17.0 years SD = 1.53; 45 men).

The situation consisted in repeating 12 sequences, alternating playing with timeouts. Teams are configured as 4+1 attackers versus 4. The unforeseen event takes place from the 5th sequence (loss of an attacking player or change of defense strategy). Communication recordings were made during down time and positions during games with GPS.

Adaptive performance was measured with scores obtained through a performance grid. The quality of the communication was measured from the interactions transcribed in verbatim. Collective movement coordination was quantified by an order parameter estimated from the dispersion of running steering angles (Fajen & Warren, 2007).

The analysis was done in 3 phases according to the model of the evolution of adaptation (Sander et al., 2015). The results for adaptive performance and communication were obtained with Friedman tests. Effective coordination was assessed with a randomization test on the order parameter.

Results

The 2 unforeseen changes were tested and one required adaptation. The performance decreased significantly after the unforeseen change before increasing again significantly. The results for

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the communication were not significant.
Coordination showed a difference between the observed dispersions and those randomized both before and after the change.

Discussion
The results of adaptive performance were consistent with Sander et al. (2015). Thus, although the type of situation studied was different, it would seem that adaptive performance evolves in a similar way.
Results of communication quality will be discussed according to the literature. The randomization test of the dispersions showed it effectively measures the coordination of a team, however it may be refined.

Conclusion
The purpose of this study was to propose an experimental method in a sporting context to measure the team adaptation triggered by an unforeseen event; As well as the mechanisms of the team adaptation process (communication and coordination). Analysis of the data by Friedman's tests over three periods yielded significant results on adaptive performance. These results showed that this experimental situation in a sporting context made it possible to measure the teams adaptation.

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Keywords: Adaptation, Team, Process of adaptation, Unforeseen change

The Relationships between team momentum and the dynamics of collective organization in football

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Introduction
Positive (M+) and negative (M-) experiences of momentum in sport contests entail positive and negative effects, respectively, on interpersonal motor synchronization in dyad [1]. However, whether these effects can be extended to teams of more than two athletes remains unknown. Therefore, the aim of this study was to qualitatively characterize the typologies of collective organizations that develop during experiences of M+ and M- in football.

Method
Four male expert football coaches (ages: 40 to 63), with 15 to 35 years national-level coaching experience, watched sequences of two international football matches, during which scoring changed rapidly and meaningfully (*remontadas*). During the viewing of the videos, semi-structured interviews prompted these experts to identify indicators of specific collective organizations and their evolutions when a team came from behind (M+) or was caught up (M-). The qualitative material collected was then coded and categorized independently by this report's first two authors who are themselves football experts. Then they compared and discussed codes and categories until consensual labels were adopted.

Results
At macroscopic level, the team block (i.e., a team's global position along the longitudinal axis of the field) was almost systematically forward during M+ phases and almost systematically backward during M- phases.
At mesoscopic level, team blocks were compact and showed a strong connectivity between individual behaviors and collective actions during M+ phases. They were stretched and showed a very large disconnectivity of behaviors during M- phases.
At microscopic level, M+ phases were associated with short distances between the player in possession of the ball and the defender closest to him and by without-the-ball offensive and defensive runs directed towards the opposing goal. During M- phases, the distances between the player in possession of the ball and the closest defender were long. Without-the-ball offensive runs were not particularly directed towards a goal, and defensive runs were either not directed towards a particular goal or directed towards the goal to be defended.

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Discussion
Patterns of collective organization that were identified are consistent with those observed when the teams pursue offensive or defensive aims [2]. They also confirm, at a collective level, the effects of momentum observed in dyadic sport contests on interpersonal motor synchronization [1].

Conclusion
This research is to be continued in light of the dynamical systems theory. The collective organization patterns that were identified would thus be considered order parameters, whereas M+ and M- experiences would play the role of control parameters [1].

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Keywords: team momentum, collective organization, football

Validation of the Ricci & Gagnon physical activity self-questionnaires with determinants of physical fitness, in subjects with abdominal obesity.

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Introduction
The daily adoption of an active behaviour contributes to the significant improvement of health regarding either physiological, physical, mental or psychosocial components. Physical activity (PA), defined as "all body movements, produced by the activation of skeletal muscles, responsible for an increase in energy expenditure greater than the energy expenditure at rest", has beneficial effects on most chronic disease in primary prevention: to prevent the risk of the onset of the disease, secondary: to limit its progression or tertiary: to avoid recurrence. PA has the advantage of being an inexpensive intervention with few side effects. In contrast, physical inactivity (PI) is defined as "a level of PA below the thresholds recommended, and sedentary behaviour corresponds to a situation of wakefulness in a seated or lying position. Both PI and sedentariness have specific but cumulative direct ugly effects on health. Thus, in the aim to screen for sedentary lifestyle and PI level in an individual, questionnaires have been developed. However, few are validated in French and meet the requirements for use in professional practice. The study aims validate the Ricci & Gagnon self-administered PA questionnaire (R&G-Q).

Patients and methods
Patients were recruited at the medical-sports centre "Mon Stade", from recipients of a physical fitness assessment, prior of an adapted PA program conducted by adapted PA teachers (i.e. Kinesiologists in others countries). Among the 595 adults, 470 had abdominal obesity according to the International Diabetes Federation criteria.
The R&G-Q (2009 version, Table 1) was completes 30 minutes before the assessment. A good reproducibility was observed among 13 peoples who completed 3 days apart (Table 2).
The fitness assessment included 3 components: 1) body composition analysis using DEXA scanner (fat mass (%FM), lean mass (%LM)); 2) maximum incremental cardiorespiratory stress test (maximal oxygen consumption (VO2 max), maximum aerobic speed (MAS) on treadmill or power (MAP) on ergocycle); 3) neuromuscular capacities (force index on a bench press (BP) and on a chest press (CP), strength endurance of the trunk flexors (Ito-Shirado) and extensors (Sorensen) tests).

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R&G-Q validation was performed by looking for correlations with the physical fitness parameters measured.

Results
Among the 470 subjects (mean age 46.3 ± 13.2 y, body mass index (BMI) 33.2 ± 5.3 kg/m2), 190 men (49.1 ± 13.4 y, BMI: 32.9 ± 5.6 kg/m2) and 280 women (44.3 ± 12.8 y, BMI: 33.4 ± 5.2 kg/m2). Analysis by gender (Table 3) showed no significant difference in scores. Analysis of the correlations between R&G-Q scores and fitness variables (Table 4) showed a significant relationship with the main fitness components: "total score" appeared positively correlated with aerobic capacities (VO2 max, MAS or MAP), with neuromuscular capacities (Sorensen, Ito-Shirado tests, strength indexes on BP and LP), but also with %LM and negatively correlated with %FM and for body composition.

Conclusion
Our study validated the R&G-Q total score with VO2 max assessment in adults with abdominal obesity, but also with the overall components of their fitness dimensions: body composition and neuromuscular capacities. The many qualities of this questionnaire (accessibility, easy to understand quickly to administer and interpretation), make it attractive to professionals of "sport and health", as a motivational tool to initiate or reinforce the adoption of an active lifestyle.

Keywords: Questionnaire, Physical Activity, Physical Fitness, Score.

Visual feedbacks of hands' movements and the construction of the body schema

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Introduction

The mirror therapy suggests that the perception of our hand in a mirror can influence neurocognitive processes of the other hand (Cantero-Téllez et al., 2019). This result is in line with the prevalence of visual feedbacks in the multimodal integration at the origin of the body schema (a neurocognitive representation of the body, Ehrsson, 2020). Our goal is to develop a new method to better understand this effect. It includes a device filming the participant's hands and broadcasting it in live on a screen in a reversed fashion. The participant can move naturally but see their hands as in a mirror. Thus, we can induce a conflict between visual and tactile/proprioceptive feedbacks of each hand. To assess the influence of visual feedbacks on the body schema, we used the Simon task (Hommel, 2011). In this protocol, participants usually saw a colored stimulus located on the right or left side of a screen. According to the color, the participants have to press a key located on the right or left side of a keyboard thanks to their right and left hand, respectively. Responses times (RTs) were shorter when the stimulus and the response hand were both located on the same side than opposite sides. We use this effect to implicitly assess how the participant considers his hand when the visual feedbacks were reversed or not. Because of the health crisis, we cannot perform our protocol. Therefore, we will focus on our method and on expected results.

Method

Participants will have their hands put on a response device. Putted right above, a camera will film their hands. The film will be broadcast in live on a screen titled at 45◦ toward the participant and put above the hands and the camera. There are 2 conditions: the image of the hands is reversed or not. Another screen, put vertically in front of the participant, allows to present stimuli of the Simon task. First, participants will have to press simultaneously 2 keys: one located on the right with their right hand and the other located on the left with their left hand. Then, a fixation cross will appear, followed by an orange or blue circle either on the right or left side of the screen. According to the color, the participants should release one of the 2 keys and reach one of the 2 keys located right in front (15cm). The relevance of this reaching movement is to force participants to consider the visual feedback of their hand in action, either the right or left according to the color. The experiment is composed of 300 trials and our sample should be composed of 2 groups of at least 36 participants.

Predictions

The RTs will be analyzed with a mixed ANOVA with the stimuli location (right/left) and the response location (right/left) as within-subjects variables and the group (reversed/non-reversed)

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as a between-subject variable. For the group with the reversed visual feedbacks, participants should respond faster with their right(/left) hand when they will see a stimulus located on the left(/right) rather than on the opposite side. This reversed Simon effect would suggest that the reversed visual feedbacks is able to influence the way of considering each hand. In the non-reversed condition, a usual Simon effect should be reported. To conclude, this pattern of results would support the relevance of our protocol to finely study the dynamic of the reconstruction of the body schema of hands.

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Keywords: Body schema, Multimodal integration, Reversed visual feedback, Visuomotor compatibility effect, Mirror therapy

"Corporeal non-property": psychomotor evaluation after a traumatic brain injury

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Introduction
Using a phenomenological approach (Merleau-Ponty, 1976), the emersiology (Andrieu, 2016) investigates the relation between the living body as physical, and the lived body as a subjective representation of the body. The discrepancy between the objective data from the living body and its distorted representation in the consciousness of the lived body defines the corporeal non-property (Agostinucci et al., 2019). Another important postulate in emersiology is the updating of self-knowledge through motor action. This model was specifically applied on the psychomotor evaluation. Assessing body representations is a central topic for psychomotor therapists in neurology. It is well known, after a traumatic brain injury (TBI), individuals tend to minimize their deficits (Azouvi et al., 2017). That is why we choose to investigate the non-property in individuals with TBI. The awareness of the deficit is mainly studied through questionnaires or scales but is rarely explored in motor evaluation. The aim of this study is to investigate self-assessments of performance directly related to motor tests.

Method
In this prospective multicentric and controlled study, 66 volunteers were recruited: 32 adults with a moderate to severe TBI who were injured in average 13 years ago, and 34 adults without any disability. Data were collected in the Parisian area, in France through socio-medical partnerships, during individual experimentations. Four motor tests were performed: balance, coordinations, digital motricity (twice), and face motricity. Before and after each test, participants assessed their perceived performance on a color scale. The link between self-assessments and motor test scores was investigated through Pearson's correlations. A repeated measures ANOVA was also performed to investigate a before-after factor and a between subject factor.

Result
Correlations between self-assessment and motor test were more often significant ($p < .05$) after the motor test and were mostly moderate [$r = .33$-$.81$]. The ANOVA at repeated measure reveals a before-after factor ($p < .05$) in four situations (4/5) but, no difference between group.

Discussion
The trend shows a higher correlation between self-assessment and motor test score in the TBI group, that suggests a great awareness of motor abilities. The before-after factor results of a change in self-awareness of performance stimulated by the motor action.

*Speaker

Conclusion
These results suggest that individuals with TBI have a great awareness of their motor ability. The action also allows a quick update of the self-performance knowledge.

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Keywords: disability, awareness, neurology, psychomotor therapy, phenomenology, perception

Facteurs psychologiques liés au fonctionnement physique lors de l'avancée en âge

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Given the economic, environmental, and health issues related to the increasing number of people over 65 years in the coming decades (Harper, 2014; United Nations, 2019), the identification of the factors associated with the maintenance or the degradation of physical functioning with advancing age is a major public health concern. Beyond the effect of sociodemographic, cognitive or medical parameters on physical functioning in old age, attention has been also directed toward psychological factors. Indeed, cross-sectional and longitudinal research has shown that psychological dimensions are related to physical functioning in old age. Based upon four oral presentations, the present symposium brings together researchers from different French Universities to present research on three psychological factors which have been related to markers of physical functioning with advancing age, namely stereotypes, subjective age, and personality traits. First, Corentin Clément-Guillotin and colleagues will test in two studies whether being physically active may also have positive effects on how older adults judge their own age group and themselves on the stereotype content dimensions. Second, Maxime Deshayes and colleagues will investigate the effect of induction of aging stereotypes on older adults' physical capacities at different levels of task difficulty. Third, Yannick Stephan and colleagues will examine whether subjective age, that is how old or young individuals feel relative to their chronological age, is related to concurrent and incident motoric cognitive risk (MCR) syndrome, a pre-dementia syndrome characterized by cognitive complaints and slower gait speed. Finally, Brice Canada and colleagues will present new data on the association between personality traits and functional limitations from large national longitudinal cohorts followed for almost twenty years, and test potential mediators of this association.

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Keywords: Aging, Physical Functioning, Stereotypes, Subjective Age, Personality Traits

*Speaker

Being old but physically active to not fall into the traditional stereotype in ingroup descriptions and self-descriptions

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Introduction
The stereotype content model (Fiske et al., 2002) posits that stereotypes are captured by two universal dimensions: warmth and competence, resulting from the fact that when people meet others, they want to know their intent (i.e., warmth) and capability to pursue their intent (i.e., competence). In particular, older people, as a low-status group, have been consistently stereotyped as warm but not competent across cultures and contexts and, as a result, discrimination is regularly observed in older people in many social areas (Clément-Guillotin et al., 2015; Cuddy et al., 2005). Previous research suggested that participating in physical activity may enable older people to gain in competence in young perceivers' impressions (Clément-Guillotin et al., 2015). The present research examines in two studies whether being physically active may also have positive effects on how older adults judge their own age group and themselves on the stereotype content dimensions.

Method Study a
One hundred and ninety-three older persons ranging from 55 to 64 years old ($n = 64$, $Mage = 60.92$, $SDage = 2.90$), 65 to 74 years old ($n = 65$, $Mage = 70.03$, $SDage = 3.04$), and over 75 years old ($n = 64$, $Mage = 81.48$, $SDage = 4.57$) were instructed to rate the extent to which items relative to competence (e.g., efficient, skillful, competent, intelligent ; Fiske et al. (2002)) and warmth traits (e.g., well-intentioned, tolerant, warm, nice; Fiske et al. (2002)) described their ingroup in general on a 7-point scale (from 1 "not at all" to 7 "extremely"). They were also asked to indicate the amount of physical activity they practiced per week. Data were analyzed using analyses of variance.

Method Study b
Two hundred and eighteen older persons ranging from 55 to 64 years old ($n = 77$, $Mage = 60.96$, $SDage = 3.15$), 65 to 74 years old ($n = 65$, $Mage = 69.62$, $SDage = 3.15$), and over 75 years old ($n = 76$, $Mage = 80.60$, $SDage = 4.83$) were instructed to rate the extent to which the same items as those used in Study a described themselves in general and the amount of physical activity they practiced per week. Data were analyzed using analyses of variance.

Results
In both studies, the most physically active (according to the WHO recommendations) participants showed higher warmth judgements but, more importantly, higher competence judgments

*Speaker

than the less physically active participants. These results were observed in each age and sex category.

Discussion

Stereotypes associated to older people may be shared and endorsed by older people themselves. The present research showed that practicing physical activity seems a good mean for older people to regain competence in ingroup judgments as well as in self-descriptions and, thus, to keep away from the stereotypes traditionally associated with the social group of older adults.

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Keywords: stereotype content, warmth, competence, physical activity, ageism

Does the effect of stereotypes in older people depend upon task intensity?

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Introduction

With the increase of age, a physical decline is generally observed, due to an inevitable biological process (e.g., Milanović et al., 2013). In addition to the natural phenomenon of aging, it seems that social factors, like stereotypes, can have a significant impact on physical capacity of elderly. On this basis, some studies have investigated if inducing a negative aging stereotype may impaired older adults' physical capacities, as predicted by the stereotype threat theory (Steele, 1997). However, the deleterious effect expected was not consistently found (e.g., Marquet et al., 2018). Previous studies, conducted in the cognitive domain, have shown that task difficulty could moderate the effect of stereotype threat (O'Brien & Crandall, 2003). Less is known however about the applicability of this moderator during physical tasks, which may potentially explain the mixed results observed. The aim of the present research was therefore to investigate the effect of the induction of aging stereotypes on older adults' physical capacities at different levels of task difficulty.

Method

Fifty elderly women ($Mage = 73.6$, $SDage = 6.8$) were recruited. Firstly, they were requested to perform a voluntary isometric contraction at a level of muscular effort that corresponded to four perceived effort intensities ("easy", "moderate", hard" and "very hard") reflecting different levels of task difficulty (i.e., baseline measurements; T1). Next, they were randomly assigned to one the three following groups: a negative aging stereotype group, a positive aging stereotype group, and a control group. Finally, participants performed the same protocol as in T1 (i.e., T2). The strength produced at each intensity was the dependent variable. Data were analyzed using linear mixed models.

Results

For the "easy" and "hard" intensities, results showed that participants in the negative stereotype group and in the positive stereotype group developed more strength after the stereotype manipulation than during baseline measurement. For the control condition, no significant difference emerged between T1 and T2 at these two intensities. At the "moderate" and "very hard" intensities, strength produced was similar between T1 and T2 for the three experimental groups.

*Speaker

Discussion

The present research showed that the effects of stereotypes induction could be different according to the intensity of a task. While some results are not fully in line with the stereotype threat theory, this work provide evidence that, as in the cognitive domain, task difficulty could modulate the effect of aging stereotypes during physical tasks.

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Keywords: positive stereotype, negative stereotype, strength, task difficulty, ageism

The Association between Subjective Age and Motoric Cognitive Risk Syndrome

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Introduction
The motoric cognitive risk (MCR) syndrome is a pre-dementia syndrome defined by the combination of cognitive complaints and slow gait speed (Verghese et al., 2013). The present research examined whether subjective age that is how old or young individuals feel relative to their chronological age is associated with the MCR syndrome. Subjective age is consistently related to a range of health-related outcomes, including dementia (Stephan et al., 2018). An older subjective age has been related to the individual components of MCR, such as slower gait speed (Stephan et al., 2015) and with poor self-rated memory(Hülür et al., 2015). Therefore, it was hypothesized that an older subjective age would be related to a higher risk of concurrent and incident MCR syndrome.

Method
The study sample was composed of 6,341 individuals aged 65 to 107 years without dementia from the Health and Retirement Study (HRS). Participants completed measures of subjective age, cognitive complaints, and gait speed and provided information on demographic factors, cognition, physical activity, depressive symptoms, and body mass index (BMI) at baseline. Incident MCR was assessed four and eight years later.

Results
In cross-sectional analyses, an older subjective age was associated with a higher likelihood of MCR syndrome, controlling for demographic factors (Odd Ratio: 1.62, 95%CI: 1.44-1.81, p< .001). This association was still significant when physical inactivity, depressive symptoms, cognition and BMI were included in the analysis (OR: 1.34, 95%CI: 1.19-1.50, p< .001). Furthermore, an older subjective age was related to a higher risk of incident MCR syndrome at follow-up (OR: 1.52, 95%CI: 1.33-1.73, p< .001), even when physical inactivity, depressive symptoms, BMI, and cognition were included (OR: 1.32, 95%CI: 1.16-1.51, p< .001).

Discussion
The present study adds subjective age to the list of factors associated with the MCR syndrome. An older subjective age may be related to MCR because it is a marker of unfavorable biological, behavioral, affective, and health-related profiles that are relevant to the MCR.

*Speaker

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Keywords: subjective age, Motoric cognitive risk, gait speed, self, rated memory

Association Between Personality Traits and (Instrumental) Activities of Daily Living Limitations

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Introduction
Limitations in instrumental activities of daily living (IADLs) and activities of daily living (ADLs) are commonly used as indicators of disability and functional impairment among older individuals. These functional limitations are associated with poorer quality of life (Gobbens, 2018), increased health care utilization and related costs (Johnston et al., 2018), and cognitive decline (Rajan et al., 2013). To advance research on the psychological factors related to aging-related functional limitations, this study examined the relation between personality traits and both concurrent and incident functional limitations. In addition, mediation analyses were conducted for the association between personality traits and incident IADL/ADL limitations to identify potential pathways between personality traits and the incidence of functional limitations.

Method
Participants were drawn from eight longitudinal samples from the U.S., England, and Japan. Participants provided data on demographic variables, the five major personality traits, and on the Katz ADL-scale and Lawton IADL-scales. IADL/ADL limitations were assessed again 3–18 years later. Disease burden, falls, handgrip strength, self-rated health, depressive symptoms, physical activity, and smoking at baseline were tested as mediators. A random-effects meta-analysis combined the estimates from all samples.

Results
A consistent pattern of associations was found between personality traits and functional limitations, and robust across samples that used different measures and from different cultural contexts. The meta-analysis indicated that higher neuroticism was related to a higher likelihood of concurrent and incident IADL/ADL limitations, and higher conscientiousness, extraversion, and openness were associated with lower risk. Higher agreeableness was associated with lower risk of concurrent IADL/ADL, but unrelated to incident limitations. Physical activity, disease burden, depressive symptoms, self-rated health, handgrip strength, falls, and smoking status mediated the relation between personality traits and incident IADL/ADL limitations.

*Speaker

Discussion
The present study extends existing knowledge by identifying replicable associations between all five personality traits and IADL/ADL limitations. In addition this study provides results that inform theoretical model of potential mechanisms that link personality to functional limitations, such as medical, physical, psychological, and behavioral pathways.

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Keywords: Big Five, Functional Limitations, Longitudinal, Meta, analysis, Mediation Analysis

Novel approaches to the complexity and the dynamics of sport performance

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Symposium overview

The volatility of the factors of sport performance and the complexity of their interactions make it difficult to study them with traditional approaches. The purpose of this symposium is to present a set of studies that exemplify novel research approaches to sport performance that are based on complexity sciences, dynamical systems and data sciences.

Borrowing an idiographic approach to time series analysis (ARIMA modeling), Teboul et al. examine how the dynamics of approach-avoidance motivations in sport achievement contexts may result from the dialectics between their sensitivity to external perturbation (adaptation mechanism) and their tendency to resist perturbation (conservation mechanism). Pursuing the dynamical approach to psychological factors of performance, Meerhoff et al. address resilience, the underlying processes of which fluctuate at short and large timescales. In the research presented, data science techniques are applied to professional football players to tease apart the micro- and macro-dynamics operating at these varying timescales. Beyond resilience, *antifragility* is a phenomenon accounting for organisms' capability to grow-rather than just protecting themselves-from encountering stressors. Antifragile reactions to stress depend on the dose of stress that is experienced. Therefore, in two empirical studies, Hill et al. explore whether optimal doses of stress can be determined to trigger an antifragile dynamics favorable to performance enhancement. Finally, Den Hartigh et al. address the issue of talent identification and selection in complex sports context. Given the complexity of sport performance factors, implementing "sample-based" tests in which a constellation of skills and characteristics of athletes is measured in a representative context is an interesting new avenue. In this perspective, the authors examine (a) whether small-sided football games can be considered as representative for 11 vs. 11 soccer games, and (b) whether soccer players' performance in small-sided games is predictive of their performance in 11 vs. 11 games.

Keywords: Approach motivation, antifragility, avoidance motivation, complexity, data sciences, dynamical systems, resilience, talent detection

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Approach-avoidance motivational states in sport: Dynamics of the conservation versus adaptation dialectics in sport

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Introduction
Approach and avoidance motivations have been conceptualized as two competing attractors, the landscape of which is determined by a control parameter, K:

K = (C × Bs) – [Ts × (1 – C)],

with C as competence expectancies, Bs as benefit for the self, and Ts as threat for the self [1].

The dynamics of such attractors results from the dialectics between their sensitivity to external perturbation (adaptation mechanism) and their tendency to resist perturbation (conservation mechanism). Using an idiographic approach, the present study aimed to examine how this dialectics applies over time in sport achievement contexts.

Method
Five athletes (3 males; 2 females) indicated on an online platform their most important sport goal to achieve over the coming months. Then they responded every week to three items, each of them drawn at random from the items of each of the three dimensions C, Bs, and Ts of the Approach-Avoidance System Questionnaire [2]. In order to allow the analysis of sufficiently long time series [3], only participants who responded to the items for at least 50 weeks were retained (i.e., two male athletes responding for 87 and 62 weeks, respectively). Time series of the parameter K-as calculated from the values of C, Bs, and Ts-were analyzed using the ARIMA (Auto-Regressive – Integrated – Moving Average) technique [3]. Based on auto-correlation analysis, ARIMA enables the formal modeling of stochastic mechanisms of adaptation (i.e., moving average models) and mechanisms of history dependence (i.e., auto-regressive models).

Results
The auto-correlation function obtained for each participants showed one significant peak, thus indicating the presence of one moving average term in each model, which could therefore be formalized by the equation:

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Kt = 2Kt–1 – Kt–2 –
*theta*1 t–1 + t,

with Kt, Kt–1, and Kt–2 as the estimated value of K at time t and its preceding times, *theta*1 as the moving average coefficient, and t and t–1 as random errors associated with the values Kt and Kt–1, respectively.

Discussion and conclusion

The prevalence of the moving average model shows that motivational states fluctuate between approach and avoidance mainly under environmental influence. This sensitivity to external perturbation and the resulting volatility of states of goal involvement are consistent with previous studies which have evidenced the transient nature of these states [4].

The present results support the dynamic nature of motivational states as well as the relevance of an idiographic approach to its further examination.

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Keywords: dynamical systems, achievement motivation, states of goal involvement, ARIMA procedures

The merits of data science in sports: Revealing micro- and macro- processes of Resilience

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Introduction

The underlying processes that explain a global dynamic process in sports often fluctuate at different timescales. For resilience, some underlying processes are micro- and others macro-dynamic (e.g., emotions and personality, respectively) [1]. The micro-dynamics are like the weather: fluctuations are apparent at a short timescale. The macro-dynamics on the other hand are like the climate: fluctuations only appear at larger timescales. Here, we employ data science techniques to tease apart which processes play a role at which timescales.

Methods

To demonstrate our methodology, we use data collected at a Dutch professional soccer club. Together with the duration of each physical activity, athletes ($n = 84$) kept strict diary records (mean $\pm$ sd $= 263 \pm 118$ entries per athlete) during two seasons of the Rate of Perceived Exertion (RPE) and -Recovery (RPR). Additionally, physiological metrics were recorded using player tracking devices (e.g., distance, high intensity sprints). We modelled the expected recovery the day after a given training using the recent load in the days prior to that training. The deviation in the actual- from the predicted recovery (i.e., the residuals) were used as an operationalization of resilience.

Results and discussion

In the current contribution I will demonstrate the results of a promising data science technique for sports. Specifically, the above operationalization of resilience was used as the *target* (or dependent variable) for our *supervised machine learning approach* (a type of technique to predict a known *target*). In three steps we unravel the dynamical nature of the *features* (or independent variables) that explain the *target*. First, we remodel the *target* with specific lags. Lag 0 refers to the standard setting: using all data up until 'today' to predict 'tomorrow'. For lag 1, a model is built using all data up until 'yesterday' to predict 'tomorrow'. Accordingly, i models can be created (where i is the largest timescale that should be examined). Then, we apply subgroup discovery [2] to reveal interesting subsets of the data for each lag. A subgroup is a

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part of the data described by a specific condition (e.g., mood = bad) that has a particularly interesting relationship with the *target* (e.g., someone with a bad mood is 3 times as likely to have low resilience). Finally, we quantify the change in interestingness of the relevant features for the different lags. Features that are mostly important at the smaller lags capture the micro-dynamic processes, whereas features that are mostly important at the larger lags capture the macro-dynamic processes.

Conclusion

The current contribution describes a data science method to uncover the timescales at which various underlying processes (e.g., daily training load, personality, etc.) play a role in a global process (e.g., resilience). This method can be applied to many settings and variables in the sports domain.

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Keywords: dynamical systems, soccer, resilience, machine learning, data science

Antifragility – Leveraging Stress to Enhance Performance

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Introduction

In the domain of toxicology and medicine, it has been shown repeatedly that organisms are able to grow from encountering stressors – a phenomenon called *antifragility*1. Specifically, stressors may indicate that behavioral adaptations by an organism are required to engage with the environment more effectively2. This beneficial effect of a stressor depends on the "dose" at which it occurs. For example, a vaccine triggers an immune response only at a particular dose. If the dose is too small, no adaptation will occur, while too large doses may be harmful3. In this talk, we will present the first two empirical studies on human sport performance that scale these insights from biology to explore whether we can determine optimal doses of stress for performance enhancement.

Method

Study 1. Climbers ($n = 37$) completed several bouldering routes with increasing difficulty (i.e., varying dose). To determine the performance, we combined two measures obtained for each route: (a) maximal performance (i.e. the percentage of the route that was completed) and (b) number of attempts required to achieve maximal performance. Then, the behavioral response was mapped as a function of the difficulty to identify the optimal dose.
Study 2. Rowers teams ($n = 3$) consisting of two athletes completed five 500m races. Stress doses were induced by assigning different target times to finish the race. The dyad's performance during each race was determined by tracing the position data of the athletes to calculate the degree of coordination in the rowing strokes (i.e., *SD relative phase*).

Results

In Study 1, we were able to identify doses that challenged the athletes to explore different motor solutions, while still being able to complete the routes for 97.30% of the athletes. In Study 2, we found a clear increase in performance of more than 30% relative to the smallest stress dose4 for all dyads in the relative phase of the finish and for two out of three dyads in the relative phase of the catch. Across both studies, a large variability in dose-responses between individuals were observed.

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Discussion and conclusion

Overall, our results indicate that we can indeed identify optimal doses of stress for human sports performance. While we were able to determine exactly which routes provided the optimal challenge for the climbers in Study 1, we saw improvements in coordination performance of the rowers to particular doses in Study 2. Given the large inter-individual variability, we recommend coaches to carefully examine their athletes' responses to varying doses in order to stimulate optimal improvements during training. Furthermore, future studies using mixed reality technologies may attempt to identify what doses of stress can be safely applied to athletes to enhance their adaptability, similar to the principles of vaccinations4.

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Keywords: Resilience, adaptation, stress, growth, sport performance

Talent selection in a complex sports context: Improving performance predictions of athletes

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Introduction
Predicting performance is a core focus in the field of talent identification and -selection. Most research has attempted to define distinct (e.g., psychological, physiological) skills and characteristics that distinguish elite from non-elite athletes. However, no specific skills and characteristics have been identified that uniformly predict elite sports performance [1]. This may be due to the fact that sports performance comes about through a complex interaction between a multitude of skills and characteristics [2]. Therefore, researchers have proposed to implement "sample-based" tests, in which a constellation of skills and characteristics of athletes is measured in a representative context [2,3]. In soccer, for instance, a typical sample is a small-sided game (SSG), in which the relevant (interactions between) personal, environmental, and task constraints remain intact. Accordingly, the focus of the current study was twofold. First, we examined whether SSGs can be considered as representative for 11 vs 11 soccer games. Second, we tested whether, in contrast with distinct skills, soccer players' performance in SSGs is predictive of their performance in 11 vs 11 games.

Methods
Sixty-three players of the U15, U17, U19, and U23 teams of a professional Dutch soccer club were included. These teams played between 11 and 17 SSGs during the season, which we recorded. To assess performance in the SSGs, we measured 9 offensive and defensive indicators (e.g., passes forward, offensive and defensive duels) using a coding scheme. Moreover, physiological and motor skills of the players (i.e., sprinting, interval endurance, agility) were measured with separate tests in the season. The criterion was the performance of players across six 11 vs 11 matches.

Results and discussion
The distribution of actions performed in SSGs was comparable to the distribution in the matches (rs = .78), which suggests that SSGs provide a representative selection context. Furthermore, individual performance in the SSGs and 11-vs-11 matches was moderately-to-largely correlated for 6 of the 9 performance indicators. (rs = .35 - .53). In contrast, the physiological and motor tests showed trivial to small correlations with the offensive and defensive performances demonstrated by players in the matches (rs = -.20 - .15). Together, this suggests a moderate-to-large

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predictive validity of individual SSG performance, but a small predictive validity of the physiological and motor tests.

Conclusion
This study provides first insights into the usefulness of SSGs in predicting soccer performance. More generally, the results support the idea that sample-based tests provide better predictions of sports performance than distinct skills and characteristics measured in isolation [2,3]. Future research may employ novel technologies to measure performance of talented athletes more comprehensively.

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Keywords: talent identification, talent development, selection psychology, small sided games, signs and samples, representative design

Urban design evaluation in virtual reality: the impact of colorful floor marking on spontaneous walking, gaze and affective states

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A body of research suggests that green environments have a positive impact on spontaneous physical activity and wellbeing of citizens (Sarkar et al., 2015; Valtchanov & Ellard, 2015). However, the implementation of nature in city grounds is not always possible. Colours can positively impact human psychological and affective states (Jalil et al., 2012), popular medium to transform urban spaces as it is a low-cost and non-invasive intervention. Nevertheless, few behavioural research investigated the impact of colourful floor marking on human affect and behaviour (Nikolopoulou et al., 2015).
We used a virtual reality setup to test the impact of colourful floor markings in a controlled environment. We investigated how colourful designs impacted the speed of spontaneous walking, gaze behaviour, the physiological affective states and perceived pleasure and activation levels of adult participants. A Virtual Reality System was used to simulate the Science Campus of the University of Lille (France). The virtual environment was designed in Unity and used a reality headset (HTC Vive). Spontaneous walking speed was measured with a 3-axis accelerometer sensor contained in the handsets. An eye tracker SensoMotoric Instruments (SMI) was integrated in the HTC Vive helmet (250 Hz) and tracked gaze behaviour. Finally, an Empatica E4 wristband was used to measure physiological responses in real time (heart rate). Questionnaires were used to assess perceived valance and arousal.

Two different environments were displayed: Urban vs. Nature. In the Urban environment, there were no green elements, only buildings. In the Nature environment, grass and trees were included. For both types of environments, a total of three design scenarios were tested: (1) no colour floor marking (control); (2) a simple line crossing the campus in three RGB colours (red, blue, green); (3) a series of RGB colours embedded in playful designs. A total of 32 healthy participants walked in the virtual space under these six design scenarios for 60 minutes. Repeated Measures ANalyses Of VAriances (RM ANOVA) were carried out with the non-parametric Friedman test. These analyses were performed using the Python-based toolbox Homer2 (Massachusetts General Hospital, Boston, MA, USA) and the significance level was set to an alpha of 0.05.

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Results indicated that subjects walked slower in Nature compared to Urban environments. Furthermore, they walked significantly faster in the Urban environment with and without colourful lines compared to Urban environment with playful designs. Gaze behaviour was different between the design scenarios, with more fixation time towards the playful designs compared to the same locations presented in the other environments. For the measurements of the affective states, we observed similar activation (higher heart rate) across environments. However, greater stress levels (lower heart rate variability) were observed in the Urban and Urban with colourful lines compared to Urban with playful designs. Participants reported greatest arousal levels in the playful design scenarios whether implemented in Nature or in the Urban Environments.
We conclude that colourful floor marking has a positive impact on the user. The different design scenarios impacted spontaneous walking, gaze behaviour and perceived pleasure. With playful designs being more efficient than colourful lines, colourful designs could play an important role to trigger spontaneous physical activity and promote wellbeing.

Keywords: Human cognition, Virtual Environments, Colour psychology, Gaze Behaviour, Spontaneous, Gait, Affective states

Do physical activity, sedentary time, motor skills and aerobic fitness predict primary school children's attention? Use of data mining strategy.

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Backgrounds

Sustained attention and inhibition are two subtypes of attention which are decisive since childhood to adapt one's behaviour to one's social and professional environment (Bell & Wolfe, 2004). The quantitative and qualitative physical activity variable such as moderate to vigorous physical activity (MVPA) and motor coordination are likely to interact with each other to positively influence attention (Donnelly et al., 2016; Tomporowski, McCullick, Pendleton, & Pesce, 2015). No studies have yet investigated these interacting effects or identified which are the most important among them to predict attention during childhood.

Methods

324 children of two primary schools participated in 5 measurement times over 3 academic school years. MVPA and sedentary time (ST) were measured by accelerometry. Motor skills were also assessed with a shuttle run test, a standing broad jump and a plate tapping test. Aerobic capacity was measured with the PREFIT 20m shuttle run test. Attentional capacities were measured with a computer-based Flanker Task: Reaction Time (RT) of sustained attention and inhibition were collected for each child. Two conditional inference trees and random forests were used to analyse the data. MVPA, ST, motor skills, grade, sex, and body mass index were included in the analysis as possible predictive variables of the two attentional variables.

Results

RT of sustained attention was predicted first by grade, shuttle run test and plate tapping test performances ($p < 0.001$). RT of inhibition was predicted first by the plate tapping test and shuttle run performances, grade and the standing broad jump performance ($p < 0.001$).The pseudo R-square of the conditional inference tree and the random forest were respectively 0.33 and 0.53 to predict RT of sustained attention and 0.33 and 0.51 to predict RT of inhibition.

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Discussion

These findings supported motor skills as a key predictor of attention in childhood. It seems that attentional improvements may be due more to a neural stimulation by physical activity than cardiovascular exercise benefits and were not negatively predicted by ST. These results are in line with previous findings which indicated the strongest relationships for the cognitive stimulation hypothesis (Aadland et al., 2017). The data mining approach highlighted the importance of gross and fine motor skills according to age in the prediction of sustained attention compared to inhibition. To predict the inhibition, the tapping test which engages fine motor skills was the main predictive variable regardless of age. Promoting motor skills participation in childhood as well as physical activity is therefore essential to provide a foundation for physical and cognitive development in children.

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Keywords: children, physical activity, motor skills, attention.

On the perception of movement vigor

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It is common to get the impression that someone moves rather slowly or quickly in everyday life. However, the basis of such a judgment remains largely unknown. Vigor refers to the overall quickness of movement and is often defined quantitatively through the amplitude-speed (or amplitude-duration) relationships that characterize point-to-point movements (Shadmehr *et al.*, 2019; Shadmehr and Ahmed, 2020). In natural behavior both the preferred speed and duration increase with amplitude, which we call here the *vigor law* due to its demonstrated robustness across effectors and individuals (Berret *et al.*, 2018; Reppert *et al.*, 2018; Labaune *et al.*, 2020). While vigor has been investigated extensively in action, little is known about its counterpart in perception. We thus conducted a series of five experiments to investigate this issue. In *Exp1*, *2* and *3*, participants had to look at dots moving on a screen, representing horizontal reaching movements varying through amplitudes and speeds (and hence durations). They had to judge if movements were fast or slow. Results in these experiments showed that the speed and duration of movements perceived as neither fast nor slow (i.e. medium) robustly increased with amplitude. Thus, the vigor law seems to hold when observers judge movements of others. However, no significant correlation was found between the perceived and the performed vigor which was concurrently evaluated. In *Exp4*, a dynamic visual illusion was used to go beyond these results. Participants had to judge if movements of dots (of various amplitudes) were faster or slower than a reference movement (RM). Three conditions were considered: (a) movements always had the same speed than RM with durations varying across amplitudes; (b) movements always had the same duration than RM with speed varying across amplitudes; (c) movements had different speeds and durations than RM but complied with the vigor law (derived from reaching movements of several participants from previous experiments). Results showed that, in (a) participants judged movements faster for smaller amplitudes (corresponding to shorter durations) and slower for larger amplitudes (corresponding to longer durations), suggesting that participants could assess the quickness of motion from its duration. However, we got exactly the reverse trend in (b) for an assessment based on motion speed. Interestingly, when movements followed the vigor law in (c), participants hesitated more and judged movements as neither faster nor slower than RM regardless of amplitude. This suggests that the vigor law could define what is perceived as a neither too slow nor too fast movement. *Exp5* followed the same protocol than *Exp4* except that all stimuli were based on the own participant's movements (evaluated before). Results were not improved by this protocol. Overall, our findings suggest that the judgment of movement quickness is not simply based on thresholds put on physical quantities such as speed or duration but on the integration of a vigor law, and that the judgment is rather *externally-based* than *internally-based*.

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Keywords: Movement vigor, Perception, Action, Judgment

Validation of the computerized Trail Making Test in adults

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In cancer patients, cognitive functions are altered and we observed an increase in sedentary lifestyle1. Furthermore, cognitive functions appear as being central in the regulation of physical activity. Higher cognitive abilities predict higher physical activity2. In neuropsychology, the Trail Making Test (TMT) is commonly used3. This brief task measures overall cognitive functioning, with Part A focusing on attention, visual scanning, speed of eye-hand coordination and information processing, and Part B focusing on executive functions. The TMT consists in connecting the circles with a pencil line as quickly as possible, beginning with 1 and proceeding in numerical sequence (part A) and alternating between numbers and letters (part B). However, the examiner has an important role as he has to time the task and count the number of errors. In order to reduce potential measurement errors, it seems advisable to computerize the test. We are therefore carrying out the validation of TMT on a computer so that it can be used as a tool for evaluating cognitive function. This study aims to demonstrate that a computerized TMT can reduce measurement errors. Specifically, we hypothesize that (i) time and error rate on the paper-pencil version and computerized version will be correlated; (ii) the time to complete the cognitive task (part A and B) will be shorter in the computerized; (iii) the error rate made by the participant will be higher during the computer condition, because experimenter may miss error(s) while counting.
Participants are over 18 years old, without any cognitive impairment and randomly assigned in 3 conditions: computerized (CC), paper-pencil (PPC), computerized + paper-pencil (CPPC) conditions. The intragroup correlation will be analyzed with a Pearson correlation. The intergroup comparison will be analyzed with an independent sample student T test.
The expected results are that (i) time in each task, and error rate in each task, will be correlated in CPPC (dependent samples); (ii) student t test (independent samples) will reveal significant differences in time and number of errors between CP and PPC.
This first step of a task validation process will permit, in the future, to assess accurately cognitive function in patients with cancer, and enhance precision of intervention aiming to change sedentary behavior, through cognitive training.

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Keywords: Cognitive Functions, Computerized Trail Making Test, Cancer Patients

Physical activity as a protective factor against deficit in emotional regulation in adult ADHD

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Introduction
Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most common neurodevelopmental disorders. People with ADHD have, depending on the form of the disorder (pure inattention form, pure hyperactivity and impulsivity form, and mixed form), deficits in executive functions, attention, working memory, as well as in emotional management, skills essential to self-awareness and self-control. Indeed, multiple studies suggest that people with ADHD encounter difficulties in regulating their emotions1, leading to the idea that emotional dysregulation is one of the components of the disorder. Today, the management of ADHD disorders, whether in children or adults, is based mainly on drug strategies, and / or support (therapy, school support, rehabilitation...). Recent work suggests that physical activity may reduce disturbances in attention, impulsivity and anxiety in people ADHD2. However, the effects of physical activity on emotional regulation remain poorly studied in adults. Thus, the aim of the present study is to measure the impact of physical activity on emotional regulation in subjects ADHD over 18 years of age.

Method
Adults over 18 years of age who have been diagnosed with ADHD of any form without comorbidities as schizophrenia spectrum disorder, bipolar disorder were invited to participate to the study. Accelerometers (ActiGraph, wGT3X-BT) were used to monitor physical activity level and sedentarity time in an objective manner. Participants were asked to wear the accelerometer on the right hip during nine consecutive days from morning to evening. During this period, they had to answer questionnaires to measure their cognitive emotional regulation, emotional skills with PEC and behaviors associated with executive functions with BRIEF-A.

Results and discussion
Data acquisition is in progress. A positive correlation between physical activity level and emotional skills regulation is expected. Adults ADHD are often prone to stress and anxiety, and to personality disorders3. A better understanding in the relationship between emotional regulation and physical activity could allow the development of a new non-drug approach that could be used as a complement to cognitive and behavioral therapy or psychological therapy.

Conclusion
If emotional regulation end self-esteem seems are dependent on physical activity level, prescription of physical activity could be recommended to adult ADHD in order to improve lifestyle quality and reduce comorbidities.

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Keywords: ADHD, emotional regulation, physical activity

Influence of body mobility on executive control in school-aged preterm and term born children

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Introduction
Prematurely born children (PC) have difficulties to resist distraction, referring to executive control (EC), at the start of schooling (1). Relationships between EC and body activity had been evidenced, such as an improvement of EC after an acute physical activity (2) or by adopting a standing compared to a sitting posture (3). The aim of the study was to determine how body mobility influences EC of school-aged PC and term born children (TC).

Method
21 PC [gestational age (GA): 29.6±2.6wk, 7 girls] and 21 TC [GA: 39.2±1.3wk, 11 girls] aged 6.7±0.4 and 6.7±0.6 years performed Attention Network Test for Children using a head-mounted display in 3 conditions of body mobility: a sitting and a standing posture where they had to stay still and a free to move condition. They had to click as fast as possible on the left/right mouse button to give the facing direction of a fish appearing on the screen. It could be surrounded by other fishes facing toward the same (congruent) or the opposite (incongruent) direction. Their number of commission errors and their median reaction time for correct responses (RT) were calculated.

Results and discussion
Commission errors of PC and TC were low and did not differ (Med=2.5, IQR=3 vs. Med=3, IQR=4, Z=.46, $p>$ .05), whatever the conditions of congruency or body mobility. Mixed ANOVA showed that all children responded faster in congruent than in incongruent trials (946±209ms vs. 1069±248ms, F=102.3, $p<$ .001, ^{2}=.72). There was a significant body mobility*prematurity*congruency interaction effect (F=4.1, p=.02, ^{2}=.10). Post-hoc analyses showed that PC only responded more slowly during incongruent trials in standing still (1185±292ms) than in sitting still condition (1077±240ms) while no difference was found between the free to move condition (1102±220ms) and the 2 others conditions. In TC, no difference of RT was found for incongruent trials between sitting still (1045±260ms), standing still (1001±214ms) and free

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to move conditions (1010±238ms). For all children, no difference of RT was found for congruent trials between the 3 conditions of body mobility.
PC might use more attentional resources than TC to stand still (internal focus), perhaps due to a lower postural control development (4) and motor inhibition (1). When PC and TC were free to move (external focus) their EC did not differ between us or with the still conditions, surely due to the high diversity of child body mobility in this ecological condition.

Conclusion
It would be interesting to test the influence of a still vs. active sitting posture on PC's EC because it let less diversity in child mobility and it seems better than the standing posture for PC performance.

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Keywords: Body mobility, Executive control, Preterm, School, aged

Social sciences

The influence of the coach's emotional intelligence and the coach's mental toughness on athletes' burnout: using the self-determination theory

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Introduction

The coach takes a large place in the athlete's environment, what is more at a high level because of the hours of training session which multiply. The coach can be considered like a social factor who can influence the athletes. Indeed, for example, his coaching style has an influence on the motivation and the burnout of the athlete and that through the basic psychological needs (i.e. autonomy, competence, relatedness) (Isoard-Gauther et *al.*, 2012). In that sense and in terms of the Self-determination Theory (Deci & Ryan, 208), there are some antecedents that can influence the level of motivation and the level of burnout with a mediation from the psychological needs.

The aim of this study was to explore the influence of the coach's emotional intelligence and the coach's mental toughness on the athletes' burnout with a mediation from the three psychological needs frustration.

Methods

Population: Seventeen head coaches (e.g. handball, soccer, rhythmic gymnastics, ski cross...) were recruited (34.4 ± 10.2 years old [22-65], 94% of men) with a part of their group of athletes. One hundred and forty-six athletes participated in this study (21 ± 6.6 years old [12-41], 66% of men).

Measures and procedure

The coaches answered the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) and the Mental Toughness Index (MTI), and the athletes answered two questionnaires. The first one measured the level of burnout (Athlete Burnout Scale) and the second one measured the level of psychological needs frustration (Psychological Need Thwarting Scale). Coaches answered online in December 2020 (MSCEIT) and in January 2021 (MTI) and the athletes answered one week later online too.

Statistics

Multilevel model was used to explore the relation between the variables.

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Results and discussion

motional intelligence and mental toughness of coaches would negatively influence the level of athlete burnout, both directly and indirectly via the frustration of the three psychological needs of the athletes. In other terms, the more coaches are emotionally intelligent with a high level of mental toughness, the less risk of athletes' burnout is high.

The psychological needs thwarting would positively influence the level of burnout. That means when athletes report a high level of frustration of needs, there is a higher level of burnout. This result would be in the same vein that those of Sánchez-Oliva et *al.* (2014). In that sense, coaches must be careful about the support of autonomy, competence, and relatedness because sometimes athlete who has a high level of burnout stops his activity.

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Keywords: Burnout, Coach, Emotional Intelligence, Mental Toughness, Multilevel Analysis

Effortless self-control in physical activity: the deleterious role of social identity threat

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Weight stigma is the social devaluation of individuals who are perceived to carry excess weight. One common form of weight stigma is social identity threat, a psychological state in which people are concerned that they will be devalued because of their social identity as an overweight person*1*. Several studies showed relations between this form of stigma and maladaptive behaviors in overweight people, such as physical activity (PA) avoidance*2*. We propose to extend this line of research by examining if social identity threat may be a barrier to PA, also in people who are concerned about their weight (independently from their real weight). In other words, in people who fear being stigmatized based on their weight. In addition, we will examine if this relationship is mediated by self-control, conceptualized as a set of effortful or effortless strategies that people use to resolve motivational conflicts between a proximal and a distal motivation*3*. This study focuses on an effortless strategy: the cognitive asymmetry process, which occurs when the activation of a proximal motivation (i.e., temptation) automatically activates the distal motivation (i.e., long-term goal), facilitating its adoption. Based on research showing that stereotypic concerns interfere with maintenance of task goals*4*, we hypothesized that activating social identity threat would inhibit the cognitive asymmetry process. Based on an a priori power analysis, 240 adult participants - concerned about their weight - were recruited. They were randomly assigned to the experimental condition, in which social identity threat was induced by asking them to read an article about the thinness standard, or to the control condition, in which the article dealt with an irrelevant social identity (i.e., elderly people)*5*. Next participants performed a lexical decision task, to assess cognitive asymmetry. This task measures the cognitive accessibility of a goal (e.g., being physically active) following the subliminal

*Speaker

presentation of words that represent temptations likely to interfere with this specific goal (e.g., sedentary behaviors), by asking participants to indicate if the letter string presented is a word or not. Cognitive asymmetry was indexed by a shorter reaction time to detect a PA-related target word after a sedentary (SED) prime than after a neutral one. Data collection is coming to an end. We expect the cognitive asymmetry effect to be reduced in the experimental condition as compared to the control condition.

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Keywords: weight stigma, weight concerns, self control, physical activity, social identity threat

Analyse socio-technique d'un dispositif villeurbannais de prévention par l'activité physique adaptée

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Introduction

Depuis 2012, des dispositifs de " Sport-Santé sur ordonnance " (SSSO) ont vu le jour. Ils utilisent la prescription d'activité physique aux personnes vivant avec une maladie chronique à des fins de santé. Né à Strasbourg le SSSO se diffuse par la suite dans d'autres collectivités françaises. Si les travaux menés sur ces actions montrent bien leur caractère " innovant " (Gasparini & Knobé, 2015 ; Marsault, 2017), notamment en ce qu'elles supposent l'articulation d'acteurs qui jusqu'ici s'ignoraient, l'étude de la construction et de l'évolution du réseau qui soutient cette innovation mérite encore d'être approfondie.

Nous nous proposons à travers cette communication d'analyser un " moment " de la trajectoire de l'innovation *via* l'analyse de la dynamique de son réseau en utilisant le cadre de la théorie de l'acteur-réseau et de l'analyse sociotechnique (Akrich et al., 2006). Ce dernier, quoiqu'utilisé pour étudier l'engagement d'acteurs dans la construction d'une politique sportive fédérale (Viollet et al., 2020), est très peu investi dans l'étude des politiques d'activité physique à visée de santé. Selon ce cadre : échecs et réussites, acteurs humains et non-humains sont analysables de manière symétrique et offrent une compréhension fine du social. Ces structures réticulaires se construisent et s'étendent à travers des opérations de traduction, c'est-à-dire de problématisation, d'intéressement et d'enrôlement d'acteurs nouveaux (Callon, 1986).

Méthodes

Nous nous appuierons sur le cas du dispositif " En forme sur ordonnance " de la ville de Villeurbanne. La méthodologie utilisée consiste en des observations participantes au sein de réunions de pilotage et de mise en œuvre du dispositif et de réunions du Groupe de Travail SSSO du Réseau Français des Villes-Santé de l'OMS. Un ensemble de 52 entretiens semi-directifs, réalisés auprès d'élus et d'agents de la Ville de Villeurbanne, de médecins généralistes partenaires du dispositif et de certains bénéficiaires ainsi qu'une analyse documentaire (ordonnance, livrets de suivi, compte-rendu de réunions, fiches-actions) viennent compléter le recueil. Une analyse thématique des données permettra de repérer les processus à l'œuvre dans l'intéressement et l'enrôlement d'acteurs hétérogènes.

Résultats et discussion

Nous verrons ainsi que le réseau local qui soutient le dispositif EFSO prend appui sur des articulations d'acteurs réalisées lors de dispositifs plus anciens destinés à d'autres publics. L'analyse

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menée nous permettra d'appréhender les processus à l'œuvre dans l'enrôlement d'acteurs nouveaux nécessaire pour une extension et une solidification du réseau. Si les médecins généralistes sont érigés en porte d'entrée unique du dispositif, nous verrons que leur enrôlement n'ira toutefois pas de soi et demandera des dispositifs d'intéressement particulier qui nécessiteront l'entrée d'autres acteurs dans le réseau de l'innovation. Les professionnels de l'APA par exemple participeront à la transformation de l'intervention en AP en local et par la même à celle du réseau de l'innovation. Ces derniers en proposant une intervention éducative différente des ETAPS classiques présents au sein des villes, visent, dans le cadre d'un projet individualisé, au développement de ressources bio-psycho-sociales à des fins de pérennisation de la pratique physique.

Keywords: innovation, Sport Santé sur Ordonnance, Activité Physique Adaptée, analyse sociotechnique

Physical Commitment Increases Adherence to Salient Descriptive Norms and Values

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Sports and physical activities (SPA) are at the heart of national and international educational guidelines (e.g., UNESCO, 2015). Beyond this political position, the processes which can explain the supposed capacity of SPA to educate are not well understood. We propose that the physical commitment that are inherent to SPA induce contexts of threat. According to models of social regulation in front of threat (e.g., TMT, Greenberg et al., 1986), threatening climates generate adherence to salient social norms, which are essential to educational success. Our study aims to demonstrate that physical commitment in SPA are associated with increased adherence to salient norms, and particularly pro-environmental ones.
139 pupils from aged 12 to 16 (M age = 14,04; 57% girls) filled a questionnaire measuring several values, including pro-environmental norms, two weeks before the experiment (Schwartz et al., 2003). This questionnaire was a diagnostic measure of pro-environmental values and offered a cover story to manipulate the salience of the descriptive norm. The day of the experiment, the participants were randomly assigned to a 2 (norm salience: pro-environmental vs anti-discrimination) x 2 (physical commitment: none vs strong) factorial design. We made one descriptive norm salient by individually giving graphic figures indicating percentages of school pupils' responses to the value questionnaire (Gabarrot et al., 2009). Then, students randomly performed a cognitive (no physical commitment) or a climbing (strong physical commitment) task before completing the same value questionnaire and as well as another questionnaire measuring behavioral intentions to participate in pro-environmental school activities (Smith et al., 2007) and perceived emotional states during the task (PANAS, Watson et al., 1988).

The strong physical commitment condition effectively induced more perception of threat, F (1, 135)= 37.15; $p <$ .001; η2p = 0.22; CI 95% = [-2.32, -1.18] and the repeated measures ANOVA on pro-environmental values revealed a significant time*salience interaction, F (1, 135)= 10.28; p = .002; ηp2 = 0.07, confirming the norm salience manipulation. The analysis also validated the hypothesized time*salience*physical commitment interaction, F (1, 135)= 4.63; p = .033; ηp2 = 0.03. When the pro-environmental norm is salient, strong physical commitment increases adherence to this norm. Contrary to our expectations, no significant effect was found on pro-environmental behavioral intentions ($p >$ .088).

Our study is the first to identify that physical commitment in SPA improves adherence to salient descriptive norms. Even if no modification of behavioral intentions was observed, these results offer new explanations about the promotion of SPA in educational guidelines. Further studies should replicate these results and better identify the underlying processes of this effect.

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Keywords: physical commitment, norm adherence, socialization, sports and physical education, values

Sports media and audiovisual technique: media coverage of video assistant refereeing during the 2018 and 2019 football World Cups

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Introduction
As globally observed in sport, football association is at the forefront of the massive expansion of digital techniques, based on the computerized quantification of reality and on the reduction of uncertainties. The media rhetoric prefers not to deal with the complexity of the referee's responsibility, and calls for more justice in football association thanks to the digital aids to refereeing, such as the Video Assistant Referee (VAR) and the Goal Line Technology (GLT). This talk examines how audiovisual assistance to football referees is covered in the journal *L'Équipe* during the two latest editions of the FIFA World Cup (in Russia, 2018 for men and in France, 2019 for women), the first ones in which the VAR was allowed. Our aim is to assess if the information produced by *L'Équipe* on the issue is responsable, complete, independent and pluralistic. Our scientific framework is at the crossroads of a sociology attached to sociodiscursive analysis and of a communicational perspective. This study shows that media discourse has evolved, rhetoric has been very supportive of VAR. Now they are more skeptical arguments. Our hypothesis? The VAR has solved some problems, but it poses new problems for referess. Journalists have difficulty in transcribing this difficulty.

Method
The journalistic monitoring software (Europresse ®) that included "VAR" and "World Cup" occurrences identified 31 articles in 2018. The 2019 women's edition was less covered by the newspaper which resulted in a slightly lower number of occurrences (28). The analysis focuses on the speeches and on their evolution in order to understand the rhetoric employed by the journalists of *L'Équipe*. The socio-discursive study of their social responsibility focuses on the games of actors and arguments, on which journalists rely to construct their judgments that reveal pivotal themes or recurring arguments. In addition, a research internship was conducted at the Clairefontaine National Football Center with the French Elite referees (June 2021). Interviews were conducted with referees and journalists.

Results and discussion
Although favorable at first, the judgment of *L'Équipe* toward the VAR gradually shifted after the device had several hiccups and raised controversies. At the end of the two studies World

*Speaker

Cups, we note that the newspaper is moving from a position favorable toward the VAR in 2018 to a more critical discourse in 2019. In doing so, the newspaper spreads the statements of more alternative media broadcasters and develops a more philosophical critique. However, from 2018 to 2019, the articles do not address the heart of the issue: a digital technique brings a rationalization that is assumed to be objective, whereas football refeering remains a highly subjective activity. The referees appreciate this dimension.

Conclusion
Given the growing controversy surrounding the massive and refined use of the VAR during the 2020-2021 season, it is difficult to predict the future trajectory of this technical innovation. However, the current debates within the IFAB seem to predict more digital tools for referees.

Main Reference
Desfontaine, P., Borel-Hänni, F., Wille, F. (2021). Sports media and audiovisual technique: media coverage of video assistant refereeing during the 2018 and 2019 football World Cups. *Revue STAPS*.

Keywords: VAR, Football, Responsibility, Controversy, Technical, L'Équipe, Television

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Digital Sciences and Technologies

Can we predict the internal load (perceived exertion) from the external load (GPS) with machine learning?

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Introduction
Machine learning methods have already highlighted the potential relationships between external and internal load indicators in soccer 1,2. In addition, several studies have investigated the relationship between internal and external load data in different team sports using linear analyses, among others 3,4,5,6. All analysis were done at the group level and for each player. The first objective of this work was to study the correlation between subjective internal load data collected with the rating of perceived exertion scale in session (s-RPE) and objective external load assessed with GPS and integrated inertial sensors. The second objective was to explain internal load from the external load dataset with a particular focus on the acceleration-related PlayerLoad™ variable, a hypothetical indicator of mechanical load 7.

Methods
Thirty-one players (age: 23.4± 4.2 years; height: 180.7± 6 cm; body mass: 77.4± 6.8 kg) from the same French Ligue 2 team were observed during 151 training sessions, 38 matches including 28 Domino's Ligue 2 matches, 1 League Cup match and 3 French Cup matches and 6 preparation matches during the 2019-2018 season. External load variables (88 in total, 58 derived from GPS and 30 from accelerometer, Optimeye S5, Catapult Innovation, 10 Hz) and internal load (derived from s-RPE) were collected for each observation. After computing all correlation at the whole and for each player, predictive models (linear, kNN, Decision Trees, Random Forest) were compared and interpreted.

Results and discussion
The first observation is that the main correlations with s-RPE are not necessarily obtained with acceleration variables. Indeed, covered distance and speed variables appear to have an important impact on s-RPE values prediction. Regarding players with offensives role, the internal load was mainly explained by acceleration whereas in players with defensives role, both covered distance and speed had higher importance for internal load prediction.

Conclusion
The resulting models' interpretation show that acceleration should be completed with speed and travelled distance in order to efficiently predict internal load. To do so, player roles have to be taken into account in order to compute personalized external load.

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Keywords: machine learning, load, gps, soccer

Assessment of two weekly training models of tactical periodization in professional rugby union players via wearable technology.

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Introduction
Tactical periodization (TP) presents a new concept of integrating the tactical, technical, physiological, and psychological elements of preparation, even expanded to rugby training [1]. So far, however, sports science literature still questions if tactical periodization can be endorsed as a scientifically validated approach to planning. As of today, no original experiments have been conducted or properly tested on TP [2]. Therefore, the goal of the present study was to (i) monitor weekly workload (2WL) variation with two types of weekly training models (specific endurance and specific speed) which represent the main tactical periodization principles, and (ii) identify the validity of TP in a professional rugby union environment.

Methods
42 professional (Pro D2 championship) male rugby players participated in this study. Data was collected for 12 weeks (6 weeks using the specific endurance model and 6 weeks using the specific speed model) of training sessions and competitive matches. The external workload was monitored using 10 Hz Global Positioning Systems (GPS) and Global Navigation Satellite System (GLONASS) technology (Vector X7, Catapult Sports®, Australia). The variables selected for analysis during the ball-in-play (BiP) time were total distance (TD), high-speed running (HSR), sprint running distance (SR), very high-speed running distance (VHSR), average velocity (AV), repeated high-intensity efforts (RHIE), number of accelerations (ACC) and acceleration distance (ACCDIS). A total of 33 training bouts and 12 matches were analysed.

Results
During training sessions, our preliminary results indicate that players realized significantly higher TD (3980.81 ± 54.37 m, ES = 0.29, p = 0.006), HSR (732.08 ± 24.32, ES = 0.37, p = 0.001), SR (166.95 ± 10.52 m, ES = 0.23, p = 0.27) and AV (75.72 ± 1.09 m·min-1, ES = 0.28, p

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= 0.009) when using the specific endurance model than with the specific stamina model (TD: 3772.26± 53.06 m; HSR: 616.63 ± 22.81 m; SR: 135.17 ± 9.76 m and AV: 71.48 ± 1.21 m·min-1) . Similarly, during competition, the 2WL displayed significant differences between the two models for TD (ES = 0.27, p = 0.02), HSR (ES = 0.33, p < 0.001), SR (ES = 0.20, p = 0.21) and VHSR (ES = 0.19, p = 0.029). No differences were found when analysing RHIE, ACC, and ACCDIS with the two models. Finally, team performance has been optimized with the use of tactical periodisation as it achieved their highest ever ranking of the last five seasons.

Conclusion

These results revealed that the weekly training model, when guided by tactical periodization, is an acceptable modality to help coordinate long-term planning during the professional season. The specific endurance model illustrates a higher total 2WL than the specific stamina model. Tactical periodization, as a holistic approach, can be applied in rugby union and lead to successful performances.

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Keywords: Tactical periodization, rugby union, professional sports training, GPS, workload

Visual tracking assessment in a soccer-specific virtual environment: a web-based study

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Introduction

Allocating attentional resources among several sources of information on the field is a common but complex activity for the soccer player. Dynamic visual attention has been studied in laboratory with the Multiple-Object-Tracking task, in which participants had to track for several seconds a subset of target objects that randomly move through a space shared by distractors of identical shape and color [1]. The relation between sport expertise and tracking performance has only been studied with generic stimuli. However, specific knowledge and perceptual mechanisms developed through sports practice might help participants to efficiently distribute their attentional resources when facing familiar visual stimuli [2]. The main objective of this study is to examine how soccer-specific stimuli influence tracking performance of participants with different sport practice. We hypothesize that tracking would be facilitated for soccer players when facing soccer-specific stimuli. To this end we developed a virtual environment in which participants have to track virtual players from a viewpoint on the soccer field.

Method

Participants had to track 4 targets on a screen for 10 seconds over 15 trials in a structured visual condition (virtual players move as in real game), nd ove
15 trials in an unstructured visual condition (players move in pseudo-random direction at constant speed). Depending on their regular sport practice, participants were divided into a soccer group (n=18), a team sport group (handball or rugby, n=17) or a non-team sport group (n=17). Because of the 2020 lockdown, the experiment was carried out at home via a dedicated web site.

Results and discussion

A mixed ANOVA (3 groups X 2 visual conditions) on tracking performance reveals only a significant effect on visual condition but no group effect and neither interaction effect. Surprisingly, even if soccer and other team players are involved in activity with high tracking demands, they do not seem to rely on higher dynamic visual attention. Regarding our expectation, we failed to see an advantage of soccer players compared to team sport players when facing soccer specific stimuli. Using soccer-specific trajectories might not be sufficient to replicate on-field settings in which soccer players have to dynamically distribute their attention.

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Conclusion
Contrary to our assumption, these early results regarding the use of domain-specific stimuli in a visual tracking task shows that the ability to dynamically distribute attention might not be facilitated for soccer players when facing soccer-specific stimuli in a web-based experiment. However before claiming any strong conclusions, this investigation should be completed under more controlled, representative and immersive conditions through the use of virtual reality. If visual attention was indeed influenced by the stimulus specificity, this would support the use of domain-specific scenarios for reliable assessment and training.

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Keywords: visual attention, visual tracking task, virtual environment, soccer

Effects of an 8-week lockdown due to Covid-19 on training habits, stress, fatigue and sleep habits in trail runners

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Introduction
The Covid-19 pandemic prompted numerous governments to impose severe restrictions, limiting the ability to participate in exercise and sport training, especially outdoors. It has been shown that the imposed measures affected the exercise habits of the general population1 and the training habits of elite athletes2. The aim of our study was to characterize the impact of the French lockdown (LD) on the training load, self-perceived stress, fatigue, heart rate variability (HRV) and sleeping habits of trail runners.

Methods
Data were recorded during 6 weeks Pre-LD, 8 weeks of LD and 6 weeks Post-LD in 56 recreational trail runners. The lockdown restricted outdoor exercise to a maximum of one hour once per day, and within a radius of 1 km of the residence. Data were collected using a phone application developed in our laboratory (Train-imm app). Participants reported training modality, duration and rate of perceived exertion after every training session, and these data were used to calculate training load using the session RPE method3. Sleep duration, self-perceived stress and fatigue data were collected once a week using a questionnaire within the app. HRV in the supine position upon waking up was collected using a different phone app (inCORPUS®) once a week.

Results and discussion
When compared to Pre-LD, training load decreased by 14% ($p < 0.001$) during LD due to a decrease in the duration of training sessions, especially for running and other endurance activities, possibly caused by the restrictions on outdoor exercise, and despite the increase in training frequency ($p < 0.001$) and the maintenance of training intensity. Training load increased Post-LD by 27% ($p < 0.001$) compared to LD due to longer session duration, despite decreased training frequency ($p < 0.001$). Running and other endurance activities (skiing and cycling) were the exercise modalities that showed the greatest increases in duration, probably due to fact that outdoor exercise was allowed again and athletes were allowed to travel to exercise in

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nature. Sleep duration increased by _˜20 min per night ($p < 0.001$) and fatigue decreased by 13% during LD ($p < 0.005$), while no effects were found on perceived fitness or stress. HRV tended to increase during LD. There was high interpersonal variability in the responses of stress, fatigue, and perceived fitness to the changes in lockdown status.

Conclusion
The French LD had important consequences on the training of trail runners, leading to decreased training load due to the reduction in training duration of endurance activities. Moreover, LD had a positive effect on sleep and fatigue, but no significant effects on stress or perceived fitness. After LD, trail runners increased their training load, mainly by increasing the types of activities that were most restricted during LD, such as long-duration endurance activities practiced outdoors.

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Keywords: Endurance training, trail running, Covid 19, phone application, training load, heart rate variability

Methodology for the induction of competitive stress during virtual reality trainings in shooting sports.

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Introduction

Among the many tools that can be used to implement mental preparation, there is a growing interest in the use of virtual environments (VEs) in the context of sport. In particular, there is a desire to strengthen the sensory-motor skills of athletes. Besides, stress management is a major issue in mental preparation and can be used to monitor sports performance. But despite the growing need to understand the stressors that can improve or degrade performances, only few works have recently started to address this issue.

The SportTrooper project, which began in 2020 in France, is a digital solution jointly conducted by onepoint, the CREPS of Bordeaux and the region Nouvelle Aquitaine. This solution, which aims to improve the management of stress in the course of high level shooters (10 meters) consists of:

- A VE corresponding to a curved screen dedicated to the display of a 360◦ video;
- Physiological sensors;
- A software interface.

The objective is to be able to generate competitive stress during trainings. It also helps monitoring mental preparation of athletes over the long term (particularly for the Paris 2024 Olympic Games).

Methods

We have carried out a psychophysiological study to test the relevance of our solution. 10 french high level shooters (6 women, 4 men) were recruited on a voluntary basis. Our hypotheses are:

- The VE produces stress on the shooter and each VR training level produce a significantly higher level of stress;
- The level of psychological stress collected in competition is equivalent to that collected in the last stage of our VR training.

To carry out the physiological measurements, we use heart rate and electrodermal response sensors (reference values are gathered on the morning of the experiment) and a thermal camera. We also evaluate the feelings of the athletes thanks to three psychological questionnaires [1] [2] [3].

The protocol consists of three sessions planned to last one and a half hours each: 1) Training without video in the VE, which is our control condition; 2) With a training video; 3) With a final video.

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Results and discussion
Due to the pandemic situation, experiments are still ongoing.
For analysing the results, we will distinguish reference and experimental situations in the VE and study variations between these two situations.
We will analyse RR intervals thanks to temporal and statistical analyses. We will also compare the means between the competition and training psychological questionnaires, using a Student's test.
A next step for this study will be to iterate this experiment and check whether in the long term (after six months of training) the SportTrooper solution has an impact on scores.

Conclusion
By reproducing stressful situations, we hypothesize that VE can induce changes at the psychophysiological level and thus provides a comprehensive mental preparation tool for the athlete, as well as supporting the work of the coach and sport psychologist.
Long-term objective of this study is improving athletes' performances through a habituation effect to competitive stress.

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Keywords: stress, virtual reality, sport, psychophysiology, competition

Cardiac indices as markers of the detection of cognitive fatigue during a continuous vigilance task

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Mental fatigue is described as a subjective feeling during and after doing a demanding cognitive task for a long time. As mental fatigue increases, one is less willing to stay engaged with the task, i.e., less motivated to continue performing the task, potentially leading to decreased performance. Different brain structures, including the prefrontal cortex and the reward circuit, have been described as playing a major role for maintaining performance in situation of mental fatigue [1].
In parallel, it has been argued that a functional network regulating both cognition and cardiac autonomic interactions can be identified. Heartbeat time series were thus used to capture emergent behavior of cognitive-autonomic network coordination in presence of cognitive fatigue. Recently, new markers, derived from nonlinear analyses of heartbeat time series were proposed to capture richer cognitive-autonomic interactions during a cognitive task [2], [3] as well as their degradation by stress induction [4].

In the present study, heartbeat time series were analyzed in association with psychological indices during a continuous vigilance task (CVT) to detect cognitive fatigue. Additionally, an unsupervised clustering analysis (k-nearest neighbor, KNN) was applied describe individual signatures.

Fifty-two volunteers (20.7 ± 2.9 years) participated in this study. After a resting phase, subjects performed CVT for 20 minutes on a computer. Reaction times (RT) were collected as well heartbeat time series thanks to ECG (AD Instruments). Each time series was analyzed in time (RMSSD), frequency (HF, LF) and nonlinear domains (refined composite multiscale entropy, RCMSE), Mental fatigue (Visual Analogic Scale) and the perceived workload (NASA TLX) were extracted from questionnaires completed before and after the task.

Perceived fatigue was significantly increased after CVT ($p < 0.001$) associated with an improved performance (decrease of RT between the first 10 minutes of CVT and the last one, $p < 0.001$)

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and a moderate perceived workload. RMSSD and HF power indices remained stable while LF power increased indicating a stability in the parasympathetic activity but an increase of the sympatho-vagal activity with fatigue. The entropy index decreased along CVT ($p< 0.01$), underlying alteration of complex interactions when subjects were exposed to fatigue. Clustering analysis identified three clusters comprising subjects with similar levels of fatigue and similar performance patterns but with different physiological signatures.

In conclusion the onset of cognitive fatigue could be interpreted from analyses of heartbeat time series, but may be not strictly explained by the same evolution in these physiological markers along the time. The use of connected tools could be used combined to the results of the present study to anticipate the alteration of cognitive and behavioral performances, linked to mental fatigue, in ecological situations.

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Keywords: Mental Fatigue, HRV, Entropy, Complexity

Adhesion to zoom classes and effects associated with physical activity of senior women in the Covid-19 pandemic

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Introduction
In Uruguay, with the pandemic situation due to the Sars-CoV-2 virus (Covid -19), in order to not only prevent among seniors a sedentary lifestyle and a reduction of functional capacity, but also to prevent falls, it was advised to adopt an exercise routine to stay active at home, respecting the rules of social distancing, through the virtual plateform "Zoom".Once the initial mistrust from seniors in the use of numerical devices is passed, they are quickly favoured by the social and cultural interactions and by this renewed autonomy.

Objective
The study aims to know the seniors' level of adhesion to physical exercise when using numerical devices, in a twelve months period throughout the Covid-19 pandemic in Uruguay, and the associated factors.

Methodology
Descriptive-longitudinal study of seniors who perform physical activity through the zoom platform and WhatsApp groups (WA) - 12 months. Variables: Stress, Anxiety, Pain, Motivation: Online type self-report Adapted Physical Self-Concept (CAF) questionnaire, linkert-type response format (never, almost never, occasionally, almost always, always). Adhesion to the zoom classes: zoom session record. Analysis by the statistical program PAST and the Scipy.stats module of Python version 3.8

Discussion
Despite the fact that they will continue the classes, 3.5% of the women suffered falls during the program, and 31,4% had perceived sensations of pain. Although the majority had participated in the program, and all were integrated into the WA groups, almost half had no motivation, and this could be related to the pandemic situation. There is an association between the anxiety, the stress and the age of the participants, X2= 030.0543; -p (0.0001). There is an association between age and adhesion of the participants, X2 = 6.532; -p (0.0382).

Conclusion
The WA group were a source of social interactions that greatly favored integration into the program . In addition, once the initial resistance to the unknown was overcome by the participants, the zoom classes became an growing source of investment, which even brought better health benefits.

Keywords: Senior, Covid, 19, Physical exercise, Virtual plateform, Adhesion

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Beating Roger Federer: Ball's trajectory production using a bio-inspired solution

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Sport's experts can anticipate the arrival point of a moving object from information about the object's position, velocity and direction [1]. Vision plays a main role in the anticipation process. In this study, we used a bio-inspired system artificial vision system composed by an event-based sensors [2] and a multi-layer spiking neural network trained with a bio-inspired spike-timing-dependent plasticity learning rule [3], [4]. These systems can process spatio-temporal data in real time, and are highly energy efficient [4]. We showed that neurons learn from repeated and correlated spatio-temporal patterns in an unsupervised way and become selective to motion features, such as direction and speed. This motion selectivity can then be used to predict ball trajectory by adding a simple read-out layer composed of polynomial regressions, and trained in a supervised manner.

Our objective was to test the accuracy of this setup in predicting the arrival point of the ball under various presentation times. A ballistic trajectory is constrained by physical laws, and based on these regularities. Likewise, we wanted to test if our network is able to anticipate the arrival point of the ball based on a snapshot of the trajectory, like sport experts do on the field, for example [5]. If after learning, neurons code for precise directions and speeds, it should be possible to accurately predict where the ball will fall from the SNN responses.

Our setup allows neurons to become selective to motion patterns such as the ball's direction or speed. This selectivity is reliable to predict ball trajectories with fine precision. Prediction's error was low even with a small part of the trajectory presented and decreases with time presentation. Results were then compared with humans. We have shown that our system performs better than humans, whatever the time presentation, and uses a different approach to make prediction.

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Bio-inspired solutions such as the one used in our study are good candidates to analyze and predict motion. They also allow processing motion information in real-time and with low resource consumption when embedded in a neuromorphic chip.

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Keywords: motion selectivity, SNN, ball trajectory prediction, STDP, unsupervised learning, spiking camera

Daily life monitoring post stroke: accelerometric references in healthy

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Introduction
After a stroke, two thirds of patients underuse their paretic upper limb, even though clinical evaluations indicate that they can use it. To better understand what patients really do in daily life, it is possible to quantify the overall amount of activity and the use-ratio between both UL with wrist worn accelerometers (Lang et al., 2017). However, to date, this approach stays silent about the nature of UL activities, even though this information is crucial for therapeutic decisions. Here, our long-term goal is to individualize home-based post-stroke rehabilitation based on continuous accelerometric monitoring and artificial intelligence methods to estimate the nature and amount of functional UL movements in daily life. We adopt a three-steps process: 1○ define accelerometric references in healthy people, 2○ define patient specific accelerometric profiles and 3○ individualize of the nature and dose of rehabilitation based on 1 and 2.
Objective: Here, we address step 1: to provide reference accelerometric profiles for typical daily life movements among healthy volunteers.

Methods
100 participants representative of age categories of the French post-stroke population (74 years) participate in a single testing session. They are asked to perform series of movements that were selected as representative of the evolution of UL function in chronic post-stroke. During the session, each participant is filmed and equipped with an accelerometer bracelet on both wrists. Movement's series are performed twice, with 2 min rest between series. To help synchronizing recording devices and facilitate data segmentation, participants clap their hands once at the beginning and twice at the end of each movement.

Results
A preliminary analysis of the first 20 patients revealed that some indicators are more useful to correctly classify a movement. The moments of the distribution of acceleration in the time domain (e.g., mean acceleration) are likely less informative than indicators in the frequency domain (e.g., mean frequency). The most informative indicators seems related to pattern recognition (e.g., histograms of oriented gradients).

Discussion
We expect that including more participants will provide enough information to adequately recognize each movement or, at least, to define more global classes (e.g., walking upstairs or downstairs

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is walking stairs). In a second time, we expect to extract relevant markers of the movement from this labelled database. Therefore, after inclusion of the entire sample, it might be possible to predict the nature of certain movements in daily life.

Conclusion

The results could allow us to complete the quantitative assessment approach with a more qualitative approach. After this study, it will be essential to try to recognize those labelled movements during a longer period of home recording with healthy subjects. Then, we will be able to consider adapting the method to a post-stroke population. A better understanding of the evolution of the quantity and nature of the movements in post-stroke daily life could improve rehabilitation programs, patients' quality of life and reduce the cost for the health system.

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Keywords: accelerometer, daily life movements, database, qualitative evaluation

Design and methods of the COMON Project : how to promote physical activity and cognitive stimulation through numerical support in Huntington's disease ?

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Huntington's disease (HD) is a rare and inherited neurodegenerative disease. It is defined by motor disturbances such as chorea, decline of cognitive capacities and psychiatric symptoms. The COMON (Cognition, Motricité, Numérique) Project unites professionals of adapted physical activity, neuropsychology, cognitive psychology and numerical engineering to develop a new approach to contest HD symptoms. Prior studies showed benefits of physical activity (PA) on motor disorders3,6, walking3 and balance3,6. Cognitive stimulation (CS) can also have a positive impact, notably on executive functions2. However, synergic effects of PA and CS through a digital tool have not been studied, despite its proven interest in other neurological disorders1. The aim is to test the feasibility and effects of a synergic protocol of PA and CS through a digital support on disabilities of patients with symptomatic HD. This study will follow a crossover design. Thus an intervention group will complete the protocol with double stimulation while a control group will follow the usual care. After a first cycle, we'll switch group roles to allow all participants to receive the protocol . We expect to recruit about twenty participants with manifest HD at stage one and two. We will compare participant's scores at different evaluations (motor, cognitive, functional, quality of life) before and after a three month training (three sessions per week). A session consists of physical, cognitive and double-task exercises. It will be presented as a digital game with music or rhythmic auditory stimulation to enhance performances during physical exercises. Indeed, studies have found benefits of rhythmic stimulation on walking parameters5 and beneficial effects on symptoms of HD when digital tools are used3. Furthermore, improvement of PA by gamification has been proven4. COMON will determine if a digital and dual intervention is feasible and effective in such a population to counter the neurophysiological decline and limit the progression of HD. In the future, the project may serve

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as a model to improve the care of HD and also to develop protocols for similar neurodegenerative pathologies.

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Keywords: Physical activity, Cognitive stimulation, Numerical engineering, Huntington's disease

Effect of using modern technology on developing the mental perception of the tactical aspect of football players Case study of the Olympic Association of Chlef Team

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Introduction

The achievement of victory as a result of the competent coach efforts depends on the use of an assortment of scientific ways and methods, alongside the selection of the best ones thereof so as to raise the technical, mental, physical and tactical levels of his players.The sports predominance depends on the extent to which players benefit from their own mental abilities in such a way that is just as important as benefiting from their physical abilities... Indeed, it is the mental abilities that help mobilizing their abilities and their energies for achievement purpose of the maximum and best sports performance". (Mohamed Larabi Shamoun, 1996, p. 5)

Additionally, the study aimed to take in hand the role of modern technologies of the audio-visual media (video) in the sports training field, compared to the contemporary scientific standards alongside their impact on the mental perception of the football players' tactical part. Likewise, the domain of our study concentrates on the method adopted by the coach with his players in the audio-visual media during the training sessions, as well as his role in the mental and tactical development that a football player needs in order to bring to light his abilities in official competitions. In virtue of which, the problem posed was as follows:

What is the impact of video technology on developing the mental perception of the game plan during the training sessions – for Algerian football players?

Tools

We used through this study the experimental method due to its suitability with the type of research.

As for the research sample, we relied on a group of senior players for the Olympic Association of Chlef Team (First Professional League), whose number reaches 24 players.

Besides, we used two training programmes: A training program devoted for players, which is:

- The first session program: Withdraw of the defence and make a quick attack (going up to the attack and search for a free player).
- The second session program: Recover the ball and use the best option.

*Speaker

Results
The reached results were as follows:
- The use of modern audio-visual technologies (video) has a major role in developing the mental perception of the tactical aspect for football players.
- The associative relationship between the mental perception and the tactical aspect for the football player contributes in raising the player's effectiveness during the official competitions.
- Players' response to video means has revealed to be positive compared to the other classic media.

Discussions
The researchers attribute the reached findings to the effectiveness of the video in learning through presentation and replay; thus, clarifying the main points of the movements in a positive way that allows the learner to be a viewer and an actor at the same time. (Label. P, 1983, p. 202) The importance of mental perception in learning the physical skills is also reflected in: "The fact that the player uses the same neural pathways that are used when performing". (Mohamed Larabi Shamoun, 1996, p. 224)

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Keywords: modern technology, the mental perception, the tactical aspect, football players

Lasso machine learning method discriminates emotional movements

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Introduction
Emotion recognition is an indispensable social skill for humans throughout their lifetimes. The emotion-related disorders give a cardinal evidence for the essential weight of this skill in the daily quality of life. To this end, our understanding of how we are able to 'detect' emotions from the way someone moves remains incomplete. Emotions per se occur rarely in isolation from other people, yet most studies are conducted on individuals removed from the group setting. Here, we advocate for a more ecological approach by adopting the group context paradigm allowing for the emotions to arise during the naturalistic scenario such as human joint action. We present a first report on the adaptation of the group mirror game (Himberg et al., 2018) to study the entanglement of emotion and socio-motor interaction.

Method
Thirty-nine volunteers (21 females) that self-reported as enjoying dancing took part in the study (M=25.44, SD=5.69). Participants were randomly assigned to groups of three strangers, matched for the same sex and level of expertise. They performed a dance improvisation task, consisting of 33 trials of 30s duration each. After each trial, participants ranked the performance of each other and then provided with a manipulated feedback of this ranking: positive ("You were chosen the best") and negative ("You were chosen the worst"). We recorded the behavioral (9 Vicon motion capture markers), psychological (self-report) and physiological (ECG) components of socio-motor interaction.

Result and discussion
We generated a model that pinpoints movement features that contribute most to emotional movement distinction. The Lasso machine learning method is tailored to detect and eliminate a large number of redundant features. The capacity of this method to do sparse learning was successfully used on EEG signals (Caicedo-Acosta et al., 2019). The Lasso method differentiated (Accuracy 93%) positive, negative and neutral emotional movements through six features: head (22%) and hand orientation (13%), hand velocity in y (13%) and z (29%) directions, and hand quantity of motion (21%).

Conclusion
The accurate emotion identification deepens our understanding of emotional expressions in naturalistic settings and has significant applications in the health domain, specifically in therapeutic practice or with people suffering from socio-motor disorders (autism spectrum disorder, elderly).

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Moreover, with today's rapid technological advancements, emotion recognition methods can enrich digital environments used by people in their daily life (e.g., virtual workspaces). This study sets our research path forward towards understanding how emotions can propagate via body movements in the group.

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Keywords: mouvement, emotion, machine learning, lasso

Self-autonomous evaluation station and tailored training algorithm to improve quality of life and physical capacities in sedentary adults.

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Introduction

It is now widely accepted that physical activity significatively improves quality of life. Moreover, the expansion of the tertiary sector has hugely contributed to the increase in inactivity over the last decades. The World Health Organization has published some recommendations about physical activity, e.g. 30 minutes 5 times a week. In the clinical domain and in professional sport, the prescription of personalized training is more effective than non-tailored intervention. We hypothesize that an individualized training based on an objective evaluation in sedentary or slightly active people will be more beneficial for quality of life and fatigue than general recommendations

Methods

One hundred and thirty-five sedentary or faintly active employees will participate in 2 testing sessions on two separate visits. In each of them, we will build user profiles, evaluating endurance, strength, power, flexibility, strength endurance, coordination and stability on different self-made ergometers. Those ergometers have been developed from the sensors to the user interface in order to be operated independently of any investigator's intervention. Intra- and inter-day reliability of the ergometers are presented below.

The subjects will fill out six questionnaires about fatigue, stress, quality of life, pain, well-being and sleep.

Then they will be randomly separated in three different groups. All three groups will be instructed to perform 150 minutes of physical activity per week for 4 months:

- Group 1 (CLA) will follow the basic recommendations of physical activity of WHO;
- Group 2 (IND) will use an application providing a physical activity recommender system in order to individualize training, based on an algorithm that ranks training sessions w.r.t. user profiles previously built;
- Group 3 (ALE) will be given some physical activities randomly chosen.

In addition, the subjects will have to fill out again the six questionnaires each month.

*Speaker

Preliminary and expected results

5 out of the 6 tested ergometers (handgrip, flexibility, stability, hip ergometer – flexion and extension) have shown good to excellent intra-day reliability, with ICCs ranging from 0.879 to 0.968 meaning that we can do only one measure on those instruments, whereas for one of them (time reaction) we should perform more than one measure. Inter-day reliability was found to be excellent for 3 ergometers with ICCs ranging from 0.936 to 0.982. Work is currently performed to improve the inter-day reliability of the other 3 ergometers (ranging from 0.160 to 0.602).
The anticipated results are significant differences in the improvement of the subjective (i.e. quality of life and fatigue) and objective (i.e. physical capacities) outcomes between CLA and IND. Moreover, we expect some differences between the group IND and ALE.

Conclusion

This study will start in Sep 2021. The protocol is quite original since we will use only custom ergometers and a custom algorithm that will provide some personalized training sessions without any human intervention. The long-term goal is to make all the testing sessions 100% autonomous. For that purpose, comparisons between autonomous versus assisted assessments will have to be performed. If the autonomous evaluation station and the custom algorithm give reliable results, it would be then possible to test and optimize training of large populations at moderate costs. Overall, the present project has the potential to make a significant difference toward a more active lifestyle.

Keywords: physical activity, evaluation, seandentary behavior

Neuroscience - motor control

Can rhythmic abilities distinguish neurodevelopmental disorders?

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Introduction

The majority of people can easily track the beat of rhythmic auditory sequences (e.g., a metronome or music) and move along with it. There is evidence that these rhythmic abilities are impaired in children with neurodevelopmental disorders, such as developmental dyslexia, attention-deficit hyperactivity disorder (ADHD), and developmental coordination disorder (DCD). These rhythm impairments are shown with a variety of tasks and measurements, which may variably involve other more general cognitive functions, such as attention or executive functions. Thus, owing to this heterogeneity across tasks and measures, it is unclear whether rhythmic difficulties *per se* are characteristic of a specific disorder or rather the outcome of impaired cognitive functioning typical of that disorders. We hypothesized that profiles of rhythmic abilities exist that characterize specific neurodevelopmental disorders as compared to healthy children, above and beyond cognitive impairment.

Method

We analyzed data from a quite large group of children without musical training and with neurodevelopmental disorders (n = 90, 29 females; mean age = 9.7 years, SD = 1.6) collected across different studies. They were divided in four groups : Controls (n = 40), ADHD (n = 16), ADHD+DCD (n = 14), and Dyslexia (n = 20). All the participants underwent selected tests from the Battery for the Assessment of Auditory Sensorimotor and Timing Abilities (BAASTA, Dalla Bella et al., 2017). The tests were the beat alignment test, the unpaced tapping, the paced tapping to tones and to music and the adaptive task. We tested attention and executive

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functions for all the ADHD, ADHD+DCD and dyslexic children, and for 26 children (out of 40) in the control group with the Test of Everyday Attention for Children.

Results and discussion
The results first showed lower scores in tasks testing sustained attention and flexibility for all groups of children with neurodevelopmental disorders relative to the control group. Only the ADHD+DCD children presented lower inhibition score than control group. The performance in rhythm perception tasks did not discriminate ADHD and dyslexics (both outperformed by the control group). Yet, ADHD children had higher motor variability than children with dyslexia and controls, and poorer synchronization performance especially when ADHD have DCD comorbidity. We examined predictors of neurodevelopmental disorders using logistic regression modeling, taking pairs of disorders as dependent variables. Interestingly, these analyses showed that the performance in rhythmic tasks is predictive of specific disorders, above and beyond the contribution of performance in cognitive tests.

Conclusion
The results confirm that both rhythmic and cognitive abilities are impaired in children with neurodevelopmental disorders. As expected, measures of rhythmic abilities, such as motor synchronization to a musical fragment or spontaneous motor tapping rate, were capable of distinguish specific neurodevelopmental disorders, on top of differences in cognitive abilities. This suggests that specific profiles of rhythm impairment, detected with rhythm perception or auditory-motor synchronization tasks, may coexist with impaired cognition in these disorders. This finding may spearhead innovative methods for identifying rhythmic profiles in children with neurodevelopmental disorders with the goal of individualizing a rhythm-based intervention.

Keywords: synchronization, rhythm, perceptual, sensorimotor, cognition

BeatWalk: personalized music-based gait rehabilitation in Parkinson's disease

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Introduction

Many studies in Parkinson's disease (PD), have reported the improvement gait with auditory cueing. Rhythmical auditory stimulations (RAS) would compensate for the deficit of self-initiated and self-paced movements timing due to basal ganglia dysfunction by acting as an alternative pacemaker. The coupled dynamical systems' approach provides a theoretical framework for predicting conditions which foster spontaneous entrainment. However individual responses to RAS fail to reveal systematic entrainment. We recently clarified the relation between the variability of patients' responsiveness to RAS and their rhythmical abilities (Cochen De Cock et al., 2018). To compensate for these individual differences, we developed an individualized approach adapting stimulations to patients' steps. We hypothesized that such interactivity would strengthen the coupling between listener's gait parameters and RAS, and demonstrated experimentally such benefits (Dotov et al., 2019). We designed a mobile application coupled with wearable sensors, BeatWalk, delivering individualized interactive musical stimulations for gait auto-rehabilitation at home. The goal of the present study was to evaluate the observance, safety, tolerance, usability and enjoyment of BeatWalk.

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Methods
Forty-five patients with PD complied to a one month, outdoor, gait rehabilitation program, using the BeatWalk application (30 min/day, 5 days/week). The music tempo was aligned in real time to patients' gait cadence while fostering an increase of +20% of patient's spontaneous cadence. Open label evaluation was based on BeatWalk use measures, questionnaires and a six-minute walk test.

Results
Patients used the application 78.8 % (±28.2) of the prescribed duration, and they mostly enjoyed it. The application was considered as "easy to use" by 75% of the patients. Pain, fatigue and falls were not increased by BeatWalk use. When using BeatWalk, patients reduced their fear of falling, and improved their quality of life (EQ5D 7.89 ± 1.42 vs. 7.59 ± 1.57, p=0.03). At the end of the program, they covered a longer distance during the six-minute walk test without musical stimulation (452.66 ± 75.39 m vs. 470.29 ± 60.11, p=0.01). Steps length and cadence were significantly increased compared to baseline.

Discussion
Walking regularly has beneficial effects on impairments, especially in gait, associated with PD. However, patients usually show reduced physical activity. Here we provide evidence that a 1-month intervention using the BeatWalk technology is safe and well tolerated. BeatWalk is easy to use in an ecological setting and enjoyable. High observance increases 'walk for exercise' duration. We also report promising preliminary results suggesting positive effects on gait parameters.

Conclusion
An individualized approach adapting musical stimulation to patients' gait prone to overcome individual differences is likely to provide a rewarding experience, increasing motivation to walk in PD.

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Keywords: auditory cueing, entrainment, music, beat tracking, rhythmical abilities, oscillators, wearable sensors, mobile application

Do Modality and Tempo of rhythmic stimuli influence sensorimotor synchronization in young adults?

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Introduction
Sensorimotor synchronization (SMS) to rhythmic stimuli is a natural human skill. In adults, accuracy and stability of SMS depend on several factors such as the modality of stimuli (Repp & Su, 2013). SMS is more stable with audio-visual compared to auditory or visual stimuli (Blais et al., 2015). It remains to know if this effect is affected by the to-be-produced tempo. We hypothesize a larger benefit of Congruent Audio-Visual (CAV) stimuli when the required tempo is close to the spontaneous motor tempo (_˜ 600ms, McAuley et al., 2006).

Methods
Actually, ten right-handed participants (age 23 ± 1 years), performed a SMS task by tapping on a button with their right thumb in synchrony with stimuli delivered for 3 trials in 12 conditions: 4 Modalities (CAV, Auditory A, Visual V, Incongruent Audio-Visual IAV) and 3 Tempi (500, 700, 900ms), presented in a pseudo-random order. Using circular analyses (Berens, 2009), we computed the mean angle (*theta*) and length (L) of the resultant vector. High *theta* and high L reflect high asynchrony and stability. Parametric or non-parametric statistics were performed on *theta* and L depending on normality and sphericity of data (significance level p=0.05).

Results
Firstly, the spontaneous motor tempo was 1123 ± 190ms. As regard to angle, the significant effect of Modality ($\chi^2 = 22.56$, $ddl = 3$, $p = 0.0000$) revealed lower asynchrony for CAV and A. Significant Modality x Tempo interaction ($F(6, 54) = 6.598$, $p = 0.0000$, $\eta^2 p = 0.423$) revealed lower asynchrony in IAV for the 900ms Tempo. As regard to length, significant effect of Modality ($\chi^2 = 9.96$, $ddl = 3$, $p = 0.0189$) revealed higher stability for A and CAV. Significant effect of Tempo ($F(2, 18) = 54.229$, $p = 0.0000$, $\eta^2 p = 0.858$) revealed higher stability for 900ms. Significant Modality x Tempo interaction ($\chi^2 = 60.569$, $ddl = 11$, $p = 0.0000$) revealed higher stability for CAV but only for the 900ms.

Discussion
Present study aimed at confirming the benefit of CAV on SMS and testing if this benefit is larger when the required tempo is near the spontaneous tempo. In line with results of Blais et

*Speaker

al. (2015), CAV and A provide most accurate and stable SMS. CAV but not IAV led to anticipation, suggesting that the temporal congruency of the auditory and visual rhythmic stimuli is mandatory for multisensory integration. Benefit was larger for CAV and IAV when the required tempo was 900ms.

Conclusion
These preliminary results highlight that audio-visual stimuli seem to potentiate SMS in young adults when the required tempo is near the preferred spontaneous tempo (900ms). Complementary EEG correlates will be presented.

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Keywords: tapping, multisensory integration, stability, asynchrony

Locomotor-Respiratory-Coupling translates into flexible breathing rhythm and stable cadence

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Introduction
The coupling between ventilation and locomotion ensures that the former sustains the latter. If the mechanical coupling is constrained by body kinematics in quadrupeds, bipedal locomotion has released both functions from their tight mechanical links. Locomotor-respiratory coupling (LRC) has nevertheless been reported in humans. Mechanical and neural interactions ensure phase locking of running and breathing. The LRC has been hypothesized to minimize the cost of transport but this influence is still debated in the literature. In two experiments, we explored the effects of LRCmanipulation on cost of transport (COT) during running in humans.

Methods
According to the theory of coupled oscillators, manipulating the frequency of one oscillator changes the oscillation frequency of the second. In a first experiment, we tested the validity of this assumption, applied to the locomotor and respiratory systems. 15 participants were included. After determining the first ventilatory threshold, locomotor (*FPpref*) and respiratory (*FRpref*) preferred frequencies, subjects ran with the instruction to change their step frequency *FP* or *FR* respiratory rate in synchrony with rhythmic auditory stimulation at *FPpref* ± 5% and ± 10% or *FRpref* ± 10% and ± 20%.In a second experiment, we studied the potential influence of the phase shift between locomotor and respiratory events on COT. We hypothesized a decrease of COT when the peaks of the centre of mass acceleration occurred at the end of inspiration and exhalation. LRC phase, kinematic and physiological variables were measured on 22 subjects who run at their preferential speed.

Results
In the first experiment, a unique optimal locomotor frequency and an optimal breathing frequencies interval were observed. The manipulation of *FP* did not result in the change of *FR* and vice versa. In the second experiment participants always maintained an optimal phase relation between the peak acceleration of the centre of mass and respiratory cycles. This robust coupling between both systems maintained constant the COT.

*Speaker

Discussion
The flexibility of the respiratory system allows the existence several optimal frequency ratios between locomotor and respiratory rates. The lack of frequency entrainment between both systems appears to be in contradiction with the strong coupling observed.

Conclusion
Breathing appears to be flexible, with the same level of efficiency noticed for a large range of frequencies. Runners are more prone to modulate their breathing than their kinematic tempo. The present data provide new insights into the dynamics of physiological rhythms and are discussed within the framework of sports performance and auditory feedback.

Keywords: Breathing, kinematics, VO2, energy

Interpersonal synchronization: Discrete correction of asynchronies vs complexity matching

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Introduction
Interpersonal synchronization represents a major topic of scientific investigation, for accounting for important coordination phenomena in sport, leisure, music activities, and also for rehabilitation purposes. Several models have been advocated for accounting for these processes. In this communication we contrast two hypotheses on synchronization: a discrete process of mutual correction of asynchronies, which belongs to the cognitivist tradition, and the complexity matching hypothesis (West et al., 2008), which emphasizes the effects of a global, multiscale coordination between systems.

Methods
We analyzed series recorded in various experimental situations (synchronized tapping, synchronized forearm oscillations, synchronized walking, walking in synchrony with an irregular metronome). Series were submitted to the Windowed Detrended Cross-Correlation analysis (Roume et al., 2018), a method that focuses on short-term synchronization process between systems.

Results
Results showed that in most cases, synchronization was dominated by discrete process of mutual correction of asynchronies. The only situation where complexity matching was unambiguously evidenced was side-by-side walking. Interestingly, walking in synchrony with an irregular metronome appeared also dominated by a discrete process of asynchrony correction.

Discussion
These results question the possibility for deriving a universal model of interpersonal synchronization. Asynchrony correction appears dominant in laboratory tasks, involving simple effectors movements (tapping or forearm oscillations). Complexity matching occurs in more natural situation, involving more global activities (walking). Finally complexity matching seems likely to occurs only when two complex, living systems, are in mutual adaptation.

*Speaker

Conclusion

We recently showed that the complexity matching effect could allow restoring complexity in deficient systems (Almurad et al., 2018 ; Ezzina et al., 2021). This result offered interesting perspectives, especially for preventing falls in elderly. The present results suggest strong limitations in the choice of tasks that could be used for such rehabilitation purposes. Further research efforts are necessary for a better understanding of the complexity matching effect in everyday life situations.

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Keywords: Interpersonal synchronization, asynchroniy correction, complexity matching, rehabilitation

Breathing rhythm shapes conscious access and the ability to guess

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At the threshold for conscious perception, the very same stimulus may or may not access consciousness, depending on the observer's cognitive state [1]. In such a context, subliminal information can be temporarily maintained in non-conscious working memory (WM), as evidenced by the ability to guess above chance level unseen stimuli features [2]. However, little is known about the influence of biological rhythms on the variability of conscious access and non-conscious WM. Building on recent findings highlighting the respiratory modulation of human cognition [3], we measured the breathing phase (inhalation vs exhalation) of thirty participants during a near-threshold Gabor orientation discrimination task [4]. Importantly, when the Gabor was not consciously perceived, observers were required to make a guess on its orientation. In addition, participants had to report as fast as possible by a button press pseudo-randomized occurrences (10% of trials) of a brief supraliminal white point. Reaction time on this parallel task was used as a measure of attention levels. Given the large interindividual variability in non-conscious WM, we used an unsupervised machine learning approach, together with classical signal detection theory, to dissociate the bad from the good guessers. For bad guessers (n=17), exhalation impaired conscious processing, as evidenced by lower perceptual awareness and longer reaction times in the parallel attentional task. In contrast, for good guessers (n=13), exhalation improved non-conscious WM. Taken together, these results suggest that the human brain prioritizes the conscious processing of external events during inhalation, while information perceived during exhalation is preferentially processed non-consciously.

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Keywords: breathing, consciousness, working memory

Assessing the integration of motor related components in Visuomotor Compatibility effect

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This study addressed the relation between the stimulus and the response when visuomotor compatibility effects are observed. We designed two experiments to test whether the integration of perceptive and motor components are underlying situations in which effects of compatibility are found between an object and a particular type of grasp. In experiment 1, participants were asked to perform a semantic categorization task on object pictures, using a foot pedal device. To trigger the presentation of the object picture, a grasp that could be compatible or incompatible with the object size had to be performed and held throughout the categorization task. Our prediction regarding the impact of the grasp compatibility on stimulus processing were confirmed by evidences of code occupation, which are clear-cut results in favor of a common coding of the perceptive and motor components. The procedure in experiment 2 was similar, except the grasp was no longer carried out while categorizing the stimuli; instead, releasing the grasp triggered the stimuli appearance, allowing measuring the time duration between the grasp and the presentation of the object picture. The same pattern of results observed in experiment 1 was found to decrease in experiment 2, as a function the temporal distance between the grasp and the processing of the object picture. Those results highlight the tight coupling between perceptive and motor components in visuomotor compatibility effects, which most likely result from a sensorimotor integration

Keywords: Visuomotor compatibility effect, Activation, Theory of event coding

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An insight into the effect of context in visuomotor compatibility through laterality, force, and behavioral immune system.

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Introduction
Nowadays, affordances (Gibson, 1979) usually refer to patterns of visuomotor associations in the brain: specific action components that are potentiated when seeing an object. Ideomotor theories suggest that action consequences can also be added to these associations(Shin, Proctor, & Capaldi, 2010). Furthermore, a broader impact of context on the activation of those visuomotor patterns has been shown in recent years (Borghi, 2018), through an effect of the task (e.g. compatibility effect disappeared when discriminating object' color instead of shape; Tipper, Paul, & Hayes, 2006); or the physical context (Wokke, Knot, Fouad, & Ridderinkhof, 2016). We present three studies enlarging previous work on the effect of context on visuomotor compatibility, by focusing on movement laterality, force, and behavioral immune system.

Method
In the first study (Michalland et al. 2019), we focused on the response times when facing prickly and soft objects while wearing gloves or not. By using a Simon paradigm, we assessed the impact of object type (prickly, neutral), action consequences (with gloves: neutral, without gloves: negative or neutral) and spatial relations between object's position and response hand on visuomotor compatibility.
In the second study (Michalland et al., in revision), we focused on the force exerted when facing objects with various weight and softness, thus looking at the fine-grained tuning between visual signals and motor commands.
In the third, ongoing study (Michalland et al., 2021), we focused on the response times when facing objects that may be a source of fomite infection, expecting the potential disease transmission to inhibit affordance activation through a (putative) behavioral immune system.

Results
In the first two studies, visuomotor compatibility varied depending on the laterality of response (left vs right hand). Firstly, as participants had to discriminate the color of the objects these results show that visuomotor compatibility effects can occur under those circumstances. Secondly, right hand responses constrained participants to consider more features of a situation than left hand responses (glove wearing, object position, prickly feature) but were more prompt to perform stereotyped movements which prevented to consider specific haptic features (weight and softness).
For the third study, data collection is currently ongoing.

*Speaker

Conclusion
Depending on the type of object, the action to be performed, and the measure used to assess individual's performance, the context (bodily and environmental) impact the force exerted, the simulated action consequences and the number of situational features taken into account, and thus both the motor and visual components of associations at the heart of visuomotor compatibility effects.

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Keywords: Visuomotor compatibility, laterality, force, affordance, context

The visuomotor effects of compatibility: a window into the size of the body schema

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Introduction

Considering the size of his own body (e.g., his hand) is of a primary relevance to properly interact with our surrounding environment (either in sport or in the case of digital technologies). Thus, our work brings on the body schema defined as the neurocognitive representation of the body (Blanke, 2012). Such schema would be mainly ground on a multimodal integration process weighting the visual, tactile, and proprioceptive signals coming from the body and would integrate information about the size of various body parts. Our goal was to present a new method relying on a peculiar visuomotor compatibility effect (Heurley et al., 2020) allowing to implicitly assess the size of the body schema of hands. The principle is to present pictures of objects that are either large of small (an apple vs. a strawberry) and according to the color in which objects were presented, participants have to press a large or small keypress. Our hypothesis is that when the size of the keypress and the size of the presented objects are compatible (e.g., both large), the response times should be faster compared to the non-compatible condition. This compatibility effect would suggest that the participant spontaneously assess the size of their own motor responses that we view as a window into the underlying structure of the body schema.

Method

Twenty-two participants (including 6 females and 21 right-handed; mage = 19.6 years; sage = 0.8) participated to this experiment. Participants was in front of a computer screen. Each trial started with a fixation cross followed by the picture of an object presented first in grayscale. Then, the objects were automatically colored in blue or orange. According to the color, the participants have to press as soon as they can a large or small switch with the palm or forefinger of their right hand, respectively. We used 4 large objects (apple, avocado, eggplant, pear) and 4 small objects (cherry, grape, hazelnut, strawberry). The experiment is composed of 144 trials.

Results and discussion

Response times (RTs) were analyzed with a repeated-measures ANOVA with the size of objects (large/small) and the size of switches (large/small) as within-subject variables. RTs of errors and below 200ms or above 1200ms (0,14% of the data) were discarded. The ANOVA revealed a significant interaction between the size of objects and responses, $F(1, 20) = 41.83$, $p < .001$, $= 0.68$. Mean RTs to press the large switch were shorter for large (453ms) than small objects (477ms), $F(1, 20) = 26.01$, $p < .001$, $= 0.57$. Conversely, RTs to press the small switch were shorter for small (409ms) than large objects (431ms), $F(1, 20) = 16.00$, $p < .001$, $= 0.44$. In line with our prediction, a compatibility effect occurs. This result suggests that the participants

*Speaker

spontaneously assess the "size" of their response. Accordingly, we will discuss the relevance of this experimental protocol to study the processes involved in the construction of the body schema, especially, the underlying multimodal integration process, under the light of existing literature on body schema (Ehrsson, 2020).

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Keywords: Body schema, Multimodal integration, Visuomotor compatibility effect, Hands

Visuomotor compatibility effect: a window into the neurocognitive processes underlying human movement

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The goal of this symposium is to present and discuss a major experimental effect allowing to study neurocognitive processes underlying the human movement: visuomotor compatibility effect. Simon and Rudell (1967) reported, in a computerized experimental protocol, a facilitation of specific motor responses based on peculiar elementary stimuli (i.e., the Simon effect). In the late 1990s, the interest for such kind of effect grew further thanks to the work of Tucker and Ellis (1998). These authors showed a visuomotor compatibility effect with graspable objects presented visually. For instance, participants' responses with the right and left hand were facilitated respectively following the perception of a picture of an object with a handle (e.g., a pan) directed toward the right or left, respectively. This effect would be due to the visual perception of affordances at the level of objects which would preferentially and automatically potentiate specific actions. A pan with the handle facing to the right, for example, would "afford" a grab with the right hand, facilitating the use of the right hand to press a switch. Since this work, and this interpretation in line with the ecological approach of perception (Gibson, 1979), a wide variety of visuomotor compatibility protocols have been used to highlight and finely analyze these automatisms.

This symposium will bring together works from STAPS, Psychology, Ergonomic, Neurosciences and Robotics to establish the state of art of current research on visuomotor compatibility effect. We will make a particular effort to highlight the relevance of this for physical activities and sports but also digital technologies as well as the clinical field. The work presented here will allow us to discuss about the neurocognitive processes at work during the visual perception and human motor actions. Thus, we will discuss the main opposition between two kinds of models: models that argue the use of a process that would simulate, at the neurocognitive level, the action usually associated with the object seen (e.g., Barsalou, 2008) vs. models arguing instead a coding process of objects according to a relevant spatial dimension in the task's context (Proctor & Miles, 2014). From this opposition, we will discuss about the interest of predictive models linking anticipation and multimodal integration of the sensory consequences of motor responses (e.g., Hommel et al., 2001) for explaining visuomotor compatibility effect.

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Keywords: Visuomotor compatibility effect, Simulation, Theory of event coding, Polarity

Stimulus-Response Compatibility Paradigm and Unmanned Aircraft Vehicle Systems

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Unmanned Aircraft Vehicles (UAV) are remoted aircrafts used by operators via ground control stations (GCS). The distance between the operators and the UAVs results in a significant loss of perceptive cues and perceptivo-motoric activities, compared with piloted aircrafts (Arrabito et al., 2013; McCarley & Wickens, 2005). One of the main challenges to improve GCSs efficiency is to increase the perceptive-motoric activity of the operators.
In this context, our study fits into the embodied and situated approach of human cognition and Human-Machine interaction. This approach focuses on perception, action and context, as the key elements in Human-Machine interaction (Proctor & Vu, 2006; 2009; 2010).
More specifically, we hypothesize that the Stimulus-Response Compatibility (SRC) paradigm (in particular the Simon effect; Simon & Rudell, 1976) applied to GCSs ergonomic design would improve the system efficiency in terms of performance, safety and mental workload.
To this end, we evaluated a standard apparatus of GCS without SRC *versus* new apparatuses of GCS applying SRC. 144 participants performed a dual task similar to real UAV's mission tasks (simultaneous target tracking and alarm processing). In accordance with our hypotheses, the results show that both the target tracking and the alarm processing performances were significantly better with the SRC apparatus. Furthermore, those results show that the mental workload were reduced thanks to the SRC apparatus.
Those results fit with the scientific literature which assigns many benefits to SRC application in ergonomics, such as response time, error rate and reduced mental workload (Proctor & Vu, 2006; 2009; 2010). More generally, we conclude that a GCS with SRC affords more safety, more efficiency and more comfort for operators.
Thanks to this study, an industrial UAV GCS have been prototyped and tested by operators. Beyond the benefits for UAVs missions, this prototyping showed that the SRC application in industrial design was easy and without additional costs.
This study also shows that the SRC must be systematically applied in aeronautics systems and in the industry in general.

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Keywords: Embodied and situated cognition, Human, Machine interaction, Unmanned Aircraft Vehicles, Ground Control Station, Stimulus, Response Compatibility.

Entropy and multifractality in heart rate dynamics as markers of specific brain-heart coordinations when adapting to cognitive tasks

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Recent works based on the neuro-visceral integration model [1] have underlined the potential of heart rate variability (HRV) dynamics to account for cognitive-emotional state. People exposed to a stressful environment or performing a cognitive demanding task exhibit adaptive coordination across brain-heart interconnections, spanning several scales of space and time. Non-invasive measurement of HRV have been shown helpful in quantifying these complex interconnections. Our recent works [2] emphasize the added value of HRV entropy to follow up emotional reactions of subjects performing a cognitive task under mild stress. Another non-linear approach, multifractal dynamic computation of HRV reflects the adaptation of systems in response to a changing environment [3]. The aim of the present study was to associate HRV complexity to cognitive functioning of subjects exposed to specific cognitive tasks.

Methods
Thirty-six healthy volunteers (20 males, 16 females) were included in this study. After a quiet phase watching a movie (*Baseline*), they performed three randomized cognitive tasks (*GO-NoGO*(GNGT), *stop signal*(SST), *Stroop*(SCWT)), while HRV was recorded using a Polar H10 chest strap.
Non-linear HRV indices, refined composite multiscale entropy [4] and multiscale multifractal index [5] were computed with custom-designed algorithms (MATLAB) to reveal entropy and fractal properties of cardiac signals. HRV time series were also analyzed in temporal (RMSSD) and frequency (HF, LF) domains.

Results
While classical time and frequency domain indices failed to distinguish specific cognitive challenges, complexity indices add significant value for interpretative hypotheses.
HRV entropy was higher during SCWT task compared to *Baseline* ($p \leq 0.001$) and to other tasks, GNGT ($p \leq 0.05$) and SST ($p \leq 0.01$), which might indicate better coordinated brain-heart interconnections.

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A greater multifractality at specific observational scales during SST task, (*Baseline* ($p \leq 0.05$), GNGT task ($p \leq 0.01$)) suggests a different restructuration of central networks.

Discussion

Entropy and multifractal markers may distinctively reflect adaptive cognitive architecture, as illustrated by the specific executive functions associated with our experimental cognitive tasks. The present results comfort the idea that non-linear HRV indices are helpful in follow-up of athletes and might extend to patients to distinguish disturbed psycho-emotional and cognitive states.

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Keywords: biosignals, cognition, complexity, entropy, fractality, HRV

Multifractal hand dynamics as a marker of motor control adaptation during a visuomotor virtual reality task in sport students

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Visuomotor performances are usually studied through the lens of component-dominant interactions. However, more recent conceptions are concerned with considering the cognitive system as an interaction-dominant one. More specifically, multiplicative interactions across scales may support effective adaptation in executive control, which is reflected in the multifractal spectrum of movement behaviour [1,2]. Here, we observed multifractality in hand trajectories during a visuomotor task in virtual reality, and contribute to the body of evidence proposing multifractal dynamics as a marker of adaptation.

The visuomotor VR-based task (VMVR) - derived from the Dynavision test - consists in hitting as quickly as possible targets/buttons spatially arranged around concentric circles on a vertical board (120x120cm). Buttons are successively lit up after being reached by the hand-held VR controllers. 59 subjects (31 women) participated in a procedure consisting in two similar (test-retest) one-minute runs repeated under four gradually challenging modes. '*Lower Visual Field (LVF)*' and '*Upper Visual Field (UVF)*' means that only upper-half and lower-half buttons respectively could light up, and in *'Standard'* any button could light up. *'Cognitive'* requires reciting 5-digit numbers displayed every 5s in the centre of the board while keeping hitting targets.

The virtual environment was displayed in a HTC Vive headset. During all conditions head and hand movements were tracked at 90 Hz. Multifractality of the 3D hand-displacement series was computed with focus-based multifractal-DFA, for dominant and non-dominant hands distinctively.

Visuomotor performance decreased with task difficulty ($LVF > UVF > Standard > Cognitive$), while the multifractal spectrum widened in a specific manner. Multifractality in *Standard* and *Cognitive* conditions was higher than in *UVF* and *LVF*. For the non-dominant hand only, multifractality was higher in *UVF* than in *LVF*. However, multifractality did not increase in *Cognitive* condition, due to a large heterogeneity demonstrating singular individual adaptation. These modifications in multifractal behaviour suggest that constraints imposed by the visual search field provoke adaptation in executive control for both hands, and that greater adaptation is needed for the non-dominant hand when shifting attention from lower to upper visual search field. This last point underlines the added value of multifractal formalism to finely explore motor-control [2]. Lastly, the absence of multifractal differences between *Standard* and

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Cognitive conditions – despite degraded performances in the last – may arise from difference in individual strategies to meet the new constraint.
In conclusion, hand movements during a visuomotor task show multifractal dynamics, which may reflect subtle adaptation in motor control when facing new constraints [2]. Virtual reality proves to be an interesting tool to control perceptual stimuli *via* the headset display and infer neurophysiological adaptations. Besides, built-in hand and head tracking makes the scientific approach cost effective, thus offering interesting perspectives for neurotraining in health and disease.

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Keywords: Multifractality, Virtual Reality, Executive control, Adaptation

Assessment of human movement complexity: toward a gold standard task and a new way of using fractal analyses

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Fractal temporal processes have been widely investigated in human movement sciences. From heart inter-beat intervals to step timing in walking task, the finding of fractal time patterns in movements was considered as the characteristic signature of healthy/young individuals, with specific alterations with aging and disease. Thus, the estimation of fractal exponent became a major concern, especially for rehabilitation purposes. However, only few studies have focused on the comparison of fractal exponents in individuals executing two different tasks, and none in our knowledge on three or more tasks. So, to enrich the literature, we propose a comparative study in which participants performed six tasks six tasks being known to generate fractal fluctuations and involving a priori different timing processes: walking, tapping, Fitts reciprocal tapping, reaction time, unimanual oscillations and bimanual oscillations. Furthermore, some recent improvements in fractal analysis methods notably the possibility of reducing the size of the time series while keeping a satisfactory level of precision, authorized us to rethink the way of using these tools. We propose a new approach of fractal analysis, analyzing the series through a sliding window, to track the changes of fractal exponent during the execution of the tasks. This new method allowed us not only to highlight an initial drift that appeared in all tasks, but also to show that tapping, Fitts reciprocal tapping, unimanual and individual hands in bimanual oscillations tasks share the same fractal exponent evolution dynamics. Finally, the classical fractal estimation methodology is not to be outdone since we evidenced in the one hand that the discrete relative phase measured in bimanual task does not allow to appropriately express the fractal exponent, and on the other hand, that walking is the task that allows the most stable and the best expression of complexity (with fluctuations close to $1/f$ noise). This last result suggests that complex tasks such as walking must be considered as a gold standard in the evaluation of fractal index in human movement.

Keywords: Fractals, Complexity, Walking, Whittle likelihood, Dynamic scaling

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Innovative Virtual Reality method to assess the influence of a blur in boxing anticipation.

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Introduction

For more than two decades, sport scientists have investigated the contribution of perceptual-cognitive skills such as anticipation, attention and decision-making to expertise, and thereby expert performance. It is now well accepted that experienced/skilled are better at anticipating an opponent's movement and consequently make earlier and more appropriate decisions. In addition, they can achieve higher levels of performance based on less information. Compared to novices, overall performance of experts is better when the environment is impoverished, thus indicating that the experts' ability to extract basic kinematic information is more resistant to visual stimuli deterioration. Somewhat counterintuitively, several studies shown that perceptual and perceptual-motor behaviour does not deteriorate [2], or can even be improved [1], when the visual stimulus is artificially blurred by the experimenter. The explanation is that the blur manipulation removes high-spatial, low-temporal frequencies in the visual stimulus that can act as distractors (e.g., deceptive gaze direction), but preserves low-spatial, high temporal visual information on motion and player position. Several studies worked on the use of blur to improve perception, anticipation and decision-making. Often, the largest improvements were found in novice and/or less skilled participants. However, it seems there is less evidence for a positive impact of blur on performance of experts, and even a negative effect in some studies and particular tasks [2].

Methods

We designed a Virtual Reality boxing environment to assess the impact of blur in an ecological approach. The participants (boxers from leisure to expert level) were equipped with HTC Vive Eye Pro and hands trackers, and had to block the coming blows from a virtual boxer. We manipulated the visual stimuli by applying a gaze contingency blur, in peripheral or central vision. 12 sequences of 3 punches were created. In control block, no blur was applied. Within the blur condition, 2 blocks of 36 sequences were presented per condition, with 3 blur intensities (low, medium, and strong blur). In the moving window condition, a mask blurred the peripheral information, that is, only a circle of 5○ around the fixation point was clear. On contrary, in the moving mask, the central information was blurred 5○ around the fixation point and clear in periphery.

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Preliminary results and discussion
Two participants participated so far. The overall performance was 31.02% of blocked punch success. The mean performance in moving mask condition was 37.96% of success, 28.24% in moving window condition and 23.46 in control condition. In blurred condition, when facing low blur, the success rate was 35.07%, 34.72% when facing medium blur and 29.51% when the blur was strong.

Conclusion
We developed an innovative method to assess the effect of blur on anticipation in boxing in a realistic task. The potential facilitator effect on performance in central blur still need to be confirmed with a larger population.

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Keywords: Virtual reality, perceptivo, motor skills, blur, gaze behaviour, boxing

Evolution of static and dynamic field dependence following virtual immersion

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Introduction

Field dependence (FD) has long been considered as an unchanging perceptive style contributing to orientation perception [1]. However, studies have shown that exposure to disruptive visual cues induces adaptative postural responses [2]. These findings are interpreted as a mark of sensory reweighting, causing a decrease in the contribution of visual cues. To this day, this assumption remains to be confirmed. Therefore, the aim of this study was to verify the existence of a reweighing of visual cues following virtual immersion (VI), known to induce sensory discordance between visual and other inertial cues, using FD measuring tests. We also investigated the link between the level of induced cybersickness, the initial FD level and the expected decrease of FD.

Materials and methods

Forty-five seated participants (mean age: 22.1±1.7; 17 women) equipped with a Virtual Reality headset were exposed to a nauseating marine virtual environment. Each minute, they were asked to indicate their discomfort state using the Fast Motion Sickness Scale (FMS) ranging from 0 (no discomfort) to 20 (extreme discomfort). VI was discontinued after 14 minutes, or if their FMS score reached 16.

The Simulator Sickness Questionnaire (SSQ) was immediately carried out after VI ended. In addition, each participant performed virtual field dependence tests before and after VI. During these tests, their head was vertically maintained by a chin rest, and they were asked to roll-adjust an initially tilted rod to the direction of gravity. The rod was placed either in a 18deg roll-tilted frame (Rod and Frame Test – RFT) or in a 30deg/s roll-moving dot scenery (Rod and Disc Test – RDT). Signed angular errors between objective and subjective gravity direction were measured.

Statistical analyses were led using non-parametric tests. For RFT and RDT separately, the differences in angular errors before (pre) vs. after (post) VI were assessed. Furthermore, Lowess fitting models were used to explain the evolution of angular errors (FDevol) from pre-VI angular errors (FDpre), SSQ score and VI duration.

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Results
Results revealed a significant decrease in angular errors after VI for both RFT (Medpre=4.44deg ; Medpost=4.42deg ; V=727 ; $p< 0.01$) and RDT (Medpre=5.35deg ; Medpost=4.02deg ; V=801; $p< 0.01$). Moreover, Lowess fitting models significantly explained the decreases in angular error (RFT: R^2=0.45 ; $p< 0.01$ – RDT : R^2=0.50 ; $p< 0.001$). Decomposition indicated FDevol is significantly explained by FDpre for both tasks ($ps< 0.001$), and by SSQ score for RFT only ($p< 0.01$).

Discussion
Virtual immersion produces a FD decrease of both static and dynamic cues. These findings seem to confirm the reweighing of visual cues in geocentric perception following exposure to disruptive visual cues. For both static and dynamic cues, this reweighing depends on the initial level of FD, but not on the duration of VI. The level of cybersickness contributes to the reweighing of static visual cues only. In an attempt to understand the absence of contribution of cybersickness level to the reweighing of dynamic cues, we speculate that the system stops to consider them as they are irrelevant. These visual reweighings highlight an evolution in perceptive style, which may impact postural adjustments during [2] and after VI. Further studies are needed to assess (1) the persistence of this phenomenon, (2) its postural consequences, and (3) whether it could benefit people with high falling risk.

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Keywords: Field dependence, Visual cues, Sensory re, weighting, Cybersickness, Virtual Reality

Validity and reliability of video analysis for ankle proprioceptive reintegration during postural control.

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Introduction
Central processing of ankle proprioception is crucial for balance control, sports performance and injury (1,2). Muscle vibration generates postural perturbations during upright standing by altering proprioceptive signals (3). This is a valid and reliable method for assessing sensory reweighting process during balance recovery (4). The ability to dynamically reintegrate proprioceptive signals after balance perturbation has been widely studied in various populations (5-8). However, expensive laboratory postural tools and complex parameters are required to objectify proprioceptive reintegration. In contrast, 2-dimensional (2D) video-based assessment techniques are inexpensive and easy-to-use in clinical practice to analyse various dynamic tasks (9). The aim of this study was therefore to assess the validity and reliability of 2D motion analysis system when evaluating proprioceptive reintegration of the ankle following balance disturbance by muscle vibration.

Methods
38 healthy individuals were subjected to triceps surae vibration while standing on a force plate (FP). Anterior earlobe displacement was recorded at vibration cessation using two-dimensional (2D) video analysis. Validity of this parameter was tested through correlation with center of pressure displacement (dCoP) recorded with the FP. Intra- and Inter-rater reliability were quantified by the intraclass correlation coefficient (ICC), change in the mean (CiM), standard error of measurement (SEM) and the minimal detectable change (MDC) of video analysis between three blinded examiners.

Results and Discussion
Earlobe displacement showed strong positive correlations with dCoP in the sagittal plane (r=0.82-0.94, $p<$ 0.001). ICC ranged from 0.99 to 1.00 and from 0.90 to 0.97 revealing excellent intra- and inter-rater reliability respectively. For intra-rater analysis, the CiM was 0.01cm, SEM was 0.27cm (95% CI:0.23-0.33) and 3.43% (95%CI=2.92-4.20) and the MDC was 0.74cm. For interrater reliability, the CiM ranged from -0.81 to 0.55cm, the SEM from 0.61 to 1.12cm and

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the MDC from 1.69 to 3.10cm. Assessment of the anterior shift of the earlobe using 2D video analysis in the sagittal plane is an acceptable, valid, and reliable method to evaluate postural recovery following muscle vibration

Conclusion
This simple method can further be used to assess the ability of the central nervous system to reintegrate proprioceptive signals from the ankle during upright standing. Further studies are needed to evaluate the accuracy of this parameter among symptomatic populations.

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Keywords: video analysis, reliability, sensory reweighting, ankle proprioception, vibration, posture

Can motor imagery compensate the fatigue induced by neuromuscular electrical stimulation ?

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Introduction
Motor imagery (MI) is the mental simulation of contraction without its corresponding motor output. On the contrary, neuromuscular electrical stimulation (NMES) is a muscle contraction evoked by an external electrical current without voluntary activation. Some studies reported that a combination of MI and NMES can induce an increase of cortico-spinal excitability as compared to one or the other modality used alone (Takahashi et al. 2019). However, MI and NMES alone showed opposite modulations on spinal excitability. For instance, Grosprêtre et al. (2019) have shown an increase of the spinal excitability following an acute training session of MI, while they reported a decrease of this excitability after an acute NMES training session inducing neuromuscular fatigue evidenced by decrease in maximal voluntary contraction (MVC) (Grosprêtre et al. 2018). Together, these opposite results question the modulation of spinal excitability when MI and ES are combined. The purpose of the present study was to assess the acute effects on MVC and spinal excitability of one training session of either MI, NMES or a combination of both.

Methods
Seven healthy subjects (age: 25.7 ± 3.8) participated in three experimental sessions targeting plantar flexor muscles: MI only, NMES only or NMES and MI performed simultaneously (MI+NMES). Each session consisted of 3 blocks of 20 contractions. Before and after each protocol, plantar flexors MVCs were performed. Rest spinal excitability was assessed by evoking H-reflexes of triceps surae muscles. The evoked force during NMES and NMES+MI session has also been measured as the total force-time integral (FTI) during all 60 contractions.

Results
Preliminary results showed no difference of FTI between NMES and MI+NMES. No changes were observed on MVC force from PRE to POST in MI+NMES, NMES and MI sessions, although a trend could be observed toward a decrease following NMES ($P = 0.06$). No changes were observed on soleus H-reflexes after MI and NMES session alone, while a slight decrease was observed during the MI+NMES session for the SOL ($P = 0.03$). H-reflex of the gastrocnemius medialis decrease after MI+NMES session ($P = 0.04$).

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Discussion
Despite no MI or NMES acute effect was observed on force and H-reflex, it seems that MI+NMES may induce a downward modulations of spinal excitability in absence of effect on MVC. Interestingly, our study showed a decrease of spinal excitability while the literature demonstrated an enhancement of cortico-spinal excitability (Takahashi et al. 2019). Therefore, these results reveal that spinal and cortical levels could be differently modulated after a combination of MI and NMES.

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Keywords: Triceps surae, H, reflex, motor imagery, neuromuscular electrical stimulation, neuromuscular fatigue, peripheral nerve electrical stimulation

Motor simulation and muscle strength development: characterization of corticomotor plasticity induced by motor imagery

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Introduction
Cerebral plasticity is the capacity of neurons to reorganize their connectivity in response to cognitive and behavioral demands. Practically, cerebral plasticity allows short-term modulation of strength performances through improved cortical gains over motor units. Covert motor strategies such as motor imagery (MI) and action observation (AO) are promising approaches to improve strength as well as to limit strength loss and prevent maladaptive plasticity (Ranganathan et al., 2004; Lebon et al., 2010; Di Rienzo et al., 2019). Covert motor stimulation can indeed promote experience-based cerebral plasticity. The main objective of this project is to extend current understandings of the specific neurophysiological processes underlying strength gains as a result of MI or AO interventions.

Methods
In a counterbalanced design involving three experimental conditions (AO, MI, and control) we recorded the total force, the electric brain potentials using electroencephalography (EEG) and the integrated electromyograms (*biceps brachii*, *triceps brachii*, *flexor carpi radialis* and *anterior deltoideus)* while participants (n = 20) performed 13 maximal isometric contractions of elbow flexor muscles against a force platform (10 s duration). During each one-minute inter-trial rest period, participants performed one of the three predetermined experimental condition: i) AO of the strength task performed by an expert athlete, ii) MI of the maximal isometric strength contraction using first-person visual and kinesthetic MI, and iii) AO of a video documentary about basketball shooting (Control).

Results
Psychometric ratings from self-report Likert scales revealed that participants experienced greater difficulty to complete the MI intervention compared to other conditions. In terms of total force, there was a main effect of conditions (η2p= .02, p=. 008). The *post-hoc* analysis revealed that both AO and MI outperformed the Control condition (p= .010, p= .0439, respectively).Muscle activation, indexed from principal component analysis of EMG signals (RMS filter), had an

*Speaker

overall greater predictive relationship on the total force produced during MI and AO than during Control (Figure 1). Cortical neural activity analyses are still ongoing, and will be presented during the congress.
Figure 1: Correlation between the second of EMG component and the total force across experimental conditions.

Conclusions
Present findings provide new insights to neurophysiological processes related with strength gains after covert motor stimulation. Our results showed an improvement in strength performance when MI and AO were administered during the inter-trial recovery periods of strength training sessions. Based on ongoing preliminary EEG data, muscle recruitment patterns suggest an effect of mental training on corticomotor plasticity, which may contribute to the optimization of training programs in sport and rehabilitation. Present findings should provide original insights on the neurophysiological mechanisms underlying priming effects of mental training on strength performance.

Keywords: corticomotor plasticity, force development, mental training

Influence of time-of-day on acquisition and consolidation processes following physical and mental practices

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Introduction

It is well-known that mental practice (i.e., the repetitive mental simulation of an action without any corresponding motor output) improves skill performance. While the time-of-day appears to be a determinant factor for the motor imagery capacity (Gueugneau & Papaxanthis, 2010), its influence on skill performance improvement remains unknown. The current study aimed to test the impact of time-of-day on acquisition (i.e., immediate training effects) and consolidation processes (i.e., passage of time/night of sleep effects) following physical and mental practices.

Method

We recruited 48 subjects, divided into four groups: two physical practice (PP) groups, trained in the morning (n=12) or in the afternoon (n=12),and two mental practice (MP) groups, trained in the morning (n=12) or in the afternoon (n=12). We scheduled the two-morning groups at 10 am and the two-afternoon groups at 3 pm, on two consecutive days (day 1: training day, day 2: re-test day). On day 1, we used a finger tapping task to measure the acquisition process (i.e., difference between the beginning and the end of physical/mental training). On day 2, we measured the consolidation process on the same task (i.e., difference between the end of training on day 1 and the performance on day 2). To assess the influence of the type of practice and the time-of-day on acquisition and consolidation processes, we conducted two rmANOVA (one for each process) with between-subject factors "Practice" (PP vs. MP) and "Time-of-day" (Morning vs. Afternoon). Finally, to analyze the absolute improvement performance, which corresponds to the gain between the initial level (before practice, on Day 1) and the final level (re-test, on Day 2), we performed a third rmANOVA with the same factors,.

Results and discussion

On day 1 (acquisition process), we observed a significant performance improvement following both practices, with a better gain following PP than MP (Practice effect), as classically observed in the literature (Ruffino et al., 2021), without any effect of the time-of-day.

On day 2 (consolidation process), we found a main effect of the Time-of-day, with a better consolidation for both afternoon groups (i.e., offline learning) compared to morning groups, without any Practice effect.

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Finally, all groups improved motor performance in comparison to their initial level. However, regarding the absolute improvement performance, we found better gains for the afternoon groups (Time-of-day effect), regardless of the type of practice (absence of Practice effect).

Conclusion

The current study highlighted the importance of the time-of-day for the consolidation process according to the training schedule. We suggest that physical or mental practice in the afternoon may be more relevant to potentiate the absolute training effects.

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Keywords: Motor imagery, motor learning, time, of, day, acquisition, consolidation

Beneficial effect of a combination of feedback, video observation and motor imagery on the performance of the swimming dive start

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Optimizing motor learning or performance is at the heart of the concerns of physical education teachers and coaches. Few works have focused on the diving swimming dive start, which consists of moving from a land to an aquatic environment generating perceptual (change of landmarks), psychological (affects) and physical (modified balance) constraints. In order to promote learning, coaches often use verbal feedback (FB). Likewise, they often use video Model Observation (MO) in particular (Clark & Ste-Marie) and mental imagery (MI) that consists in internally simulating a motor action. MI can be combined with MO and / or FB (Robin et al., 2020a, b) to optimize its effects. The purpose of this study was to evaluate the effects of a combination of FB, MO and MI on the performance of the swimming dive start in non-experts. We hypothesized that participants benefiting from MO and MI, in addition to the FB relating to actual trials previously performed, would obtain greater performances than those who benefited from a combination of FB plus MO or FB only (control condition).
One hundred and six student volunteers (Mage = 19.3) were randomly divided into 3 groups: Control, MO and MO + MI. The experimental procedure consisted of 3 phases spread over 6 sessions. During session 1 (pre-test) the participants made 5 swimming dive starts (filmed and timed) followed by a 25-meter swim. They then performed 4 sessions (acquisition phase) each comprising 8 x 25-meter swim with dive starts. All participants received verbal feedback (FB) every 2 trials, those in the MO group also received video from a peer model, and the MO + MI group imagined (3rd person perspective) performing a dive start after MO. Session 6 (post-test) was similar to the pre-test. The underwater distances times and speeds and the 25-meter swim times were used as dependent variables. The results (repeated measures ANOVAs) showed that all the participants improved their underwater speed. However, the performance of the control and MO groups, concerning the other dependent variables, remained stable between the pre- and post-tests. On the contrary, the participants of the MO + MI group significantly improved the underwater distance as well as the 25-meter swimtimes. These results confirm those of previous studies showing the beneficial effects of a combination of MI, MO and / or FB on performance (Robin et al., 2020a, b), especially when there is not a large number of trainning sessions. The lack of difference between the Control and MO groups, and the poor performance evolution of the latter raise questions about the need for a greater amount of practice to benefit from the effects of FB and / or MO, and on the choice of pair-skilled model whose effects could potentially be greater with self-modelled (Clark & Ste-Marie, 2007).

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Keywords: Motor imagery, action observation, feedback, performance, swimming dive start

Identification of EEG markers that reflect expertise in attentional focus and motor imagery: Heading for neurofeedback procedures to improve sport performance

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Elite athletes' expertise is characterised by the development of precise internal models including appropriate motor predictions, which contribute to improve movement precision and velocity [1]. This expertise is reflected by a neural efficiency that refers to more spatially localized or less intense brain activity patterns required to achieve peak performance [2]. We aim to enhance these optimisation abilities through an electroencephalography (EEG) neurofeedback-based cognitive training procedure. More specifically, we will target motor imagery (MI) and attentional focus (AF) abilities, which have been shown to impact significantly sport performance [3] and to be underlain by specific EEG pattern modulations, including sensorimotor rhythms (SMRs) [4]. MI is a "perception-like process in the absence of any external stimulus input" [5]. MI usually consists in the retrieval of past motor experiences from long term-memory to reproduce them mentally, without overt movement. MI and motor execution activate similar cortical networks and are reflected by akin EEG patterns including a desynchronisation of SMRs. Practically, there is ample evidence that combining MI with physical practice enables athletes to improve movement accuracy, speed and coordination [6]. Attention is a multimodal process including attentional orientation, as well as selective, divided and sustained attention. All are involved in sport training and performance. It has been demonstrated that AF is associated with SMR synchronisation [4]. MI and AF training procedures are limited by the difficulties in assessing performance in real-time. Indeed, these cognitive processes are mainly underlain by modulations of brain activity that cannot be directly perceived by the athletes or their staff. EEG-neurofeedback will allow us to overcome this limitation by providing athletes some feedback about their capacity to self-regulate the appropriate brain activity associated with MI and AF. A recent meta-analysis [7] reported a positive impact of EEG-neurofeedback on both athletes' performance and ability to modulate their brain activity. However, the authors pointed out methodological weaknesses to be overcome: i) the regular absence of a control group, ii) the small sample size in the studies, iii) the large variability in the neurophysiological markers (frequencies and localisations) used as targets for the neurofeedback training, and iv) the lack of theoretical and empirical groundtruth. We will focus on these two last aspects in our experiment, by uncovering specific markers of

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MI and AF that correlate with expertise. While measuring their EEG, we will ask experts in internal martial arts (e.g., Tai Chi Chuan) -who are also experts in MI and AF- and novices to perform specific movements (e.g., pinch, push and hit), MI and attentional tasks. With machine learning tools, we will identify specificities in EEG modulations that translate expertise. We will then use these patterns as markers for a future EEG-neurofeedback training protocol.

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Keywords: Neurofeedback, Attentional Focus, Motor Imagery, SMR, Tai Chi, Athletes

An electroencephalographic (EEG) study of attention allocation during dual task treadmill walking in young adults and children.

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Introduction

Automatic gait control is defined as the ability of the nervous system to successfully walk with minimal use of executive and attentional resources (Clark, 2015). Previous findings investigated the attentional cost of walking by using a dual task (DT) paradigm. This cost is more important in children than in adults because of motor and cognitive development (Schott, 2018). However, little is known about the neural correlates during DT walking in children (Sukar, 2021). In the current EEG study, event-related potentials (ERP) were used to explore the development of brain markers during DT walking.

Method

An auditory oddball task was performed by seventeen healthy young adults (24-29 years) and sixteen children (7-12 years) under two cognitive difficulties (easy or hard) and two motor tasks (sitting or walking on a treadmill at preferred speed). Participants were instructed to mentally count one (easy) or two (hard) predefined animal sounds out of four sounds. There were five conditions: Easy (ST1) and hard (ST2) cognitive simple tasks (ST) while sitting, walking simple task (STm), easy (DT1) and hard (DT2) DT when walking.

Gait data was recorded with six inertial measurement sensors. The cognitive performance was evaluated through the error score. ERPs were assessed through the P3a latency and maximum amplitude defined between 250 and 600ms after the stimuli around Fz.

A 2 groups (adults, children) x 2 cognitive tasks (easy, hard) x 2 motor tasks (sitting, walking) analysis of variance (ANOVA) with repeated measures on the last two factors was applied to cognitive and ERPs measures. A 2 groups (adults, children) x 3 cognitive tasks (none, easy, hard) ANOVA with repeated measures on the last factor was applied to gait variables.

Results

A significant main effect of group was found on most parameters. In children, the cognitive error ($F(1,33)=17.8$, $p< .001$), the coefficient of variability of stride time (CV) ($F(1,33)=22,2$,

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p< .001), and the P3a amplitude (F(1,33)=22.4, p< .001) were higher. No effect of group was found on the P3a latency.
There was a main effect of cognitive task, with an enhancement of error score (F(1,33)=17.2, p< .001) and P3a amplitude (F(1,33)=22.7, p< .001) under the hard cognitive task compared to the easy one. A significant main effect of motor task was found on P3a latency, with a later peak in the DT than ST (F(1,33)=22.9, p< .001).
A main effect of cognitive task was also found for the CV (F(2,6)=6.31, p=.032), with a lower variability in DT1 than STm for both groups.

Discussion and conclusion
Our results showed a lower gait variability in both groups under the easy cognitive DT compared to the walking simple task. Yamasaki (1991) suggested that minimal variability occurs at the comfortable speed, when gait is most efficient. This motor strategy was used by adults as well as children, likely indicating an adaptive mechanism to reduce task competition for cortical resources during easy DT walking (De Sanctis, 2014). Results also indicated that P3a latency was modified by the DT (Maidan, 2019). In addition, in both groups, the hard cognitive task led to lower error score and higher P3a amplitude with no effect on motor performance. Thus, our findings confirmed that P3a amplitude reflects the cognitive task complexity and attentional demands (Polich, 2004).
As expected, children showed an overall worse performance (higher error score and gait variability) and greater attentional demand with higher P3a amplitude than adults. To our knowledge, this study is the first to demonstrate age-related changes in neural markers during DT walking in children.

Keywords: EEG, gait, dual, task, attention, children

When mechanical engineering inspired from physiology improves postural-related somatosensory processes while standing on a moving surface

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Introduction
A challenge in motor control research is to understand the mechanisms underlying the transformation of sensory information into postural reaction when equilibrium is jeopardized by the displacement of the support under our feet. Being the first to be stimulated by this relative movement, the plantar skin receptors (i.e., mechanoreceptors) play an important role in disequilibrium. The relative motion of skin and underneath surface provides mechanical friction (i.e., shear forces) and induced vibrations that stimulate them. In this light, their stimulation most likely depends on the physical characteristics of the supporting surface. We hypothesized that a biomimetic surface complying with the characteristics of the mechanoreceptors and the skin dermatoglyphs would optimize their responses and facilitate the cortical processes associate with the somatosensory inputs involved in the control of equilibrium

Methods
15 subjects stood with the eyes closed on either a biomimetic, smooth or striated surface. We measured the amplitude of the cortical response (i.e., P1N1) extracted from EEG recordings following mechanical stimulation of the plantar sole (i.e., somatosensory-evoked potential) using a sudden but low amplitude (peak 0.05m.s-2) postural disturbance with the translation of the supporting surface. We reasoned that the amplitude of P1N1 measured over the leg somatosensory representation should be a key variable for comparing the amount of sensory inputs reaching the cortex. Presumably, when additional quality information is available to the CNS, postural responses to the perturbation should be improved.

Results and discussion
The amplitude of the SEP was greater on the biomimetic surface compared to the control surfaces ($F2.28 = 6.72$, $p=0.041$). This was likely due to a greater stimulation of the mechanoreceptors suggested by the greater shear forces triggered by the platform displacement with this surface ($F2.28 = 16.23$, $p=2.1*10\text{-}5$). However, the postural reaction (i.e., timing and amplitude) did not differ between the 3 surfaces. Moreover, EEG source localisation showed greater activation in the superior parietal lobule and in the extrastriate body area on the biomimetic surface. These regions are involved in body representation, sensorimotor integration, and action prepa-

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ration (1). By contrast, greater activation of the dorsolateral prefrontal and posterior cingulate cortices with the smooth and grooved surfaces, respectively, suggested greater cognitive control (2).
Therefore, adding a cognitive task should be less detrimental for the postural reaction when participants standing on a biomimetic surface. In a second experience with the same experimental set up we tested this suggestion, with an incrementally memory loading before the postural perturbation (n=16). Our preliminary results showed that the latency of the postural reaction was shorter with the cognitive task (F1.15=8.15, p=0.012), specifically for the biomimetic condition. Overall, our results can be interpreted in the framework of the beneficial effect of an external focus of attention on the movement performance (i.e., postural reaction). This allows more sensorimotor and efficient control solely when standing on a biomimetic surface.

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Keywords: EEG, balance control, cutaneous plantar inputs, mechanoreceptors, biomimetic surface, dermatoglyphs, attentional demand

Natural human postural oscillations enhance early and late ERPs associated with empathy for pain.

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Introduction
Affective neuroscience benefits from advances in virtual characters to investigate emotion communication. However, the genuineness of virtual characters needs to be further developed in order for them to trigger spontaneous emotional reaction in users and favor a natural interaction (Kegel et al., 2020). In this perspective, adding human-captured postural oscillations (biological idle motion) to a virtual character has been reported to increase the participants' self-reported empathic response to the character's facial pain expression (Treal et al., 2020). The present study aimed to examine what sub-processes of empathy might be specifically affected by the presence of idle motion, using electroencephalography. It was hypothesized that idle motion will influence event-related potentials (ERPs) associated with affective resonance (N2-N3) and perspective-taking (central and right late positive potential, cLPP, rLPP) (Sessa et al., 2014; Vaes et al., 2016).

Method
20 young adults (7 women, mean age = 23.1 ± 3.8 years) were presented video clips (duration = 1s) of a virtual character expressing a dynamic facial pain expression. The character was either animated with biological idle motion (idle condition) or without any body movement (still condition) (see Treal et al., 2020 for a similar method). Participants had to judge the pain intensity of the virtual character using a visual analog scale (2 conditions x 100 trials). Neural activity was recorded using 64 active electrodes (actiCAP slim, Brain Products). Three ERPs were analyzed: N2-N3 (FC1, FC2, FCz, C1, C2, Cz, 250-400 ms), cLPP (C1, C2, Cz, CP1, CP2, CPz, 600-1000 ms) and rLPP (C4, C6, CP4, CP6, 600-1000 ms). Paired t-tests were performed on behavioral and cerebral data between idle and still conditions.

Results
Results showed a significant influence of idle motion compared with the still condition on the participants' pain judgement ($t(19) = 3.23$; $p = .004$) as well as on the N2-N3 ($t(19) = -2.24$; p

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= .037) and rLPP (t(19) = 2.42; p = .026) cerebral responses. However, no significant effect of idle motion was found on the cLPP (t(19) = -1.11; p = .282).

Discussion

Results replicated previous findings showing an increase of the participants' perceived intensity of the virtual character's pain expression when its body was animated with idle motion. More importantly, idle motion influenced the early cerebral response associated with affective resonance (N2-N3), revealing an early integration of biological idle motion by the human brain. It also influenced the later response associated with perspective-taking (rLPP). Taking together, these results suggest that the use of idle motion increase the ability of participants to empathize with the virtual character. This demonstrates the importance of adding body motion when designing affective neuroscience paradigms to trigger a more spontaneous and genuine emotional interaction with participants.

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Keywords: Empathy for pain, Virtual character, Social neurosciences, Idle motion, EEG

The cerebral bases of street crossing decision

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How do Humans decide if they can cross a street? That is, how they estimate if the approaching car offers a time-to-contact (TTC) that allows a safe street-crossing? Previous studies have demonstrated that several optical cues specifying this TTC, or the car's distance (e.g., Lojois & Cavallo, 2007), contributed to this estimation.
The present study aims at unravelling the cerebral bases supporting this task. In the TTC perception domain, it has been shown that when the object approaches the observer, primary sensorimotor areas, the inferior parietal lobule, the ventral premotor cortex, and the supplementary motor area are engaged (Coull et al., 2008; Field & Wann, 2005). However, it remains unknown whether such activations reflect the TTC estimation process or rather the preparation/execution of the motor response it triggers. As pointed out by Vaidya et al. (2019), brain imaging methods (e.g., MRI or EEG) measure correlation between brain activity and behavior. As such, they should not be interpreted as a direct and causal demonstration of the brain areas that affect the behavior.

We here tested 15 patients before and during an awake brain surgery, during a brain tumor resection. The patients were presented videos of virtual car moving on a road, as they were positioned in front of a street to cross. The car could approach with a TTC varying between 2 to 6 s, at two different velocities, and performed 150 trials. From this pre-surgery condition, we computed the TTC value that allowed a 10% or a 90% gap acceptance rate. During the per-surgery condition, we presented these two gap values, for 4 repetitions per brain area, while various brain areas were stimulated, hence deactivated. We computed from the binomial probability what should be the theoretical acceptance rates for these two values to conclude on the potential role of the area.

The preliminary results shows the causal involvement of areas implying the left temporal lobe (superior and supramarginal gyri), frontal lobe (Broca area and superior gyrus) and the right superior parietal area. The results are congruent with a previous study (Baurès et al., 2021) even if they remain to be completed.

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Keywords: Brain area, awake brain surgey, street crossing decision, Time, To, Contact

Effects of Motor Speed on Frontal-Hemodynamic Responses in Whole-Body Movements

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Introduction

The speed of movements is of particular importance to perform an action efficiently over time. Over the past two decades, research in sport psychology found that self-paced movements were less physiologically, metabolically, and thermoregulatory challenging than enforced pace exercise of the same intensity (e.g., Alberty et al., 2008; Landeret al., 2009). Crucially, the cognitive cost of action production is also highly dependent on the pace of motor execution, with slow and fast movements requiring more attentional resources than close-to-spontaneous pace movements (Guérin et al., 2021a). A plausible hypothesis is that producing movement close to the spontaneous pace solicits less frontal brain activation. Yet, the brain mechanisms underlying the effect of motor tempo remains insufficiently documented, especially in the context of whole-body movements in which functional brain imaging is quite challenging. The aim of the proposed study will be to examine prefrontal and motor activity during the execution of whole-body movements varying in motor speed.

Methods

The a-priori sample size computation indicated that 14 participants (f = .52; α = .05; 1-β = .80; based on the fNIRS results from Guérin et al., 2021b) will be required to achieve sufficient statistical power. Participants will be asked to perform three tasks varying in ecological validity (i.e., circle drawing, steady-state cycle ergometry, steady-state walking). These tasks will be executed in sensorimotor synchronisation with fast (i.e., 300 ms), close-to-spontaneous (i.e., 600 ms), and slow paces (i.e., 1200 ms). Functional near-infrared spectroscopy (fNIRS) will be used to monitor brain activity of participants because of its high tolerance for motor artefacts (Leff et al., 2011). Behavioural performance and physiological parameters (i.e., heart and respiratory rates) will also be recorded.

Results

We hypothesise that producing movement close to the spontaneous pace should lead to less prefrontal and motor brain activation than fast and slow movements production. This effect should be magnified for daily movements (i.e., walking). In addition, the pattern of brain activity observed for spontaneous pace movements should be associated with better behavioural performance.

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Discussion
Results of the present study will shed light on the cerebral correlates underlying the motor facilitation effect specific to the spontaneous pace. In addition, we will confirm that fNIRS is an appropriate technique to investigate brain activation in whole-body movement paradigms.

Conclusion
Collectively, the findings ensuing from the proposed study will make a substantial contribution to the existing literature by disentangling the brain mechanisms involved in the timing of motor behaviours.

Keywords: fNIRS, sensorimotor synchronisation, motor timing, spontaneous pace, whole, body movements

Does virtual reality fool our brain only? Spinal excitability changes during a virtually simulated falling

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Introduction
Virtual Reality (VR) is known to induce important brain activations at the level of sensorimotor regions, particularly when participants can interact within their virtual environment (1). However, the question to which extent virtual reality can trigger the sensorimotor system, and more particularly if it can reach lower nervous levels such as the spinal system, remains open. Here, the aim was to assess whether VR simulation of postural challenging and stressful situations (Richie's Plank Experience) can interfere with spinal excitability of postural muscles.

Method
For this preliminary experiments, 8 healthy young participants were enrolled. To assess spinal excitability, H-reflexes of triceps surae muscles have been elicited through electrical nerve stimulation while participants were standing. Participants were equipped with VR headsets. VR set-up consisted in an urban environment in which participants evolved by walking and standing quiet were required. Participants went through several conditions and situations, during which stimulations were evoked: standing quiet out of VR (noVR), standing in VR at ground level on the street (groundVR), standing on the edge of a builduing (plankVR) and falling from the building (fallingVR). Myoelectrical activity of the triceps surae, body oscillation and head movements were measured throughout the experiment.

Results
No differences in head rotations and myoelectrical activity was found between conditions. While triceps surae Hreflex (soleus and gastrocnemius Hmax/Mmax) was not affected from noVR to groundVR, a tendency toward a decrease has been observed between noVR and plankVR. The most significant finding was a drastic decrease of Hreflex during falling (-47±26.9 % between noVR and fallingVR, p=0.015).

Discussion
The H-reflex is usually reduced during the aerial phase of drop jumps (2). The influence of vestibulo-spinal tract on the triceps surae H-reflex, a main actor of drop landing and balance, has been proposed. However, it has been reported that in quiet standing position such as during our protocol, postural oscillations were not sufficient to activate reflex modulation by the

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vestibular system (3). Then, in absence of significant head and body movement, vestibular information was not likely to modulate the spinal excitability during simulated falling.
On the contrary, visual feedback could have their importance in modulating the spinal excitability even in a quiet posture. A complex visual environment, for example, could also depress the amplitude of the H reflex (4). Here, the absence of difference between noVR and groundVR demonstrated that visual cues cannot solely explain these results.
Finally, spinal excitability is also reduced when standing on the edge of a raised platform, revealing that postural anxiety can lead to a reduction of H-reflex (5). In the present study, in absence of variation in afferent feedbacks from postural muscles (similar EMG activity among conditions) as well as in head rotations (no vestibular influence), such a decrease of spinal excitability during simulated falling might rather be attributed to inputs from the brain which responds to a situation of danger.

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Keywords: Virtual Reality, Neurophysiology, Spinal excitability

Adaptive processes applied to whole-body reaching movements in changing gravitational force fields.

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Pointing towards an emergency button in the International Space Station may not be critical for astronauts in microgravity, since recent studies revealed early and functional sensorimotor adaptation of reaching movements in weightlessness (Bringoux et al. 2020; Macaluso et al. 2016, 2017). However, after long-duration space missions, it remains unclear whether astronauts could deal with reloading when exposed to a novel gravitational force field.
Sensorimotor reorganization occurring during microgravity suggests that unloading is taken into account before movement onset. Precisely, dynamics of the novel gravitational context are updated in internal models of motor commands and their sensory consequences, allowing the central nervous system to generate scaled motor actions (Bringoux et al. 2020; Gaveau et al. 2016; Macaluso et al. 2017; Rousseau et al. 2016).

Strikingly however, adaptation to reloading may involve longer adaptive processes both on arm movements (Gaveau et al. 2016) and running (Sainton et al. 2015). While few studies investigating motor responses following hypergravity exposure revealed non-immediate adaptive processes on focal kinematics (Bock et al. 1992; Crevecoeur et al. 2009; Mierau et al. 2008), these adaptations were not directly compared to those occurring during weightlessness. Furthermore, these studies did not report postural and electromyographic (EMG) responses that might also underly focal adaptation (Casellato et al. 2012; Chomienne et al. 2021; Macaluso et al. 2017). Finally, to our knowledge, the effect of successive changes of the gravitational level affecting these motor responses has not been investigated yet.

Here, we investigated the effect of unloading and reloading on whole-body reaching movements performed by standing subjects during parabolic flights. Nine naïve participants were asked to reach as fast and as accuracy as possible a close target (Tclose) or a far target (Tfar) during alternated episodes of microgravity (0g), hypergravity (1.8g) and normogravity (1g). Reaching movements were analyzed regarding spatial accuracy, arm kinematics, postural strategies, and EMG activity of main postural and focal muscles.

Preliminary results show that participants accurately reached targets in 0g from the first trials, thus confirming early sensorimotor adaptation reported in previous studies (Bringoux et al. 2020; Casellato et al. 2012; Macaluso et al. 2017). In contrast, participants hardly reached the

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targets in 1.8g (undershoot $>$ 3 cm after 50 trials). Strikingly, compared to 1g observations, normalized arm kinematics and postural strategy were not modified by hypergravity exposure. Accordingly, EMG activity did not change significantly in 1.8g (while modified (pre-)activations of Tibialis Anterior and Biceps Femoris were found in 0g). Thus, contrasting with fast adaptive mechanisms governing functional motor responses in 0g, the preservation of a comparable motor organization in 1.8g relative to 1g might be at the expense of the goal-directed motor performance.

Overall, these preliminary data raised an important issue for motor control by highlighting distinct adaptive processes when being exposed or re-exposed to different gravitational fields.

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Keywords: motor control, microgravity, hypergravity, sensorimotor adaptation, whole body reaching movement

The haptic channel conjecture in physical interactions: A proof using tasks asymmetry and Granger – Geweke causality

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People often communicate and coordinate their behaviors using physical interactions. In a classic example two people cooperate to move a table in a room. Such coordination is mediated by interaction forces and haptic perception (4). However, the role of the "haptic channel" (3) remains elusive.
To unlock this issue, we designed a cooperative task which afforded a control of asymmetry between actors. In symmetric (N = 20) and asymmetric (N = 23) experiments we used Granger-Geweke causality (GGC) (2) to characterize the haptic exchanges between actors. This well-established method estimates the amount of influence of each actor onto the other based on Wiener's (5) prediction approach. Therein the past variation in process x is said to cause a variation in process y if including the evolution of x in a prediction model improves the prediction of the evolution of y. Later Geweke extended the approach to the frequency domain: parceling out Granger Causality (GC) in frequency bands, that is, the frequencies at which the influence takes place (1).

In both experiments dyads of participants had to move with one hand a sliding mobile reciprocally left and right, to point at spatial targets and synchronize with a periodic sound. Vision of the other was occluded and behavioral interaction was restricted to forces and haptic perception. We recorded (500Hz) mobile's position and each participant applied force using A/D card and custom programs.

In the symmetric experiment each participant had access to spatial and temporal cues, and was asked to perform both synchronizing and pointing tasks.

In the asymmetric experiment each participant had access only to one of the cues and were assigned *Synching* or *Pointing* goals accordingly. In the last trial the roles were swapped.

Data analysis included the estimation of performance indices for the synchronizing and pointing tasks.

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To ensure the robustness of our results we used parametric and non-parametric methods (1) to estimate GGC (2) and then GC in the time domain from its integral. Random permutations were used to test for significance ($P < .01$).

Performance indices showed that dyads manage to perform well in both tasks and experiments. Forces were similar between the dyads in the symmetric case, but in the asymmetric one the *Pointing* actor applied more force than the other.

We found that asymmetry in the division of labor induced a leader-follower cooperation, as defined in the GC framework, capturing an asymmetry of roles. The *Synching* actor was clearly leading, while the *Pointing* actor was following. This is particularly interesting as the later was producing larger force overall. Moreover the *Synching* actor's force displayed a faster fluctuation component, at which GGC showed causal influence was passed onto the partner, suggesting a regulation of the timing of the task at that faster frequency. Those results were kept when the participants roles were swapped.

Could this finding be a first clue to define the elusive "haptic channel" allowing haptic communication?

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Keywords: haptic, haptic interaction, physical interaction, coorperative task, haptic communication, granger causality, granger geweke causality

Hearing differently after vertical prism adaptation

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Introduction

The interest in prism adaptation was born at the end of the 19th century to investigate sensorimotor plasticity. The aftereffects are not restricted to sensorimotor level but extend to spatial cognition (e.g., Colent et al., 2000). Moreover, auditory pitch are spatially represented: low frequencies are associated with left and down sides of space, and high frequencies with right and up sides of space (e.g., Lidji et al., 2007). Recent studies observed aftereffects on auditory perception in healthy participants after adaptation to a leftward optical deviation (Bonnet et al., 2021; Michel et al., 2019). The vast majority of prism adaptation studies have focused on the horizontal dimension. Yet, in healthy humans, the spatial association of auditory frequencies is more spontaneous in the vertical dimension (Lidji et al., 2007). The current study aimed to investigate aftereffects of vertical prism adaptation on auditory perception.

Method

We included 24 right-handed, healthy and nonmusician participants. We used the classical open-loop pointing task to assess the sensorimotor aftereffects. Aftereffects on auditory perception were assessed by using the 'auditory interval bisection judgment' for one auditory interval (724 Hz – 1330 Hz). Participants had to orally indicate which limit of the auditory interval (low or high) a target frequency was closer to. The sensorimotor (i.e., open-loop pointing) and the cognitive (i.e., auditory interval bisection judgment) tasks were performed before and after adaptation to an upward optical deviation (UD) or downward optical deviation (DD). The open-loop pointing task and the adaptation procedure were carried out on a vertical touchscreen.

Results and discussion

First, participants showed an initial sensorimotor downward bias, which was exacerbated after adaptation to UD and reversed after adaptation to DD. These vertical sensorimotor aftereffects were symmetrical. Second, the initial auditory bias observed toward low frequencies confirmed pseudoneglect as previously shown (Bonnet et al., 2021; Michel et al., 2019). Finally, after adaptation to DD, this bias was shifted toward high frequencies. This asymmetrical aftereffect provides innovative data about representation of auditory perception and its modulation by vertical prism adaptation.

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Conclusion
The current study was the first demonstration of aftereffects on auditory perception after vertical prism adaptation to DD.

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Keywords: Prism adaptation, Sensorimotor plasticity, Auditory perception, Spatial representation

Optimal speed/accuracy in the tennis serve and golf swing

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Introduction

The aim of this study was to identify an optimum speed/accuracy in the execution of sporting actions in the tennis serve and in the golf swing. The relationship between speed and accuracy in the execution of a movement has been formalized by the work of Fitts (1954). This work showed an exchange function between speed and accuracy. However, sports expertise demonstrates the ability to perform actions that are both fast and accurate. A few studies suggest that there is an optimal zone for speed and accuracy around a movement speed of 88% of its maximum (Schmidt & Sherwood, 1982). It also appears that intensive practice leads to the development of performance in very specific execution conditions (Keetch et al., 2008). In this context, this study aims to identify the optimal execution conditions in the tennis serve and golf swing.

Methods

For both sports actions, the protocol was the same. After a 10-minute warm-up, an initial test was proposed with 10 strokes to be performed at maximum speed (measured with a radar for the ball for the tennis serve and for the club head for the golf swing). This test established the maximum reference speed.

The participants then performed six blocks of serves or swings at different percentages of this maximum speed in a random order: 70%, 76%, 82%, 88%, 94% and 100% with an intention of accuracy in relation to a target. For each condition, a margin of + or - 2.9% was given and the participants had to perform seven trials per condition.

Results and discussion

The results were similar in both actions. They showed a linear increase of the distance to the target with the speed of execution confirming Fitts' law (1954). At 88% of the maximum speed, the accuracy was higher than that predicted by the regression line (Figure 1). This result confirms the hypothesis of an optimum speed/accuracy located at this intensity and feeds the reflection and the understanding of the expertise in the control of the gesture.

Figure 1. Linear regression between the speed conditions and the distance to the target for the tennis serve on the left and the golf swing speed on the right. The black discs correspond to the measured values, the red discs to the values predicted by the regression line. The measured value in the 88% condition is significantly different from the predicted value.

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Keywords: motor control, Optimal speed/accuracy, expertise

Joint-specificity and lateralization of upper-limb proprioceptive perception

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Proprioception is the sense of position and movement of body segments based on receptors distributed all over the body. Little is known on how proprioception varies across different body parts. Some proprioceptive differences between joints and arms have been reported by using active and/or contralateral matching tasks. Overall, a better performance was found at the non-preferred arm (Roy and MacKenzie 1978; Goble et al. 2006; Goble and Brown 2007), and at the elbow compared to the wrist (Sevrez and Bourdin 2015; Li and Wu 2014). However, the role of motor commands in active tasks and the implication of contralateral sensory and motor systems precludes a pure assessment of proprioception. In this study we compared the proprioceptive acuity between the elbow and wrist joints of the preferred and non-preferred arms using an ipsilateral active matching task. We hypothesized that upper-limb proprioceptive acuity is better at the elbow and at the non-preferred arm.
Each joint was passively moved to a reference configuration, memorized by the participants, and then passively moved back and forth around it. During this passive mobilization, participants had to verbally report (eight responses) each time they detected that the current joint configuration matched the reference configuration. We used separate repeated measures ANOVAs to determine the main effects of the Joint, Laterality and Response as well as their interactions for the signed error (measure of directional bias) and the absolute error (measure of accuracy). Similarly, we investigated the main effects of the Joint and Laterality as well as their interactions for the variable signed error (variability of the signed error) and the variable absolute error (variability of the absolute error). We also used linear correlation analyses to determine the relationship of the participants' errors between the four conditions.

Results showed that variable signed errors at the non-preferred elbow were lower compared to the preferred elbow and both wrists ($F(1,6)=10.3$, $P=0.018$, $\eta 2=0.633$). Signed errors at the elbow were also more stable than at the wrist across the eight responses per condition ($F(7,42)=6.3$, $P< 0.001$, $\eta 2=0.511$). Across individuals, signed errors at the preferred and non-preferred elbows were correlated ($r=0.79$, $P=0.03$). Also, variable signed errors at the preferred and non-preferred wrist ($r=0.86$, $P=0.006$) and the preferred wrist and elbow ($r=0.83$, $P=0.01$) were correlated.

While correlations between proprioceptive errors suggest that an individual with a relatively good proprioception at one joint may have a good proprioception at another joint, our findings

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indicate that proprioception is better at the elbow and at the non-preferred limb. Thus, proprioception seems to vary across joints and limbs, suggesting that a single joint assessment does not allow for a general assessment of an individual's proprioception.

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Keywords: Proprioception, Kinesthesia, Position sense, Elbow, Wrist, Laterality

Benefits of observing point-light displays in postoperative rehabilitation of the total knee prosthesis.

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Introduction
The ability of human beings to recognize and interpret human movements was highlighted by the point-light display (PLD) paradigm (Johansson, 1973). This paradigm consisted of recording actions just from markers placed on their main joints (shoulders, elbows, wrists, hips, knees, ankles) and on the head. More later, some studies have shown that the observation of actions would have beneficial effects on the rehabilitation of patients suffering from central or peripheral motor disorders (see Sarasso et al., 2015 for a review). However, these studies used videos and not PLD rending difficult the study of mechanisms implied. The objective of the project was to confirm the interest and feasibility of observation of point-light display to improve the management of patients who have undergone total knee arthroplasty to treat symptomatic osteoarthritis.

Method
Patients who have undergone total knee arthroplasty (7-9 days after operation) were divided in two groups: the experimental and the control groups. Both groups made conventional therapy consisting of physiotherapy sessions twice a day every day during 3 weeks. The experimental group made also a visualization task consisting of observing and recognizing 12 point-light human actions (running, walking, etc.). This visualization task (about 5 minutes) has been made twice a session, three times a week for three weeks. We assessed functional motor abilities (the time and the score for the time up and go (TUG) test and the scores for the Western Ontario and McMaster University Osteoarthritis (WOMAC) test), perceptual abilities (percentage of recognition and detection of point-light human actions), and scores in self efficacy. All assessments have been done on the beginning and at the end of the programme (pre-test and post-test). Mixed ANOVAs were performed with group (control, experimental) as the between-subject factor and moment of the test (pre-test, post-test) as the within-subject factor.

Results
The preliminary analyses carried out on 23 participants (10 control and 13 experimental, mean of age: 62.9 years) show an improvement of performance after therapy for all tests ($p < .001$) except for the scores of self –efficacy where the difference between pre and post test was not significant ($F(1,21) = 3.01$; $p = .09$). Moreover, we observed an interaction between the group and

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the moment of the test on the WOMAC scores ($F(1,21)=4.59$; $p< .05$) and recognition of PLD ($F(1,21)= 15.21$; $p< .001$) suggesting that the improvement of performance in the experimental group is superior to the improvement of performance in the control group.

Conclusion

Although these results stay preliminary, they suggest that the observation of point-light human movements can increase the recovery of functional motor abilities in patients who have undergone total knee arthroplasty. Futures studies should confirm these results and explore the conditions (e.g., attentional focalisation or sex correspondence between the observer and the actor) that could optimise the beneficial effect.

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Keywords: Action observation, Point light display, rehabilitation, knee surgery.

Life Sciences - Physiology, Biomechanics

Conditions socio-environnementales de préparation sportive des médaillés et non médaillés paralympiques français

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Introduction
La performance sportive est déterminée par une pluralité de facteurs allant du biologique au social. Si les premiers ont largement été étudiés, la littérature scientifique ne fait que peu état des conditions socio-environnementales en lien avec les performances. L'objectif de cette étude est d'étudier ces conditions auprès des sportifs paralympiques français.

Méthodes
En avril 2020, le Comité Paralympique et Sportif Français en collaboration avec les fédérations concernées a établi une liste large des pré-accréditations de 259 sportifs détectés comme ayant des chances plus élevées d'être sélectionnés pour les Jeux Paralympiques de Tokyo. Tous ces sportifs ont été invités à répondre à un questionnaire en ligne. Cette communication portera sur les sportifs des Fédérations Française Handisport et de Tir (N=186).
123 questions étaient regroupées en 5 thèmes : la préparation sportive, le parcours sportif, la situation socio-professionnelle, la situation de handicap et les blessures. La performance a été établi en se basant sur le modèle Foundations – Talent – Elite – Mastery (FTEM) qui combine participation et nombre de médailles obtenues en compétitions internationales. Les sportifs étaient invités à renseigner à quels Jeux Paralympiques ils avaient participé depuis Séoul (1988) et s'ils avaient obtenu une médaille. Ils étaient ensuite invités à répondre aux mêmes questions pour les championnats du Monde et d'Europe de 2017 à 2019. Une variable continue Linear FTEM (LFTEM) a été construite en combinant ces informations. Premièrement, des analyses univariées ont été conduites. Certaines variables catégorielles ont été manipulées pour obtenir les découpages les plus équilibrés, et en lien avec la problématique de recherche. Deuxièmement, des analyses multivariées ont été réalisées. A ce stade préliminaire d'analyse, des régressions linéaires ont été utilisés. Le but était d'obtenir le modèle le plus explicatif et parcimonieux possible.

Résultats
67.7% des sportifs interrogés ont renseigné le questionnaire. En moyenne, ils étaient âgés de 34.0 ±10.5 ans, avaient participé à 2.9 ±2.3 compétitions internationales et réalisés 1.4 ±1.8 compétitions internationales avec médailles. Les résultats préliminaires montrent que le modèle

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le plus explicatif et parcimonieux incluait deux variables, le nombre d'années d'expériences dans la discipline paralympique quel que soit l'âge des sportifs et la pratique antérieure d'autres disciplines sportives, et expliquait 32% de la variance de LFTEM.

Discussion
Ces résultats montrent que l'âge des sportifs est moins explicatif de la performance que le nombre d'années d'expérience dans la discipline. Ils montrent également que les sportifs ayant pratiqué d'autres disciplines sportives par le passé sont plus susceptibles d'avoir été performants dans leur discipline paralympique. Des modèles plus complexes cherchant à établir des scénarios de performance distincts pourraient être développés pour améliorer la compréhension de la performance paralympique.

Conclusion
Ces résultats peuvent aider les fédérations dans leur stratégie de développement des pratiques sportives à destination des publics en situation de handicap pour favoriser l'atteinte de la haute-performance paralympique.

Keywords: paralympique, performance, facteurs sociaux, facteurs environnementaux, parcours sportif

The search for stability in para-shooting: a medical and sporting compromise.

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Introduction
As part of the Paraperf project, a priority " sport de très haute performance" research program, specific work was carried out with the French para-shooting team in order to respond to individual issues for the Tokyo 2021 Paralympic Games. Although the issues of postural control and stability are widely studied in competitive shooting in the able-bodied, only a few studies have been carried out on visually impaired paralympics. While the goal of postural stability may seem similar [1,2], the approach is quite different. In fact, in the context of para-shooting, the handicap and deficiencies of each athlete ask for an individualized response. We have selected 2 cases of athletes.

Method
For each of the athletes, we have quantified the impact of spasticity on the posture by a comparative biomechanical analysis (100hz, Motive, Optitrack) of the movement in a match situation, and on the performance of 10 shots at 10m (Scatt MX02) before and after intramuscular infiltration of anesthetic.
Athlete 1, international SH1 level, hemiplegic, is a specialist in pistol shooting at 10m. In his practice but also in his professional life, the athlete is disabled by an almost continuous contraction of the elevator muscles of the shoulder. This hyperactivity becomes painful in stressful situations such as important competitions. We have specifically quantified the shoulders angle in relation to the horizontal axis.
Athlete 2, international SH2 level, hemiplegic, is a specialist in 10 and 50 meters rifle shooting. As part of his practice, the athlete is disabled by dystonia of the finger flexors of the hand which allows the rifle to be held on the gallows. This dystonia presents at random during the pre-shot aiming, making the athlete apprehensive with each shot. We specifically quantified the range of the area of the polygon formed by the fingers of the hand (M1 M2 wrist).

Results discussion
Regarding athlete 1, we observe an increase in the angle of the shoulders (13 ∘ vs 18 ∘) which is explained by the lowering of the shoulder by 4cm (133 vs 129cm from the ground). At the shooting performance, we see an improvement: 88 points versus 82, 38 versus 34.6 mm for the stability of aiming.

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Regarding athlete 2, we observe a decrease in the opening of the hand (6.1% versus 1.4%). In terms of shooting performance, we do not observe any changes in the 104 score versus 102 points, but a decrease in the stability of aiming 15.5 versus 9.2 mm. This decrease is explained by a less unstable trace due to the barrel movement suppression by the involuntary contraction of the fingers.

Conclusion

The multidisciplinary performance approach of the FF Tir highlights the relevance of a joint reflection involving the technical staff, the athlete and the medical staff. The therapeutic management of the consequences of the pathology requires the medical team to appropriate the characteristics of the sport, the regulatory constraints, and the performance criteria in order to support the staff and the athlete to perform and reduce the risk of counter performance

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Keywords: Parasport, Shooting, Stability

Influence of wheelchair on performance in wheelchair rugby players

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Introduction

Wheelchair rugby is a Paralympic sport practiced by players with different impairments. According to their level of disability, wheelchair rugby players are classified into two classes: high point (HP) and low point (LP). Nowadays, inertial measurement unit (IMU) is a recent tool allowing to measure performance parameters such as sprint time and ability to accelerate during field tests in wheelchair rugby players [1]. Few studies which have focused on comparison of HPs and LPs showed that HPs produced higher significant velocities than LPs. In addition, we showed that players most often using offensive wheelchair produced significant peak velocity at the acceleration and constant peak velocity phases than players using defensive wheelchair [2]. However, it is unclear if difference in performance was related to their classification or to the wheelchair type: offensive wheelchair (OW)/defensive wheelchair (DW). To our knowledge, no study investigated the influence of OW or DW on straight-line performance parameters in wheelchair rugby. Consequently, the aim of this study was to compare OW and DW on straight-line performance using IMUs. We hypothesised that using OW would lead to have higher performance during the straight-line sprint than DW.

Methods

13 able-bodied people with or without experience in wheelchair propulsion (age: 21±1.1 years old; height: 171±7.6 cm and mass: 65.2±9.1 kg) participated in this study. OW (mass: 21.8 kg) and DW (20.7 kg) with the same wheel size (25 inches) and the same camber degree (18o) were used by all participants. All participants performed 20-m sprint in random order with both wheelchairs. IMU was placed between two spokes near a hub on each rear wheel of both wheelchairs. Rolling resistance were measured using a mass of 20kg added on wheelchair's seat for both wheelchairs. Sprint time, velocity and peaks velocity have been quantified.

Results and discussion

Our results showed that rolling resistance was higher with DW than OW (-7.63±1.07 vs -5.68±0.76 N, $P < 0.004$). Sprint time was better with the DW than OW (7.24±0.70 vs 7.50±0.75 s, $P < 0.04$). Peak velocity and mean velocity of the sprint were higher with DW than OW

*Speaker

(14.66±1.65 vs 14.16±1.55 km/h, P< 0.03 and 10.06±0.95 vs 9.71±1.02 km/h, P< 0.04 respectively). No significant difference in asymmetry were found between both wheelchairs. The results of this study did not confirm our hypothesis. The DW would have a higher performance than offensive wheelchair. Difference in performance between both wheelchairs would be due to their manoeuvrability. OW is heaver, shorter and more manoeuvrable, causing more movement of steering, and may increase difficulty for participants to control OW during the sprint. Consequently, the participants could have difficulty to develop the higher peaks velocity on straight-line with OW despite its lower rolling resistance compared to the DW.

Conclusion

The performance of offensive players who most often use OW would not be linked to their wheelchair.

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Keywords: peak velocity, field test, inertial measurement unit

Field test using Inertial Measurement Units (IMU) in a high-level wheelchair badminton player - preliminary results

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Introduction

Wheelchair badminton is a recent sport announced since October 7, 2014 in the organization of para-badminton events at the Tokyo Paralympic Games in 2020. The practice of wheelchair badminton and its internal logic require players to make specific movements: athletes repeat successively forward (Pav) and backward (Parr) propulsion. To our knowledge, few studies have been interested in analyzing this sport and its particularity (1). However, it exists a lack of knowledge regarding the dynamics of the backward and forward propulsion of the athletes. Similarly, no authors report the loss of the propulsion efficiency when the athletes wear their rackets in comparison to hands-free propulsion. A field test allows to assess this specificity of wheelchair badminton: the Pav/Parr test carried out with and without the use of a racket. Thus, the goal of this study consists in analyzing the kinematics of the Pav and Parr with and without racket. We hypothesized that both, the racket, and the direction of the propulsion impact performance parameters.

Method

A french international wheelchair badminton player volunteered in this study (age, mass). The participant performed several successive Pav and Parr over 3m straight line for 1 minute as quickly as possible starting with Pav. As soon as he crossed the 3m line, he set off in Parr. This test was carried out with and without the use of a badminton racket. Two IMU were placed on the athlete's personal sport wheelchair and measured instantaneous velocity and accelerations.

Results

Without the use of the racket, the average (AV) and maximum (MV) velocities, acceleration on the first three pushes (A) decreased respectively by 7%, 12% and 8% in Parr compared to the

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Pav (Table 1). Transition time (TT) between Pav and Parr does not appear to change. Similar results were observed with the use of a racket when comparing Pav and Parr (16%, 16%, 28% and 17%). Moreover, lower A (-2%) and higher AV (+2%) were detected during Pav with the use of the racket. In Parr, AV, MV and A decreased respectively by 7%, 7% and 17%. Similarly, the transition time from Parr to Pav and Pav to Parr increased respectively by 8% and 7% when using a racket.

Discussion

With or without the use of the racket, the athlete seems less efficient in Parr compared to Pav. The acceleration and velocity decrease in Parr. This lack of efficiency is stronger when using a racket. In addition, the use of a racket seems to have a greater impact on the performance of the athlete in Parr due to the loss of acceleration and velocity and the longer time transition from Parr to Pav time. The difficulties of coupling hand and handrim may be at the origin of this loss of efficiency. Indeed, the use of the racket hinders the athlete when gripping the handrim. An ergonomic modification of the handrim could make it possible to limit the drop-in performance during propulsion with the use of the racket. Moreover, specific trainings with racket during Parr could increase performance as previously proposed by the authors in wheelchair tennis (2).

Conclusion

Our preliminary results concerning this study are promising and require additional experiments for generalization. Investigating the risk of injury could also benefit to athletes and coaches.

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Keywords: badminton, wheelchair, inertial units, performance, reverse propulsion

Involvement in Multiple Race Events Among International Para and Non-disabled Swimmers

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International elite Para swimmers form a large portion of the overall multi-medalist winning population. For the highest performing Para swimmers, world class performances were achieved across different strokes. The aim of this study was to quantify the level of involvement across different events and to examine this in relation to the level of performance.
The performances in swimming speed of the top 100 females and males for both Para- and non-disabled swimmers were collected in 11 race events between 2009 and 2019 (4,400 performances for 307 Para females and 365 Para males, 605 non-disabled females, and 715 non-disabled males). We tallied the number of events in which each swimmer was involved. Swimmers were grouped according to the total number of race events in which they participated. Then the association between involvement and level of performance was investigated.
Para swimmers with impairment from classes seven to 14 were involved in a range of race events across different strokes. The most common combination for both Para and non-disabled athletes was over similarly distanced races of the same stroke (50 and 100 m freestyle). The more race events in which Para swimmers involved, the higher the level of performance that was achieved. This trend can partially be explained by the less concentrated competition pool for Para swimmers compared to able-bodied swimmers. Para swimmers with minimal and no physical impairment perform in multiple race events more often than able-bodied swimmers. Fewer Para swimmers at the international level and a less concentrated competition pool could explain these differences.

Keywords: Paralympic swimmers, Impairment classification, Disabled athletes, Network analysis, Specialization, Age

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Is the visual impairment origin a performance factor? Analysis of international level Para swimmers and Para athletes

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Purpose
Panels of experts on Paralympic disciplines have highlighted the need to investigate if the disability origin for visually impaired swimmers and track and field athletes could influence their performance. The aim of this study was to investigate the effect of congenital and acquired visual impairments on the international performance of Para swimmers and Para track and field athletes.

Methods
We collected results from visually impaired Para athletes competing in Para swimming or Para athletic events at all IPC-labelled competitions between 2009 and 2019. The dataset contained 20689 races (6381 from males and 4239 from females in Para swimming; 6904 from males and 3165 from females in Para athletics). Disability onset was collected from the International Paralympic Committee (IPC) website. We separated disability origin into two groups to distinguish those with a congenital disability from those with an acquired disability. In visual impairment classes (11-12-13), the performance level and the age performance relationship were investigated according to the visual impairment origin in both sports disciplines.

Results
In classes 11 and 12, peak performance was achieved earlier by male and female swimmers with a congenital visual impairment compared with those who had an acquired impairment ($p < 0.05$). No differences were present in class 13 or in any class in Para athletics ($p > 0.05$). A similar performance level was observed among the two sport disciplines for each class ($p > 0.05$).

Conclusion
This study demonstrated that disability origin is a performance factor among visually impaired swimmers. The earlier age at which peak performance is achieved could allow for better individualization of athlete support and enhance the understanding of swimmer's potential. More investigations should be conducted to corroborate these findings.

Keywords: Swimming, Athletics, Paralympics, Disability, Origin, Age

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Biomechanical performance analysis of wheelchair racing using IMU sensors

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Introduction

Science tends to become crucial for sport performance in elite athlete, but also for the beginner. In wheelchair racing, analyses were classically done in laboratory on a wheelchair roller ergometer. Even if practical for measurement, propelling on a roller ergometer differ noticeably from over-ground locomotion where the athlete has deal with his trajectory and equilibrium while seeking to provide the highest power output as possible accompanied with good propulsion technique. Hence, measuring performance indicators directly on the field is of crucial importance for efficient athlete support. In biomechanics, the emergence of miniaturized inertial measurement units (IMU), which are a combination of 3D accelerometer, 3D gyrometer, 3D magnetometer, provides a good opportunity to make biomechanical performance analysis directly in the field. In some context, IMU are used within a data fusion framework allowing the body segment orientation to be assessed in 3D space. In wheelchair, through a simple mechanical model, instantaneous linear and angular velocity could be accurately determined based on 3D gyrometer data and the assumption of wheels rolling without slipping.
This aims of this preliminary study was to quantify wheelchair linear and angular velocities, and trunk inclination during wheelchair racing on two young talents.

Material and method

Two young talents practicing wheelchair racing participate to this preliminary study (CER-STAPS, IRB 00012476-2021-05-02-84). After performing their classical personal warm up, they were asked to perform a series of 100m, 200m, 400m, 800m and 1500m on a track at a high but not maximal intensity. The resting time was chosen by the coach according to the fatigue state of the athlete. Four IMU (Xsens, MTX, 100 Hz) were fixed on the wheelchair frame, both rear wheels and the trunk (on the sternum). The wheelchair linear and angular velocities were then calculated from angular velocity measured by the IMU fixed on both rear wheels, based on

*Speaker

a simple kinematical model and under the assumption of rolling without slipping. The trunk inclination with respect in the wheelchair reference frame was also obtained using a Kalman filter implemented in the Xsens software. The angular velocity measured by the IMU fixed on the frame was used to evaluate the validity of the assumption of rolling without slipping because it directly allows the measurement of the rotation velocity of the wheelchair reference frame.

Results
First, the comparison of the frame angular velocity obtained by the IMU fixed on the frame and the angular velocity calculated from the angular velocity of the rear wheels makes valid the assumption of rolling without slipping at quasi all instants of a wheelchair racing course. Second, the instantaneous linear velocity allows highly repeatable patterns to be identified, which were noticeably different for the two participants. Third, a noticeable difference in the trunk range of motion was observed between the two participants (about 15 vs 30$\circ$).

Discussion
Although preliminary, this study allows promising interest of IMU measurements for biomechanical performance analysis of wheelchair racing. The very low mass and volume associated to the wireless properties of such sensors would allow carrying out such measurements directly during real competition that would be of great interest for coaches. However, more efforts are still needed to link technical characteristics and intra-push linear velocity profile.

Keywords: Wheelchair, Racing, IMU, Performance

Study of relation between sleep and physical activity in young and middle-aged adults: preliminary results

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Background
According to the 2021 National Institute for Sleep and Vigilance survey, in France, almost half of men and women are not satisfied with their sleep. These figures are worrisome considering the growing evidence of the harmful effects of sleep restriction on health (James et al, 2017). The majority of first-line treatments of insomnia still relies on pharmacological therapies. Studies about the effects of exercise and physical activity are still rare but highlight the beneficial effects on sleep (Banno et al, 2018; Hurdiel et al, 2017). This research aim to investigate the relationship between sleep, physical activity habits and cardiorespiratory fitness.

Methods
Thirty-one women and thirty-two men aged 18 to 60 years old (23 $\pm$ 6.1 years old) were included in this study. They completed a wide range of self-report questionnaires about sleep and stress, including Pittsburgh Sleep Quality Index (PSQI) and Perceived Stress Scale (PSS). Horne et Ostberg circadian questionnaire was also administered in order to analyze the effect of chronotype on sleep. Moreover, they wore an accelerometer GT3X on the non-dominant wrist to analyze their sleep parameters and physical activity habits (Migueles and al, 2017). Total sleep time (TST) and wake after sleep onset (WASO) were used to evaluate objective sleep quantity and quality respectively. Accelerometer also provided data regarding percentage spent in sedentary, light, moderate and vigorous physical activity during seven days for each participant. Finally, subjects performed a submaximal test to estimate their cardiorespiratory fitness. (VO2max) (Beekley et al, 2004).
Dependent variables were objective and subjective sleep parameters, respectively.
Three sleeper categories were defined according to PSQI score, from best to worst sleep: good ($\leq$ 5), borderline (6,7) and poor (^{3}8) quality (Lund et al. 2010). TST and WASO quartile were used to classify participants according to objective sleep parameters determined by actigraph (actilife 6).
Analyses of variance (ANOVA) and chi squared tests were used to test differences between the different groups for dependent variables.
Factors with a p-value lower than 0.20 were included in a polytomous analysis. Polytomous logistic regression was used to identify independently risk factors of poor sleep. Adjusted Odds Ratios (AOR) were calculated.

*Speaker

Preliminary results
Among all participants 54,0% were good sleepers (PSQI $\leq$ 5), 22.2% were borderline sleepers (PSQI between 6 and 7), and 23.8% were bad sleepers (PSQI $\geq$ 8).
The factors associated with a poor subjective sleep quality were spending a lot of sedentary time (AOR: 1.12 ; p< 0.001), low time in moderate (AOR: 0.89 ; p< 0.001) and vigorous (AOR: 0.76 ; p< 0.001) physical activity and having a high stress score (AOR: 1.13 ; p< 0.001).
Sex, age, Horne and Ostberg score and VO2max estimation were not contributing factors for poor subjective quality sleep.
No factor was associated with poor objective sleep parameters (TST and WASO).

Conclusion
In our study, high sedentary time seems to lead with poor subjective sleep quality. However moderate and / or vigorous physical activity could be associated with subjective sleep quality. Nevertheless, in this study, physical activity habits were not associated with sleep determined by actigraph. Exercise and the perception of sleep for people complaining about poor sleep quality may seem to be associated.

Keywords: sleep, exercice, heath, stress

Good nap, perform high? anywhere?

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Introduction
An effective countermeasure recommended for reducing sleepiness during the day is napping. The problem related to the physical environment where the nap takes place is a major key issue that has received little interest. The first problem that comes to the shore is related to the disturbing effects on sleep induced by the sitting-sleep position. The second major issue is associated with the environment light and noise. In order to handle the issues stated above, the startup SOMBOX has developed a private nap rooms with the aim to provide the possibility to take a nap, in suitable environmental conditions whatever the situation. Designer ad lightening system accompanied with a background relaxing music and smells in a soundproof box. This study aims to examine different nap conditions impact on muscular power and sustained attention tasks. Subjects had to nap in a quiet room either in a bed or in a reclining chair and in the SOMBOX too.

Methods
39 healthy adults (20 male and 19 females; age, 25 ± 4 year; height, 173 ± 8 cm; mass, 67 ± 12 kg) were recruited to participate in this study. After a normal night, participants were assigned to have a 25-min nap at 13:00, in the following environmental conditions: bed, SOMBOX, reclining-chair, and a control condition (no-nap). Driving task was performed using driving simulator. Driving session consisted of a 104 min trip. To asses sustained attention, we used standard deviation of vehicle lateral position (SDLP) averaged by 10-min intervals. Explosive Leg Extensor Power (ELEP) was measured after the driving test using the Nottingham power rig.

Results and discussion
ELEP did not depend on nap conditions (df=2.75, p=0.56). Such physical performance is not influence by nap.
SDLP showed significant differences for nap condition (df= 2.723; p< 0.001), time on driving (df= 4.047; p< 0.001), and interactions between time of driving and nap condition (df= 11.986; p< 0.001). After 10-min of driving, SDLP was significantly lower in bed than in no-nap condition. Besides, SDLP was significantly lower in SOMBOX condition for last 50-min, and for the last 40-min in reclining chair compared to no-nap condition. Together these results evidenced that taking a nap aid to maintain a better vigilance levels compared to the no-nap condition.
SDLP values in bed were lower for 60-min than in SOMBOX, and for 70-min compared to

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reclining chair. However, non-significant differences were observed between the SOMBOX and reclining chair condition. The beneficial effects of napping are determined by the physical environment of the nap, with the best vigilance level obtained after taking a nap in a bed.

Conclusion
Napping is a good countermeasure to the post lunch dip, concerning sustain attention tasks. Bed is the best way for napping. SOMBOX which propose bed condition is disadvantaged by their awakening and falling asleep protocol. Lightening and relaxing music accompaniment finally lead to a decrease of sleeping time (sleep onset delay and a sleep offset advance).

Keywords: nap, sleep, chronobiology, cognitive performance, physical performance

Effect of the Depth of Cold Water Immersion on Sleep Architecture and Recovery Among Well-Trained Male Endurance Runners

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Introduction
The aim of the present study was to investigate the effect of the depth of cold water immersion (CWI) (whole-body with head immersed and partial-body CWI) after high-intensity, intermittent running exercise on sleep architecture and recovery kinetics among well-trained runners.

Methods
In a randomized, counterbalanced order, 12 well-trained male endurance runners (VO2max = 66.0 ± 3.9 ml·min–1·kg–1) performed a simulated trail (≈18:00) on a motorized treadmill followed by CWI (13.3 ± 0.2∘C) for 10 min: whole-body immersion including the head (WHOLE; n = 12), partial-body immersion up to the iliac crest (PARTIAL; n = 12), and, finally, an out-of-water control condition (CONT; n = 10). Markers of fatigue and muscle damage-maximal voluntary isometric contraction (MVIC), countermovement jump (CMJ), plasma creatine kinase [CK], and subjective ratings-were recorded until 48 h after the simulated trail. After each condition, nocturnal core body temperature (Tcore) was measured, whereas sleep and heart rate variability were assessed using polysomnography.

Results
There was a lower Tcore induced by WHOLE than CONT from the end of immersion to 80 min after the start of immersion ($p < 0.05$). Slow-wave sleep (SWS) proportion was higher ($p < 0.05$) during the first 180 min of the night in WHOLE compared with PARTIAL. WHOLE and PARTIAL induced a significant ($p < 0.05$) decrease in arousal for the duration of the night compared with CONT, while only WHOLE decreased limb movements compared with CONT ($p < 0.01$) for the duration of the night. Heart rate variability analysis showed a significant reduction ($p < 0.05$) in RMSSD, low frequency (LF), and high frequency (HF) in WHOLE compared with both PARTIAL and CONT during the first sequence of SWS. No differences between conditions were observed for any markers of fatigue and muscle damage ($p > 0.05$) throughout the 48-h recovery period.

*Speaker

Conclusion
WHOLE reduced arousal and limb movement and enhanced SWS proportion during the first part of the night, which may be particularly useful in the athlete's recovery process after exercise. Future studies are, however, required to assess whether such positive sleep outcomes may result in overall recovery optimization.

Keywords: polysomnography, muscle damage, core body temperature, heart rate variability, slow, wave sleep, performance, limb movements, arousals

Ambulatory study of the relationship between perceived light and sleep

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Introduction

The day-night alternation, particularly the variations in light captured by the retina, directly stimulates the internal clock, synchronizing it over 24 hours (1). Therefore, light is often considered among the essential environmental contributions in controlling physiological functions (2). The different light exposure characteristics such as the time of day, the duration, the intensity, and the wavelength specifically impact the body clock (3). Preliminary results showed that subjective sleep quality was affected by the self-reported duration of exposure to natural light (4). This present study aims to determine the impact of light exposure on sleep, circadian rhythmicity and physiological and psychological measured objectively.

Methods

Two hundred healthy participants, between 18 and 80 years old, will be evaluated. Over 7 days, environmental and physiological parameters will be evaluated. During the day, perceived light (spectrum, intensity, and temperature) will be recorded by a portable device attached to glasses. The rhythm of motor activity, or the activity/rest cycle, will be measured by actimetry (MotionWatch8®). Heart rate will be measured continuously by an ActiHeart® device. Fatigue, drowsiness, level of alertness, and anxiety level will be assessed by questionnaire twice a day at various hours to study the circadian rhythm of these functions. At night, environmental conditions (light intensity, sound volume, temperature, humidity) will be recorded by a sensor placed by the participants in their bedrooms. Volunteers will be asked to wear a Somno-art® bracelet all night in order to measure night actimetry and heart rate, in order to monitor sleep (ie: sleep quality, quantity and sleep architecture).

Results and discussion

Participants' inclusion and data acquisition will start in June 2021 and should last one year. In comparison to the people with fewer hours of natural light exposition, we expect that people who are more exposed will have better sleep quality. Better sleep outcomes should be associated with better alertness and lower fatigue and anxiety during the day.

Conclusion

This study could help to formulate recommendations in terms of quantity, timing, and intensity of exposure to natural light to reduce the risk of sleep disturbances.

*Speaker

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Keywords: Sleep, Light, Biological Rhythm, Physical Activity, Fatigue

Effects of cycling workstation to get tertiary employee moving on their overall health: the REMOVE study.

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Introduction

Time spent sedentary and low levels of physical activity (PA) are known to be major predictors of cardiometabolic risks (1,2). Sedentary Behavior (SB) has continuously increased over the last century due to environmental changes, including technology, structure of industries, automation and computerization (3–5). With the emergence and expansion of the tertiary activities, the occupation domain has largely contributed to the general adoption of SB, especially with the generalization of the desk-bound activities (6). For instance, during a 8-hour working day, office workers spend on average about 77% of the time sitting, 18% standing and only 5% in other activities (7). Office workers are therefore particularly vulnerable to the adverse health effects of SB. Recently, various strategies to reduce sedentary time in the workplace have been developed (8) such as portable pedal machine (PPM). Most of these studies were conducted in individuals suffering from overweight or obesity and tested whether such workstations were efficient to increase daily energy expenditure. However, data in normal weight people to support the preventative effect of such strategies remain scarce (9). The REMOVE study aims at evaluating the health effects of a 12-week cycling desk intervention among healthy office workers.

Methods

A prospective, open-label, multicentre, randomized controlled trial (RCT) is conducted in office-sitting desk workers. Forty healthy office workers who have 0.8 full time equivalent hours and 75% of this time in a sitting position has been recruited from tertiary worksites in Clermont-Ferrand, France. Subjects have been randomly assigned to one of the two following interventions: i) PPM3: performance of two 30 min of cycling desk (using portable pedal exercise machine – PPM) per working day for 3 months, or ii) CTL: 3 months with no intervention (control). Every following outcomes are assessed at baseline (T0) and at 3 months (T1): 7-days PA and SB (3-D accelerometers), body composition (bioelectrical impedance), resting metabolic rate and cycling energy expenditure (indirect calorimetry), eating behaviours (questionnaires), physical fitness (aerobic fitness, upper and lower limb strength), metabolic outcomes (glycemia, insulinemia,

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lipids profile, inflammatory cytokines), self-perceived stress, anxiety, quality of life at work and job strain (questionnaires).

Results
The REMOVE study is currently on going and will end in June 2021. We hypothesize that the daily use of a cycling workstation for 3 months will increase PA and reduce SB on both working and non-working days and will improve physical and psychological health outcomes compared to a control condition with no intervention.

Discussion
The REMOVE study will tend to provide new insight in a field that remains poorly explored (10,11) with a potentially huge impact on global health. While the use of active desks has been mainly tested in individuals with overweight or obesity (9), the REMOVE study will determine the impact of active desk –PPM- on PA behavior and health outcomes in healthy employees during three months using a primary prevention approach. The objective assessment of the effects of worksite PPM on PA and SB will be extended to the entire day and week, including non-working days. To our knowledge, this trial is the first to assess the effects of the use of cycling desk (PPM) on the physical, cardiometabolic, psychological and overall health of tertiary employees.

Keywords: sedentary behavior, physical activity, cycling workstation, tertiary societies, workplace

Impact of extreme physical inactivity and low-dose testosterone treatment on iron distribution in male rats

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Introduction
Extreme physical inactivity induced by microgravity or bed rest for hospitalized patients caused iron misdistribution (3). Recent studies published by our lab demonstrated that spleen iron overload quickly occurs in humans and rodents associated with hepcidin upregulation (1,3), the key peptide hormone that regulates iron storage and absorption. While the liver is preserved from iron overload, the impact of extreme physical inactivity on intestinal iron absorption remains unclear. The role of skeletal muscle atrophy remains also poorly understood, whereas skeletal muscle contains 10 to 15% of total body iron (4). This iron misdistribution could induce oxidative stress in overloaded organs, but also anemia, leading to reduction in functional capabilities of astronauts and increasing recovery time for patients. Recently, the impact of low-dose testosterone treatment has been explored by the NASA to limit musculoskeletal deconditioning in astronauts (2). As testosterone is known to decrease hepcidin synthesis, such treatment could also interfere with iron metabolism. Consequently, the objectives of the present study were to assess in rodents the impact of extreme physical inactivity and low-dose testosterone treatment on iron metabolism explore the underlying mechanisms.

Methods
To this purpose, male Wistar rats were assigned to four experimental groups: control (CTL), treated by testosterone enanthate (10mg/kg) (T), hindlimb-unloaded (HU), and hindlimb-unloaded and treated with testosterone enanthate (HU+T).

Results
After 7 days of HU, we did not observe any effects of testosterone on iron metabolism parameters. Serum iron concentration and transferrin saturation, key markers of iron availability, remained unchanged in unloaded and testosterone-treated animals ($p=0.22$; $p=0.68$ respectively). Likewise, hepatic hepcidin transcription increased both in HU (+355 %; $p< 0.001$) and HU+T groups (+358%; $p< .001$). Such increase could be due to activation of IL-6/STAT3 pathway, since STAT3 phosphorylation significantly increased in the liver ($p=0.038$). We also confirm in the present study that extreme inactivity rapidly increases spleen iron concentrations. Finally,

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duodenum Perl coloration seems to indicate that extreme physical inactivity promotes an increase of iron levels in macrophages located in the chorion of duodenal velli (p=0.048).

Conclusions
Complementary biochemical and molecular analyses on duodenal, liver, spleen, and soleus are currently performed to better understand the mechanisms involved in iron misdistribution. These results would help to develop nutritional or pharmacological countermeasures to improve the health of both astronauts and bedridden patients.

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Keywords: Extreme physical inactivity, Iron metabolism, skeletal muscle

Eccentric contractions: recent advances in neural, musculotendinous and psychophysical insights for exercise prescription

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Eccentric muscle contractions are known or believed to be unique. Even though eccentric contractions are less studied than concentric and isometric contractions, some of the specific features of eccentric contractions were already observed more than a century ago. In 1896, Chauveau measured the rates of oxygen consumption while ascending stairs forwards (i.e., concentrically) and descending them backwards (i.e., eccentrically). He observed that the energetic cost of descending stairs was less than the cost of climbing. At the same era, isolated muscle experiments showed that heat production during active stretched muscle was lower compared to active shortening (Fick, 1892). Since then, many studies have sought to increase our knowledge of this unique mode of contraction. Yet, despite the importance of eccentric muscle contractions during human movement, the mechanisms underpinning eccentric muscle contractions have not been fully explained. Developments in investigating techniques as well as growing evidence acknowledging the usefulness of eccentric exercise in rehabilitation settings participate to the keen interest of eccentric muscle contractions in the literature over the last decade. Hence, the purpose of this symposium is to present recent advances in our understanding of eccentric muscle contractions through neural, musculotendinous and psychophysical approaches and their consequences for exercise prescription.
List of communications that will be presented during this symposium:
- Glories D, Duclay J. Why is the neural control of lengthening contractions considered so unique?
- Lacourpaille L. Does elastography provide a valid estimation of the amount of muscle damage?
- Da Silva F, Monjo F, Colson SS. Kinesthetic alterations after submaximal fatiguing eccentric contractions: the role of central fatigue
- Clos P, Lepers R. Eccentric cycling: training benefits, fatigability and perspectives

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Keywords: fatigue, elastography, cycling, kinesthesia, electromyography, muscle damage, perception

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Why is the neural control of lengthening contractions considered so unique?

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A large number of studies from the last few decades have established that, during lengthening contractions, the control strategy employed by the nervous system differs from those used during isometric or shortening ones (for a review see 1). Most of the studies first concluded that the muscle is not fully activated during a lengthening maximal voluntary contraction (MVC), as supported by a decrease in electromyographic activity (EMG) that may occur 2, and/or by a voluntary activation level often not maximal 3, when compared to isometric and shortening MVCs. More recently, the interaction between cortical and spinal neural mechanisms involved in the modulation of the neural drive during lengthening contractions has been investigated by different research groups by comparing the effect of the muscle contraction type on: i) the motor-evoked potential elicited by transcranial magnetic stimulation 4, ii) the cervicomedullary motor-evoked potential 5, and iii) the Hoffman-reflex obtained by electrical stimulation 6. In most cases, a specific depression of the corticospinal excitability was found during lengthening contractions, which was mainly attributed to pre and post synaptic inhibitory mechanisms acting at the spinal level, although their relative contribution may be modulated by the descending neural drive from supra-spinal centres 7.
This interaction between cortical and spinal neural mechanisms could be investigated by computing corticomuscular coherence (CMC), i.e., the frequency coupling between electroencephalography and EMG oscillatory activities. While CMC has mostly been investigated during isometric contractions (for a review see 8), we recently were the first to quantify CMC during both isokinetic lengthening and shortening contractions compared to isometric contractions 9. We thus highlighted a specific decrease in CMC during lengthening contractions compared to isometric ones, with a concurrent decrease in spinal excitability. This specific behaviour indicates a decrease of the mutual interactions between cortical and muscle oscillatory activities, associated with a higher spinal inhibition, during lengthening contractions.

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Keywords: Eccentric, H-reflex, corticomuscular coherence, motor control, cortico-spinal excitability

Does elastography provide a valid estimation of the amount of muscle damage ?

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Muscle damage after unaccustomed exercise is a common experience in sports or daily life activities. It is a long-held belief that the amount of damage may vary greatly among synergist muscles depending on the exercise features, muscle properties, and muscle coordination. However, the inability of non-invasive experimental technique to estimate muscle damage limits our understanding on their aetiology. Accurate quantification of muscle damage requires histological examination of muscle biopsy samples by determining the number of myofibrillar disruptions (Raastad et al. 2010). As this is an invasive procedure, it is unlikely to be routinely used in sport settings and clinical practice. The amount of muscle damage can be indirectly estimated through the time course of the strength loss observed in the couple of days after exercise (Paulsen et al. 2012). Norwegian partner has shown a strong relationship between the strength loss at 6 hours after exercise and the amount of fibers with myofibrillar disruptions observed in the following 96 hours using biopsies (r = -0.92) (Raastad et al. 2010). However, strength loss is assessed through global joint torque that does not provide any information about the extent of damage in each individual muscle. Taking advantage of shear wave elastography, our team showed that the muscle shear modulus of elbow flexor and plantar flexor muscles significantly increase in the early instants after exercise (Lacourpaille et al. 2014b; Guilhem, [...], Lacourpaille, et al. 2016). We hypothesized that this finding could originate from the perturbation of calcium homeostasis (Whitehead et al. 2001). In that case, the increase in passive muscle shear modulus subsequent to a damaging exercise would be closely related to the number of myofibrillar disruptions and membrane damage resulting in intracellular calcium overload. To reinforce this hypothesis, we ran a second experiment on 53 healthy subjects. It showed that the early increase in muscle shear modulus (mean of the main synergists) after eccentric contractions is linearly correlated to the magnitude of strength deficit measured at 48 hours after exercise (Lacourpaille et al. 2017). This result was found in both knee extensors (i.e., mean of vastus lateralis, vastus medialis, rectus femoris; r = -0.82) and elbow flexors (mean of biceps brachii and brachialis; r = -0.80). However, the strength deficit measured 48h after exercise remains a very indirect indicator of the amount of damage. Therefore, it is required to replicate our study with a more direct measurement of the amount of damage using biopsies. We believe that the ability of shear modulus measurements to provide a valid estimation of muscle damage will ultimately represent a substantial gap for basic and clinical sciences.

Keywords: shear modulus, muscle stiffness, eccentric contractions

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Eccentric cycling: training benefits, fatigability and perspectives

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In the past decade, eccentric cycling has become popular in rehabilitation settings and has been increasingly studied (1). This growing interest is essentially due to greater training benefits from eccentric than conventional (concentric) cycling (2). Notably, superior improvements in lower limb maximal voluntary torque were reported after training in eccentric than concentric cycling at the same heart rate intensity several weeks (3, 4). Eccentric cycling also induced more fat mass decrease and lean mass increase compared with concentric cycling performed at the same oxygen uptake (5). Even though this training modality was deemed feasible among patients and is of particular interest in those unable to exercise at high oxygen uptake (6), several aspects remain to be further studied in order to enhance its use in rehabilitation settings. This is where the notion of fatigability comes into play. Fatigability refers to objective (e.g., decrease in maximal voluntary torque) and/ or subjective (e.g., muscle pain) mechanisms involved in the general symptom of fatigue (7), which can undermine the adhesion to an exercise program. Torque loss and delayed-onset muscle soreness the days following an eccentric cycling bout have been extensively studied in comparison with concentric cycling at the same power output (8). However, little is known on how eccentric cycling is perceived and to what extent it alters neuromuscular performance (e.g., maximal voluntary torque) when matched with concentric cycling for internal load (e.g., heart rate, effort perception) (2). In a yet unpublished work, we found that muscle pain was lower during eccentric than concentric cycling at the same power output, but similar at the same effort perception. Interestingly, eccentric cycling impaired more maximal voluntary torque than concentric cycling perceived similarly difficult. This result prompts to be cautious when setting eccentric cycling intensity based on effort perception. Critically, it also raises the question of an optimal individual range of exercise intensity (1) and internal training load, which are likely to be different from those typically used in conventional cycling. Other perspectives to hone exercise prescription include the effects of eccentric cycling on upper limb strengthening, as the elbow flexor muscles seem to be importantly solicited when power output is sufficiently high (10). Moreover, since torque levels are higher than during conventional cycling, modulating eccentric pedaling cadence may impact the resulting strength gains of a program. Finally, we have hypothesized that locomotor eccentric exercises may be beneficial to patients suffering from neurodegeneration or after a stroke, by combining hemodynamic and endogenous neural processes (11).

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Keywords: neurorehabilitation, perception of effort, subjective responses

Kinesthetic alterations after submaximal fatiguing eccentric contractions: the role of central fatigue

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Introduction

Kinesthesia, one of the proprioceptive senses, refers to body position and movement senses and plays a fundamental role in sensorimotor control [2]. Despite the presence of kinesthetic alterations following fatiguing eccentric contractions in human studies, the mechanisms underlying these alterations remain unclear. Although, recent research suggested the implication of fatigue-related central alterations [1, 3], studies investigating the underlying mechanisms are lacking.

Methods

Two experiments investigated the acute and delayed effects of repeated eccentric contractions on knee kinesthetic senses and knee extensors (KE) neuromuscular function before (PRE), immediately after (POST), 24- (POST24) and 48- (POST48) hours after a submaximal unilateral fatiguing exercise. Sets of eccentric contractions were performed until participants reached a 20%-decrease in maximal voluntary isometric contraction (MVIC).

The first experiment assessed the position sense using bilateral position-matching tasks at 30∘ (JPM30) and at 70∘(JPM70) of knee flexion. The second experiment investigated the movement sense using threshold to detect passive movement (TTDPM) tasks both knee flexion (TTDPMFLEX) and extension (TTDPMEXT). Twitch interpolation technique was used during both experiments to assess central and peripheral fatigue of KE.

Results and discussion

Both experiments led to similar acute and delayed KE neuromuscular fatigue. The 20% MVIC decrease was associated with both acute central and peripheral fatigue, as indicated by significant decreases of the voluntary activation level ($p < .01$) and evoked torques ($p < .001$) at POST. Despite persistent peripheral fatigue and perceived muscle soreness at POST24 ($p < .01$), voluntary activation level had returned to control values.

Kinesthetic alterations were found only in presence of central fatigue during both experiments. During the first experiment, knee position sense was altered only at POST during the JPM70 task ($p < 0.05$), participants overestimating the length of their KE (i.e., increased position-matching errors). Position-matching errors and voluntary activation decreases were significantly correlated at POST ($r = –0.60$, $p = 0.03$). During the second experiment, knee movement sense was significantly altered only at POST during both TTDPMFLEX and TTDPMEXT tasks, as

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revealed by increased TTDPM values and number of unsuccessful trials ($p < 0.05$).
Results also showed that despite persistent peripheral fatigue and perceived muscle soreness at POST24 and POST48 ($p < .01$), knee position and movement senses were no longer altered during both experiments. This demonstrates that muscle damage might not be involved in the impairment of kinesthetic senses with eccentric-induced fatigue.

Conclusion
The kinesthetic alterations observed following repeated eccentric contractions during both experiments are in line with central fatigue-related impairments occurring within the brain during the integration and/or the processing of proprioceptive sensory inputs. Future studies are needed to understand how eccentric-induced fatigue affects the integration and the processing of kinesthetic inputs at the central level.

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Keywords: Quadriceps, Voluntary activation, Peripheral Fatigue, Sense of position, Sense of movement, Proprioception

Neuromuscular origin of chronic fatigue among patients with multiple sclerosis.

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Introduction
Multiple sclerosis (MS) is an autoimmune chronic disease targeting myelin of the central nervous system (CNS). Among the manifestations caused by the disease, fatigue is the most common and disabling symptom, being reported by 55% to 78% of MS patients (Lerdal et al., 2007). Causes of the MS-related fatigue remain poorly understood but an impaired neuromuscular function could contribute to this phenomenon (Coates et al. 2020). In fact, a higher fatigability in MS patients could lead to a greater reduction in functional capacity and over time, the repetition of the activity of daily living could induce fatigue accumulation (Twomey et al., 2017). This study aims to characterize the causes of chronic fatigue in MS patients using a multifactorial assessment, focusing primarily on neuromuscular function.

Methods
Fourty-four participants with relapsing-remitting multiple sclerosis (RRMS), and 15 healthy controls will be recruited. MS patients will be assigned in 2 groups (high fatigue [HF] and low fatigue [LF] group) based on the response to fatigue questionnaires (FSS and MFIS). Participants will take part in three visits in the laboratory. The main outcome of this study comes from an incremental fatiguing exercise until exhaustion on a home designed cycling-ergometer. Maximal voluntary contraction (MVC), central (voluntary activation, motor evoked potential [MEP], silent period) and peripheral fatigue (resting twitch, compound muscle action potential [M-wave]) using transcranial magnetic as well as peripheral nerve stimulation techniques was assessed on quadriceps before, during and after the fatiguing task. The two other visits will allow to assess other potential mechanisms of fatigue (sleep quality, maximal oxygen uptake (VO2max), heart rate, muscle volume (MRI) and metabolic fatigue (P31 NMR). The experiment was conducted according to the Declaration of Helsinki and was approved by the local Ethics Committee (CPP Nord Ouest VI, ethics committee agreement 19.02.22.52507 received on 21 November 2019).

Results
Based on preliminary data from 41 MS patients (23 fatigued and 18 non-fatigued), parameters from cardio-respiratory test such as VO2max (28.4 ± 10.0 vs 27.0±8.8 ml/min/kg), ventilatory thresholds (VT1: 39.7±7.6 vs 42.5± 5.8% VO2max; VT2: 67.8±7.9 vs 69.7±8.2% VO2max)

*Speaker

and maximal aerobic power (147±47 vs 145±63 W) were similar between HF and LF except for the maximal heart rate (169±15 vs 156±18 bpm).
Although similar MVC torque loss was displayed at exhaustion for the both groups, MVC torque seemed to decrease to greater extent for the HF group than LF group after the third stage (-15.7%±10.9 vs -9.3%±16.8), and this was associated with a higher RPE for HF (11.8±2.5 vs 9.8±10.2%). At this stage, a lower MEP/M-wave amplitude was measured for the HF compared to LF. However, no differences for voluntary activation and peak twitch was found between these 2 groups.

Discussion
These results provide novel insight into relationship between fatigue and fatigability among patients with MS. HF could have lower resistance during a fatiguing task than LF leading to a higher perceived exertion. Cortico-spinal excitability was also lower for the fatigued groupe compared to the non-fatigued groups. A better understanding of the etiology of chronic fatigue will permit to propose an adapted rehabilitation intervention. This second phase of rehabilitation will be offered to patients as a follow-up of the present study.

Keywords: Multiple Sclerosis, Fatigue, Neuromuscular function, Fatigability

Home-based, video-supervised exercise study testing improved cardiorespiratory fitness and enhanced muscle metabolism in chronic kidney disease.

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Sarcopenia is a common complication of chronic kidney disease (CKD). Sarcopenia is defined by decreased muscle mass or function increasing risk of sedentarism, disability and premature death. Sarcopenia is central to the frailty phenotype that is associated with adverse metabolic and clinical outcomes. Existing evidence suggest that skeletal muscle mitochondrial dysfunction is a key mechanism underlying sarcopenia in CKD1. Additionally, reduced cardiorespiratory fitness (CRF) associated with sedentarism and chronic diseases increases all-cause mortality risks2. Regular exercise improves CRF, muscle mitochondrial function and physical functioning in CKD3. There is a critical need for practical, safe, interactive, and personalized home-based exercise targeting improvements in physical functioning. Compared to gym-based training programs, home-based training is cost-effective, feasible, and ensures high adherence.
There is little to no data regarding potential metabolic and physical consequences of CKD related mitochondrial dysfunction and as to whether home-based personalized exercise intervention can improve CRF and muscle function in CKD. This study aims to measure the efficacy of a home-based, video-supervised, and personalized exercise program on CRF and mitochondrial muscle function. Participants with moderate to severe non-dialysis CKD will be recruited and randomized to exercise (EX, n=30) or control (CTL, n=10) group. EX will consist of home-based, video-supervised 30 to 40min exercise sessions, 3 times a week for 12 weeks. The 3 weekly sessions will include: 1 session of 1) body weight high-intensity interval training, 2) strength training, and 3) moderate intensity walking. One week of video-supervised exercise will be alternated with one week of self-directed exercise. Each 1-week video-supervised session will be conducted by personal trainers using a videoconference tool. Self-directed exercise weeks will be conducted using pre-recorded exercise videos. The CTL group will receive a Go4Life "Workout to go" sample exercise routine created by the national institutes on aging (NIA). Pre and post intervention, CRF and work efficiency will be measured using a graded cycle ergometer test. Muscle metabolism and function will be assessed using 31Phosphorus magnetic resonance spectrometry (MRS) to measure muscle oxidative capacity and oxygraphy (Oroboros) to measure mitochondria respiration in permeabilized muscle fibers from vastus lateralis muscle biopsies.

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Preliminary data analysis suggests an improvement in CRF as well as high correlation between work efficiency and mitochondrial respiration.
This study will shed new light on the pathophysiology of sarcopenia in CKD and identify a cost-effective, home-based interventions that improves physical function, CRF, and wellness.

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Keywords: exercise, cardiorespiratory fitness, muscle metabolism, chronic kidney disease

Mechanisms of muscle pH regulation in sickle cell disease

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Introduction

Sickle cell disease (SCD) is a genetic disease emerging as a major public health problem with approximately 5 million people affected worldwide (Piel, Steinberg and Rees, 2017). SCD is due to the synthesis of abnormal haemoglobin S (HbS). The mode of transmission of the disease and according to the parents' genes, the descents can be either healthy subjects (AA), or so-called asymptomatic sickle cell trait carriers (AS), or symptomatic patients (SS) (Piel *et al.*, 2013; Ware *et al.*, 2017). In patients, SCD causes among others painful vaso-occlusive crises and severe chronic anaemia. These clinical manifestations disrupt oxygenation of tissues (Setty *et al.*, 2003), including the skeletal muscle (Waltz *et al.*, 2012). From that point of view, muscle pH regulation mechanisms (MPRM) could be altered. Lactate and H+ transport (via MCT1, MCT2 and MCT4) is an important contributor of MPRM (Juel, 2000). Several other mechanisms modulate and/or complete the action of lactate and H+ transport (Na+/H+ exchanger NHE1, Na+/bicarbonate co-transporter NBC and carbonic anhydrases CAII, CAIII and CAIV) (Juel, 2000; Kristensen and al, 2004). Besides, because women are more anaemic than men, a sexes difference in MPRM might be suspected. The aim of the present study was to investigate some parameters of MPRM in AA, AS and SS. Specifically, we hypothesised that 1) SS might have developed higher MPRM than AA and AS, and 2) that in SS, women had developed higher MPRM than men.

Methods

Vastus lateralis muscle biopsies of fifty-eight SCD patients were analysed (20 AA, 20 AS and 18 SS). Muscle content of MCT1, MCT2, MCT4, NHE1, NBC, CAII, CAIII and CAIV was studied by Western Blot. ANOVA and Tukey's post-hoc tests were used to compare data of AA, AS, and SS. Significance was accepted when $p \leq 0.05$.

Results

Muscle content of MCT4 was higher in AS than AA ($p = 0.012$) and that of CAII was higher in AS than AA and SS ($p = 0.008$ and $p = 0.010$, respectively). No difference was observed between AA and SS. No significant difference was observed among groups for MCT1, MCT2, NHE1 and NBC. No significant difference was observed between SS men and women.

*Speaker

Discussion

The present study is the first to evaluate muscle content of proteins involved in pH regulation between AA, AS and SS, and to compare SS men and women. Contrary to our hypothesis, SS do not display higher mechanisms of muscle pH regulation than AA. On the other hand, AS showed higher MCT4 and CAII muscle content than AA. Still contrary to our hypothesis, women did not develop higher muscle pH regulatory mechanisms than men. Taken together, these results suggest that 1) AS may be subjected to muscle pH challenges and that consequently they developed compensatory regulation mechanisms, 2) the lack of specific adaptation of the studied muscle pH regulatory mechanisms in SS may be a way to protect patients against sicking since the studied mechanisms may favour the release of lactate and H+ from the muscle to the blood, while H+ in blood triggers sickling, and 3) women do not seem to have developed specific adaptations.

Keywords: SCD, pH regulation, genotypes, skeletal muscle

Does proximal ischemia in intermittent claudication worsen gait instability? A preliminary study

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Introduction

Peripheral artery disease is a common cardiovascular disease (Fowkes et al., 2017). Intermittent claudication is due to stenosis in the lower limb's arteries. Occurring at different levels (distal, proximal or proximo-distal) this leads to a restriction of blood flow, muscle ischemia, and associated ischemic pain, especially during walking exercise. This sensation of pain alters the gait pattern, especially in case of unilateral disease where asymmetry between limbs appears (Gardner et al., 2010). Only our recent article has studied gait alterations depending on the unilateral distal or proximo-distal location of ischemia in the leg (Guilleron et al., 2021). Few is known about proximal ischemia. Therefore, we aim to assess gait alterations in case of unilateral proximal ischemia compared to distal and proximo-distal ischemia. This additional knowledge on the effect of ischemic pain on gait will help to improve the effectiveness of rehabilitation protocols.

Method

25 subjects (10 with distal ischemia, 10 with proximo-distal, and 5 with proximal) were evaluated during a treadmill walking test (at 3.2km/h with a 10% grade). We recorded the unilateral and total stance phases, foot angle progression, step length and time at three phases (pain-free, pain onset, and maximum pain forcing the patient to stop). A factorial 2 x 3 x 3 ANOVA [leg (symptomatic or asymptomatic) x phase of pain (pain-free, pain onset and maximum pain) x location (distal x proximo-distal x proximal)] was performed with a post-hoc Fischer least significant difference when applicable.

Results

The step length and step time are significantly lower in proximal ischemia in both limbs compared to proximo-distal ischemia (-8.5% and -10.5% respectively, p=). The foot angle progression increases significantly in distal ischemia compared to proximal and proximo-distal ischemia (-21.0%). During maximum pain, the total leg stance in proximo-distal and distal symptomatic legs is significantly decreased compared to proximal asymptomatic leg. The single-leg stance of the proximo-distal and distal asymptomatic legs is significantly increased compared to distal, proximo-distal and proximal symptomatic legs.

*Speaker

Discussion and conclusion

We highlighted that the locations of ischemia did not induce similar gait alterations. It seems that proximal ischemia leads to worsening of alterations in these parameters and induces more gait instability when the pain is maximum. These differences according to ischemia location must be taken into account in order to adapt more specifically the physical rehabilitation protocols and therefore improve their efficiency.

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Keywords: peripheral artery disease, gait alterations, location of ischemia

The effect of progressive intradialytic exercise program (resistance + endurance) combined with melatonin supplementation on postural stability in hemodialysis patients

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Introduction

Hemodialysis (HD) patients have impaired postural balance and mobility [1], which is associated to an elevated risk of falling which can result in multiple complications. However, the effect of exogenous melatonin (MEL) supplementation on postural stability in HD patients has not been studied yet. The aim of this study was to investigate the effects of progressive intradialytic EX program (resistance + endurance) combined with MEL supplementation on muscle strength and postural stability.

Methods

33 participants undergoing HD volunteered to participate in the current double-blind, randomized, placebo-controlled trial. Participants were randomized into three groups: [Exercise (EX) + MEL] (n=11); [EX + Placebo (PLA)] (n=11) and [Control (CON) + PLA] (n=11) groups.

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Participants included in the [EX+MEL] and [EX+PLA] groups were submitted to endurance and resistance training for 12 weeks. 3 mg of MEL for [EX+MEL] group or PLA for [EX+PLA] and [CON+PLA] groups, was ingested before nocturnal home sleep in a double blind. Before and after the intervention, the participants were submitted to evaluate postural stability parameters (CoPLX: stability in the medio-lateral axis; CoPLY: stability in the anterior-posterior axis; area (CoPAr) and the velocity of oscillation of the pressure center (CoPVm)) in three conditions on a firm surface (eyes open (EO) [EO Condition], eyes closed (EC) [EC Condition], and EO while doing a cognitive task [Dual Task Condition]. Three-maximum repetition (3RM) testing was performed to mesure muscle strength of knee extensors .

Results

All postural parameters in EO Condition and EC Condition were improved in both types of intervention [EX+MEL] and [EX+PLA] without significant difference between groups. Parameters of postural stability in the dual task condition were only significantly improved in [EX+MEL] group. The muscle strength of knee extensors was increased in [EX+MEL] and [EX+PLA] groups ($p< 0.001$, $d=0.99$; $p< 0.001$, $d=0.84$ respectively).

Discussion

The improvement of postural balance in this study could be explained by the beneficial effect of exercise training on muscle strength and physical function. However, The nocturnal surge in MEL above dim light MEL onset is absent in this population [2]. Indeed, previous studies showed that postural stability and motor control were affected by sleep deprivation [3]. The improvement of static balance with double task in [EX+MEL] group could be explained by the benefit of nocturnal MEL supplementation, since beneficial effects of MEL on actual sleep time and sleep efficiency were confirmed after 3 months of MEL supplementation [4].

Conclusion

MEL supplementation combined with intradialytic exercise could improve postural stability in different condition in HD patients. Thus, we recommend that nephrologists consider and implement this in HD units as well as therapeutic and as preventive interventions in this high-risk population.

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Keywords: Hemodialysis, postural stability, intradialytic exercise, melatonin

Preliminary results of the Physical Activity and Carotid Atherosclerotic Plaque hemorrhage (PACAPh) project

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Atherosclerotic disease is a vascular disorder characterised by a deposit of fat and the infiltration of circulating monocytes (MC). Carotid plaque can remain silent until it promotes major ischemic events possibly leading to death. Worldwide, carotid atherosclerotic plaque instability is one of the major causes of ischemic strokes. The Instable plaques contain leaky neovessels that bleed into intraplaque haemorrhage as well as large content of blood infiltrated pro-inflammatory MC.1 In recent cross-sectional studies, our team demonstrated that atherosclerotic patients practicing moderate physical activity (PA) have less intraplaque hemorrhage2 and less pro-inflammatory circulating MC3 than non-active ones.
The objective of this study is to determine the effect of an individualized home-based PA intervention on carotid atherosclerotic plaque instability factors, through the evaluation of intraplaque haemorrhage and MC phenotype measurements.

The PACAPh study is a longitudinal, interventional, monocentric, randomized, controlled study. 80 asymptomatic patients will be recruited with carotid stenosis $> 50\%$, without indication of surgery or intercurrent inflammatory diseases. Patients will be randomized 1:1 either in the control or in the PA group. The control group will follow its usual care. Patients of the PA group will receive a connected wristlet for daily steps count, and a PA instructor will call them twice a month to set new daily steps goal. The final objective will be to increase by 30% the daily step count. In both groups, tests will be done before and after the 6 months intervention. Intraplaque haemorrhage will be assessed by gadolinium injected MRI. Fitness will be evaluated by quadriceps maximal isometric strength, 6 minutes walking test coupled with VO2 measurements. MC subsets will be assessed by flux cytometry.

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31 patients were included (16 men, 73±8y/o). To date, 10 patients completed the entire protocol. Thus, only descriptive statistics will be presented here. MRI data are not yet analysed. PA group increases daily steps by 29% whereas control group decreases by 32%. PA group decreases less its quadriceps strength than control group (-20% vs. -28%). Percentage of classical pro-inflammatory MC are increased after the 6 months in the control group while rate of MC subsets is not modified in the PA group.

Fitness results suggest that the PA intervention increases the active behavior of patients while limiting the strength decreases. PA intervention might also limit the shift anti- to pro-inflammatory phenotype of MC and the reduced time of coagulation initiation observed in the control group. To confirm these results, the analysis of the 6month results of a majority of our patients is upcoming and more patients needs to be included.

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Keywords: Athéroclérose, Activité Physique, Bracelets connectés, Hémorragie Intraplaque, PACAPh

Association between habitual physical activity and bone health in very old patients

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Introduction
With the increase in life expectancy, osteoporosis is becoming a major public health problem with an ageing people.Osteoporosis is a common disorder characterized by low bone mass but also by an altered bone microarchitecture, resulting in decreased bone strength with an increased risk of fractures. The lack of physical activity has been identified as a modifiable risk associated with poor bone health [1]. The aim of this study was to examine associations between habitual physical activity (HPA), sedentary behavior (SB) and bone microarchitecture (Normal TBS versus Degraded TBS) in very old patients.

Methods
76 of 83 patients recruited from the geriatric day hospital were included in this study. Bone mineral density (BMD) and TBS (bone microarchitecture) were measured using dual-energy X-ray absorptiometry. HPA, moderate and vigorous physical activity (MVPA), and SB were assessed objectively over 7 days using an Actigraph accelerometer for 7 days. Physical performances were assessed by the short physical performance battery (SPPB) and the grip test, nutritional status by mini nutritional assessment, pre-albumin and daily energy and macronutrient intake. We analyzed women and men separately (M: 83.8 ± 5.3, n=26; W: 84.0 ± 5.4 years, n=50) and grouped by the TBS: Normal TBS group > 1.31 and Degraded (or partially degraded) TBS group < 1.31.

Results
In women, T score on all sites was significantly higher in Normal TBS than in Degraded TBS (Lumbar: -0.03±1.41 versus -2.53±1.47; total hip: -1.28±1.08 versus -2.42±0.99; femoral neck: -1.52±0.93 versus -2.60±0.89, $p < 0.001$). In men, this result is only noted only at the lumbar spine (TBS Normal: 0.78±2.13 vs TBS Degraded: -0.94±1.83, $p < 0.01$). No significant difference was observed between Normal TBS and Degraded TBS groups for nutritional status and physical performances. Only in women, vector magnitude (200±83 versus 145±81 counts.min-1), daily physical activity energy expenditure (145±90 versus 94±82 kcal.j-1) and MVPA (1.35±1.22 versus 0.80±0.94 %) were significantly higher in patients with Normal TBS compared to Degraded TBS ($p < 0.05$). No significant differences were observed in men for these parameters.

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In patients with Degraded TBS, SPPB score was significantly lower ($p < 0.05$) for the group that had bone fracture (6.1±2.3) compared to the group without bone fracture (8.0±2.9).

Discussion

Our study pointed out that physical activity energy expenditure was significantly lower (-43.7%) in patients with degraded TBS compared to normal TBS patients. This was linked to a time spent at a lower level of MVPA during the day in these patients. The analysis by gender showed that these results were only observed in women. However, sedentary behavior, physical performances and nutritional status did not differ according to the quality of bone microarchitecture, as well in women as in men.

Conclusions

This study suggests promoting habitual physical activity with regard to an increase of MVPA, with particular attention to elderly women with degraded bone microarchitecture. It's necessary to consider rehabilitative management after bone fracture in elderly patients with degraded bone microarchitecture.

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Keywords: accelerometer, daily physical activity, trabecular bone score, bone fracture

Acute Effects of Whole-Body Vibration on the Postural Organization of Gait Initiation in Young Adults and Elderly: A Randomized Sham Intervention Study

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Introduction

Whole-body vibration (WBV) is a training method that is commonly used by clinicians to improve specific motor outcomes in various populations such as young healthy adults and elderly [1]. However, WBV has also been shown to alter plantar sensitivity and increase leg rigidity. These effects may potentially alter postural stability. Thus, the purpose of this study is to clarify the effects of acute WBV application on the balance control mechanisms during gait initiation (GI) in young healthy adults and elderly. It was hypothesized that the balance control mechanisms may compensate each other in case one or several components are perturbed following acute WBV application, so that postural stability can be maintained or even improved.

Method

Forty-one healthy young adults and 40 healthy older adults were randomly assigned to one of the four following treatment groups: a Young WBV training group (YWBV), a Young Sham Group (YSG), an Elderly WBV training group (EWBV) and an Elderly Sham group (ESG). YWBV and EWBV received a single WBV session (four 45s bouts of WBV at a 50-Hz frequency and a 2-mm vertical displacement). YSG and ESG received a placebo treatment, i.e., participants followed the same procedure as the WBV groups except that no " real " vibrations were applied. In each group, participants performed two series of GI on a force-plate at a spontaneous velocity: one series just before, and a second series immediately after their specific treatment (WBV or sham). Classical GI parameters were compared across conditions.

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Results
Main results showed that the amplitude of mediolateral "anticipatory postural adjustments" (ML APA) and the dynamic stability were both improved in YWBV, while no effect was observed in the other groups. An increased stance leg stiffness (k) was observed in YWBV only. Positive correlation was also found between ML APA and k.

Discussion
In the young adults, the positive effect of WBV on dynamic stability was ascribed to the increase in the ML APA following WBV application, which did overcompensate the potentially destabilizing effect of the increased stance leg stiffness [2]. In the elderly, no such anticipatory (nor corrective) postural adaptation was required since acute WBV application did not elicit any change in stance leg stiffness.

Conclusion
WBV application may be effective in improving dynamic stability but at the condition that participants are able to develop adaptive changes in balance control mechanisms, as did the young adults. Globally, these findings are thus in agreement with the hypothesis that balance control mechanisms are interdependent within the postural system [3], i.e., they may compensate each other in case one component (here the leg stiffness) is perturbed.

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Keywords: Whole, body vibration (WBV), gait initiation, elderly, young adults, anticipatory postural adjustment (APA)

Effects of Home-Based Videoconferencing Adapted Physical Activity, Bright Light Exposure and Vestibular Stimulation Programs on Sleep in Older Adults: Study Protocol for a Randomized Controlled Trial

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Introduction

Aging is often associated to impaired sleep, and older adults frequently report changes in the timing of bedtime (both earlier and later), difficulties to fall asleep and increased time spent awake at night. Moreover, sleep disturbances are related to negative consequences on well-being, daily activities and cognition [1]. Thus, preserving sleep in older adults appears essential to maintain quality of life.

While sunlight is often considered the main time giver for the biological clock in humans, non-photic stimuli such as physical activity are essential for entrainment of circadian rhythms and also benefit to sleep quality [2]. However, the effect of combining different time givers on older adults' sleep remains unknown, and further research is needed.

Although the precise mechanisms of the action of exercise on circadian rhythms are not clearly known, the impact of physical activity may be partially due to the activation of the vestibular system, which is solicited when the body is in motion. Recently, studies conducted in animals and humans suggested a link between vestibular system and circadian rhythms [3]. However, research concerning the effect of vestibular stimulations on sleep are still scarce: only one study reported that electrical vestibular stimulations could enhance sleep-wake transition by reducing sleep latency in volunteers with difficulties to fall asleep [4].

One of the major issues related to interventions for older adults is accessibility: many barriers are stated by seniors who are not physically active, such as the distance between home and sports facilities. Therefore, providing home-based interventions seems relevant for this population, especially given the current period. Nevertheless, the effect of this kind of modality needs

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further exploration.
Thus, this study aims to examine the impact of three home-based interventions compared to a control arm on sleep and on overall quality of life in older adults with a sleep complaint.

Methods
One hundred older adults between 60 and 70 years old with a sleep complaint are randomized to one of the four home-based videoconferencing programs: 1) physical activity, 2) physical activity combined with bright light exposure, 3) galvanic vestibular stimulation or 4) health education (control arm). The impact of these interventions is assessed with detailed sleep (polysomnography, actigraphy...), physical (gait, balance...), behavioral (anxiety, depression...) and cognitive (executive functions and memory) examinations.

Results and discussion
Recruitment began in January 2021 and will end in June 2022. In comparison to control arm, we firstly expect an impact of both physical activity and physical activity combined with bright light exposure on sleep and quality of life. We further expect this effect to be more pronounced for older adults who will benefit from the combination of physical activity and bright light exposure. Secondly, we hypothesize that galvanic vestibular stimulation would enhance sleep and quality of life compared to the control group.

Conclusion
The results of this study are expected to foster the development of recommendations and preventive strategies to maintain or even improve sleep quality in older adults and, consequently, to improve quality of life throughout aging.

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Keywords: sleep complaint, aging, adapted physical activity, bright light exposure, galvanic vestibular stimulation, web, based program, well, being, cognition, circadian rhythms, polysomnography, actigraphy

Non-inferiority of a home-based videoconference physical training program in comparison with face to face training in healthy older adults

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Background
Older adults often fail to reach the recommended amount of physical activity to prevent age-related declines in metabolic, cardiorespiratory and muscle function. Effective home-based physical training programs could neutralize most of the barriers preventing older adults from being active, and supervision through videoconference may be considered an optimal solution. The present study aimed to test whether a physical training program administered through videoconference can be at least as effective as the same program administered face to face.

Methods
Participants, aged between 70 and 80 years, free from pathological influences of the vestibular system, unstable cardiorespiratory diseases or signs of cognitive impairment, were randomized in a control group (n=13), a group following a face-to-face physical training program (n=15), and a group following the same program through videoconference (n=13). The physical training program consisted of a combination of exercises for improving muscle function, functional activities and cardiorespiratory fitness. The program lasted 16 weeks, with 2 weekly sessions of 1 h each. Pre and post-intervention evaluations included body composition (fat mass, muscle mass), strength/power (isometric: hand grip, knee flexion and extension, trunk extension, dynamic: lower limb extension power) and cardiorespiratory (VO2 max) measures. Statistically, the effect of the training program on the different outcomes was tested in comparison to the control group. Then, the non-inferiority hypothesis was tested with a Student's t-test using a non-inferiority margin of 50% of the lower limit of the 95% confidence interval of the difference between the control and the face-to-face group.

Results
In comparison to the control group, both intervention (videoconference and face-to-face) significantly improved body composition, strength/power and VO2 max. The benefits of videoconfer-

*Speaker

encing on body composition, especially on fat mass (p=.015) as well as on VO2max (p=.008), were considered non-inferior to those obtained with the face-to-face condition. However, most of the strength/power benefits were not considered as important when the training program was administered through videoconference as when it was administered face-to-face, except lower limb extension power (p=.019) and knee extension strength (p=.044) that were at least as important in the videoconference compared to the face-to-face group. However,

Conclusion
To improve older adults' muscle function, face-to-face training may remain a solution of choice. However, training through videoconference could be viewed as effective as face-to-face training for improving body composition parameters and cardiorespiratory fitness. Remote training through videoconference could be considered a particularly compelling solution, especially in the present sanitary conditions. In fact, besides reducing costs and distance between trainers and trainees and allowing older participants to remain active while staying at home, it brings significant health benefits to older adults.

Keywords: Exercise training, Aerobic fitness, Neuromuscular function, Body composition, Non inferiority trial

Effect of ergothionein in the prevention of age-related muscle deconditioning

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Sarcopenia is defined as the progressive decline of skeletal muscle mass and strength occurring with aging. Preventing loss of muscle mass and function associated with sarcopenia is a critical point to maintain mobility, healthy quality of life, and decrease fall-related injuries. Although physical activity remains the most efficient strategy, other approaches have been explored, including the use of antioxidant strategies, whey proteins and hormone replacement treatment. Ergothionein appears as a promising nutritional supplementation. Indeed, this latter is known to activate antioxidant and anti-inflammatory genes by the Nrf2 pathway activation. Nrf2 pathway appears to be an interesting target to fight against aged-induced muscle deconditioning. Indeed, NRF2 is at the origin of the antioxidant responses of the cells allowing to reduce the damage created by oxidative stress during ageing process at proteins, lipids and DNA level. Moreover, the activation of NRF2 allows to positively regulate the protein balance, to reduce inflammation, to prevent apoptosis, to restore an efficient autophagy and to promote the proper functioning of satellite cells responsible for muscle regeneration. Through these effects, ergothionein is a potent cytoprotector.
The aim of these studies was to test the effects of ergothionein as a potential nutritional strategy against aged-related muscle deconditioning with and without physical activity.

For first experiment 16 mice (C57B6J; males; 16 months old) were randomly assigned in either a placebo group or a group supplemented with ergothionein (70mg/kg/day for 1 month and 35mg/kg/day for 2 months) diluted in drinking water for 3 months. For the second experiment, 25 mice (C57B6J, female; 16months old) were randomly assigned in a ctrl group, a placebo group, a group with freewheeling, a group supplemented, and a group supplemented with freewheeling (70mg/kg/day for 1 month and 35mg/kg/day for 5 months). Physical tests have been carried out before supplementation and at the end of each month of treatment. Muscles and blood samples were collected at the age of 19 months for the first experiment and 22 months for the second one. Western blot analysis and immunofluorescent staining have been achieved in different skeletal muscles.

Ergothionein supplementation prevents the aged-related decrease in muscle maximal strength (handgrip test) in both experiments with and without exercise. Furthermore, ergothioneine did not impaired oxidative capacity (MAV measurement) and appear as a complement of endurance training adaptations. These results are supported by a prevention in muscle fiber number loss

*Speaker

(+22,6%, p< 0,05) and, in the second experiment, by the prevention of muscle atrophy in the exercise groups. At the molecular level, supplemented mice present lower muscle protein content of proinflammatory cytokines (TNF-α, p< 0,05; and IL-1β, p< 0,05). Ergothionein seems to restore autophagy pathway as shown by a lower inhibition of Ulk1 (p< 0,05), and lower content of p62 (p< 0,05). Regeneration capacity could also be impacted with greater content of MyoD and health cellular niche markers.
Ergothionein appears as a promising nutritional strategy whatever gender to prevent in part age-induced muscle deconditioning. Its additional effects to endurance training make it especially interesting in the field of healthy aging. Further studies are needed to better characterize the molecular effect of ergothionein and its benefits in humans.

Keywords: muscle deconditionning, ageing

Complex systems approaches to apprehend the adaptability of human behaviour with a special focus on healthy aging and chronic diseases: a meta-narrative review

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Introduction

Aging and the prevalence of intricate chronic diseases are a major health problem and their management is a highly complicated challenge. In this view, the World Health Organisation has argued for the need of an integrative and dynamic systems approach, to reconsider the notion of health in terms of organisms' or individuals' adaptive capacities [1]. Therefore, the evaluation of the adaptability of human behaviour (AHB) becomes a major health issue. The complex systems approaches (CSA) are relevant for this purpose. Using physiological or psychological time series analyses, they allow to assess the AHB by capturing the interactions between the components of a system or an organism. [2]. However, the CSA for assessing the AHB are currently manifold, relying on different theories, methodologies, and level of observations. As a consequence, an overall synthesis of this field is timely. Thereby, our objective is to highlight the commonalities and divergences in the way the notion of the AHB has been studied by CSA, with a special focus on aging and chronic diseases.

Methods

This article uses the methodology of the meta-narrative review [3], which is designed to shed light on a heterogeneous field by highlighting the contrasting and complementary ways whereby researchers have studied the same or similar subject. In order to extract quantitative, qualitative and mixed articles addressing AHB using CSA from PubMed, ScienceDirect and Web of Science, two selection phases will be carried out: the first on title and abstract, and the second on full text. Exclusion criteria will be established at both phases of the selection. At several predefined stages of the process, follow-up phases will allow to verify the concordance scores, which had to be at least 80%, between the articles included/excluded by all co-authors. Selected articles will be mapped according to the following criteria: scientific areas, definition of the ABH, focus on AHB (primary *vs.* secondary), approaches (experimental *vs.* non-experimental), objectives (theoretical, clinical or mixed), and interpretative levels (analytic, systemic or idiographic). Finally, a narrative synthesis will be employed to interpret how these different approaches can be commonly understood on the levels of theoretical conception and applied perspectives.

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Results
2454 articles have been extracted from the databases, and we start the selection on title and abstract.

Discussion
The meta-narrative review offers the possibility to apprehend the different ways in which the adaptability of human behaviour has been conceptualized and evaluated by complex systems approaches. In this way, our goal is to provide a common understanding of these approaches to promote the investigation of the adaptability of human behaviour as a valuable conception of health, especially in the context of aging and chronic disease.

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Keywords: Adaptability, Resilience, Aging, Chronic disease, Health, Systematic review

Accelerometry-based determination of physical activity level in adults with cystic fibrosis

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Introduction

Regular participation in daily physical activity (PA) needs to be incorporated as part of daily care in cystic fibrosis (CF). In fact, PA is independently linked related to aerobic capacity (1,2), an important predictor of survival. The current PA recommendations for adults with CF are from 150 to 300 min per week of moderate-to-vigorous PA (MVPA), or 30 to 60 min/day (2). It appears in the literature an important discrepancy for the daily PA level in this patients (3,4). These differences could be due to numerous factors that are not already well described. The aim of our study is to perform an observational study of daily PA level in the CF population of the "Mucosud" network (Limoges – Bordeaux – Toulouse) and help to orientate the management related to PA.

Methods

This observational study is carried out on patients followed in the CF resource and competence centers. Inclusion criteria was CF diagnosis and age higher than 18. Each patient was asked to wear during 7 consecutive days a PA tracker (Actigraph GT3x), allowing to quantify spontaneous daily PA. The tracker was not worn during sleep and water activity.

The main outcome was MVPA time per day. Each outcome was expressed as mean±SD. Significance level was defined with $p < 0.05$ for Fischer's exact test and week day/weekend comparison.

Results and discussion

In this stuyd, we present the preliminary results of the Limoges cohort. 26 patients with CF were included but data from 7 of them could not be analyzed (3 dropouts, 3 trackers not received and 1 with low wearing time). Data from 19 patients (29.3±11.1 years; FEV1: 66.4±19.6%) were analyzed, with mean tracker wearing time of 806±10min/day.

Mean MVPA time was 36.3±17.5min/day, with important individual variability (minimal value: 2.4min/day; maximal value: 71.6min/day). This result is in accordance with Savi et al. who reported MVPA time around 30min/day. However, Troosters et al. reported moderate PA level

*Speaker

of 15min/day (5). Overall, 12 of 19 CF patients (63% vs. 37%; p=0.32) meet the PA recommendations.
There is no effect of weekday or week-end on the reported parameters. Correlation between FEV1 and moderate PA time was not significant (p=0.098; r=0.391).

Conclusion
Preliminary results indicate that a majority of the participants of Limoges cohort meet PA recommendations. But this outcome is counterbalanced by an important individual heterogeneity. Moreover, FEV1, an important clinical factor in CF, only slightly explains moderate PA time, indicating that others factors may be involved in PA profiles. These results are interesting to better understand PA profiles of CF patients. This would be helpful for improving the management of the patient, by individualizing PA programs and addressing PA barriers.

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Keywords: Cystic Fibrosis, accelerometer, profile, PA recommendations

Analysis of the modifications of the different components of eating behavior during acute exposures to cold and heat

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Introduction

Athletes and military personnel often face harsh thermal environments (heat and cold) during their competitions/missions or during their training sessions. These populations are characterized by frequent chronic energy deficits that may disturb physiological functions and therefore performance. These unusual thermal exposures may potentially reduce or increase this state of inadequate energy intake. However the amount of studies is limited and further studies are required to improve these knowledge. The aim of this study, that should start at the beginning of 2022, is to assess the effects of a 24-h exposure to heat (HOT-30 ∘C) and cold (COLD-16 ∘C) on several components of eating behavior and spontaneous physical activities compared to a thermoneutral condition (NEU-22 ∘C).

Methods

Twenty young, lean, healthy, and active participants (10 women/10 men) will realized these 3 sessions (1 month apart). After a night of sleep at 19 ∘C, a resting metabolic rate assessment will be realized followed by a blood sampling to assess the basal level of eating behaviors hormones. Participants will consume a standardized breakfast while the temperature of the thermal apartment will be adjusted according to the session. The participants will then spend 24 h per group of 4 in the thermal apartment (it is equipped with 4 individual bedrooms, a common large room, two bathrooms and a kitchen) during which core temperature, heart rate, thermal sensation and comfort, hunger, energy expenditure and their spontaneous displacements will be monitored. During four 2-h periods (11-13 h, 15-17 h, 19-21 h, and 8-10 h), food will be made available and the quantities eaten will be measured through connected scales. Thus, all their activities (several leisure activities will be made proposed) and food intake will be discretely assessed without human presence. Moreover, food reward (LFPQ) and olfactory and gustatory function will be assessed at 14 and 18 h 45, respectively. Finally, resting metabolic rate and another blood sampling will be realized just after the last breakfast.

Expected results

We expect to identify factor(s) that may contribute to explain modifications of energy balance during exposures to heat and cold in a free, but controlled context. This study and others may

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help developing specific nutritional guidelines for populations that are very likely to be exposed to harsh environments during a moderate-to-long period.

Keywords: Eating behavior, heat, cold, energy intake

Beneficial effects of a personalized home-based training among patients suffering from the Marfan syndrome

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Background
The Marfan syndrome (MFS) is an autosomal hereditary pathology affecting 1:5000 peoples. The alteration of the fibrillin 1 gene (*FBN1*) results in the haplo-insufficiency of the FBN1 protein mainly altering the vascular system (*e.g.* aneurysm, dissection, rupture of the aorta). International recommendations have gradually allowed MFS patients to perform training program because of its potential benefits. However, to date, there are no data on the effect of a long period training in these patients.

Objectives
The aim of the present study is to investigate the effect of a 3-month personalized home-based training on the quality of life (QoL) of patients suffering from MFS.

Methods and results
At least 90 MFS patients will be included in the study. They will be randomly placed into 4 groups: control group; endurance; resistance and endurance + resistance training groups. The training program will last 3 months and will be performed at patients' home. There will be 2 training sessions per week telemonitored by a specialist of physical activity and cardiologists. Pre and post-training evaluations will be performed at the Bichat-Paris Hospital, France. They will consist on assessing psychometric based on self-administered questionnaires (FiRST, GPAQ, ISP-25, MOS SF-36) and physiological parameters such as the peak oxygen consumption, aorta diameter, cardiac ventricles function and skeletal muscle power at rest and during exercise.

Conclusions
It is hypothesized that this new alternative way of MFS patients care (*i.e.* the combination of endurance and resistance training) will improve their QoL, cardiorespiratory fitness and skeletal muscle power.

Keywords: Marfan, telerehabilitation, exercise, endurance, resistance, personalized training.

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Benefits of cardiac telerehabilitation on cardiorespiratory capacities during COVID-19 pandemic in coronary artery disease patients

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Background

A cardiac rehabilitation program is essential to restore or increase physical capacities and reduce cardiovascular disease risk.[1] However, the COVID-19 pandemic led to the closure of most cardiac therapy centres. Thus, it was necessary to adapt and propose a new method of rehabilitation.[2,3] The aim of this study was to measure the effects of telerehabilitation on cardiorespiratory functions in coronary artery disease patients.

Methods

40 patients (mean age: 63 ± 9 yrs) were included. Patients completed a 3-week physical exercise intervention with five sessions per week. The training program consisted of thirty minutes of cycling and thirty minutes of strength training. The participants wore a connected watch to monitor their heart rate and gave their perception of effort according to the Borg scale.

The week before and after training program, patients performed cardiorespiratory tests and medical interview with a nurse about their cardiovascular risks. According to their needs and in addition to physical activity, medical, diet, psycho and/or tobacco specialist could be proposed by phone or video conference.

Discussion

Though all of the data has not yet been analysed, we observed good exercise tolerance and adherence without adverse events. All patients showed an increased maximal power output and VO2 during final cardiorespiratory test. A 3-week exercise program could maintain or improve cardiorespiratory fitness, functional capacity and general quality of life.

Conclusion

Telerehabilitation offers an effective and safe alternative cardiac rehabilitation during COVID-19 period. In the future, telerehabilitation could facilitate the continuity of care for patients who are geographically distant.

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Keywords: cardiac rehabilitation, telerehabilitation, coronary artery disease, COVID, 19, cardiorespiratory fitness

Cerebral oxygenation may predict cognitive performance under acute normobaric hypoxia

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Introduction

It is well established that hypoxia impairs cognitive function *(1)*. Hypoxia has been recognized as one of the most serious single hazards during flight at altitude. Performance of central executive function as assessed by n-back task is known to be reduced with hypoxia and there is a strong correlation between n-back task performance (*i.e.* working memory capacity) and reductions in cerebral oxygenation *(2)*. But none of these studies has investigated the physiological variables such as cerebral oxygenation and heart rate (HR) as predictors of altitude-induced decrease cognitive performance.Controlled protocols in a laboratory setting need to be performed first with the concomitant measures of cerebral oxygenation state and HR during standard cognitive tasks before the implementation of a protocol in an ecological situation. The present study aimed to test the association between changes in cerebral oxygenation, HR and cognitive performance during acute normobaric hypoxia exposure at an inspired oxygen fraction (FiO2) of 11.3% (5000 m). Additionally, we sought to identify cerebral oxygenation and HR threshold values that are predictive of decreased cognitive performance.

Methods

In a simple-blind protocol, 10 participants attended two sessions (i.e., hypoxia and normoxia) two to seven days apart. The order of the sessions was randomized. One session consisted of 9 blocks of a visual 2-back task of 49 stimuli interspersed with 30 seconds of rest. For the hypoxia session, 2 blocks were carried out first in normoxia, 3 during the ascent to hypoxia (i.e., decrease of FiO2 from 21.9% to 11.3%, about 750 m.min-1) and 4 blocks were at a simulated altitude of 5000 m (FiO2 = 11.3%). Participants were instructed to respond as fast and as correctly as possible on the visual 2-back task. The variables of interest were the concentration of oxygenated (O2Hb), deoxygenated (HHb) blood and total hemoglobin (tHB), the tissue oxygenation index (TOI), different indicators of HR variability, the response time and performance values for the cognitive task and the subjective workload (NASA-TLX) score.

Results (full analysis is ongoing) and discussion

The first results show that the NASA-TLX score was higher in hypoxia (H) than in normoxia (N) session. This means that hypoxia induces a higher mental load, in particular the "effort"

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dimension which is the only dimension different in H than in N. N-back performance (correct response) was not influenced by the condition (*i.e.,* normoxia vs hypoxia). The reaction time values remain to be explored, as well as cerebral oxygenation and HR responses.

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Keywords: near infrared spectroscopy, monitoring, working memory, simulated altitude

Characterization of the combined effects of exercise and immuno-chemotherapy treatments on tumour growth and skeletal muscle in MC38 colorectal cancer mice.

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Introduction

Cancer is a global health burden with a complex therapeutic care including primary treatment, such as chemotherapy, and secondary treatment to improve clinical outcome. Additionally, to tumor growth, cancer is associated with skeletal muscle dysfunction and chronic fatigue lowering life quality of cancer patients. MC38 mice are a model of colorectal cancer characterized by a profound skeletal muscle dysfunction (1) and recently, it was showed that a combination of immuno- and chemotherapy displayed increased efficacy compared to chemotherapy alone in MC38 mice (2). It was proposed that this treatment may limit tumor growth by activating anti-tumoral immune cells such as Natural Killer (NK) cells and lymphocytes T CD8 (LT8) (3). Acute exercise is associated with an activation of NK and LT8 cells and increased blood perfusion in the tumor (4). Consequently, acute exercise before immuno-chemotherapy treatment could be a potent potentiator of this combined treatment efficacy. Hence the aim if this study is to characterize the combined effect of acute exercise completed just before immuno-chemotherapy on tumor growth and skeletal muscle in MC38 mice.

Methods

Four weeks MC38 mice will perform incremental maximal speed (MS) test (5,6) and be randomly separated in four groups (n = 14/groups): control (CTRL), immune-chemotherapy (TRT), exercise (EXE) and combined intervention (TRT-EXE). Both TRT and TRT-EXE will receive immuno-chemotherapeutic treatment 5 times per week for 30 days, moreover TRT-EXE and EXE will be submitted to 50 min of treadmill exercise at 60% MS before each treatment administration (5). All along the protocol, tumor growth will be monitored. At D4, 7 mice/groups will be sacrificed to study the tumoral microenvironment in NK and LT8 cells. Mice will perform

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MS test again at D28 to measure the effect of repeated acute exercise on physical fitness. At D30, mice will be sacrificed to study the effect of each intervention on tumor environment, *ex vivo* muscle contractility and muscle mass.

Expected results

As previously described by Grasselly *et al* (2), the tumor growth should be limited in TRT group compared to CTRL. We also expect that exercise can decrease tumor growth in the EXE group by activating NK and LT8 cells and enhance tumor vascularization to increase tumor immune cells infiltration. Considering skeletal muscle, we expect that repeated acute exercise should preserve skeletal muscle function by limiting amyotrophy, mitochondrial dysfunction and by increasing muscle strength and endurance. In the TRT group, immuno-chemotherapy might decrease oxidative stress and inflammation to limit the apparition of muscle dysfunction. Finally, we expect potentiation of immuno-chemotherapy and repeated acute exercise with increased responses in both tumor and muscle for TRT-EX group compared to TRT and EXE groups.

Conclusion

This study may provide insights on the combined effect of pre-treatment exercise and immuno-chemotherapy in colorectal cancer and lead to an improvement of therapeutic care of cancer patients.

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Keywords: exercise therapy, tumor environment, muscle dysfunction, immune cells

Contractile and viscolastic properties of peroneus muscle in athletes with a history of ankle sprain.

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Background
Lateral ankle sprain is a common injury among athletes. Moreover, poor recovery can lead to negative consequences such as reinjuries or chronic ankle instability (CAI). The musculature most involved in rehabilitation and prevention of lateral ankle sprain appears to be the peroneus muscles.

Purpose
To analyze differences in peroneal neuromuscular response between the previously injured limb and the healthy one in athletes with previous ankle sprain during last year.

Methods
Cross-sectional study. Inclusion criteria involved having suffered an ankle sprain during last year and to be completely recovered at the moment of the analysis. Peroneus longus and brevis muscle tone, contraction time and stiffness were analyzed by Tensiomiography and Myotonometry. Paired t-test statistical test was performed to explore differences between the injured and healthy limb

Results
Forty-six athletes (26 females and 20 males) were recruited for this study. Tensiomiography and Myotonometry parameters did not found statistically significant inter-limb differences.

Conclusions
Peroneus longus and brevis contraction and viscoelastic properties are recovered after rehabilitation of an ankle sprain. Muscle tone, contraction time and stiffness should not be considered as risk factor to suffer a reinjury or CAI after an ankle sprain.

Keywords: peroneus muscle, ankle sprain, electromyography, muscle activity

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Effect of COVID-19 lockdown on sleep quality, sleepiness and chronotype in active and non-active French adults.

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Introduction
March 17, 2020, the great lockdown has been imposed to contain epidemic wave of Covid-19 in the French population with unprecedented restrictions of movement and out-of-home activities for 8 weeks. These constraints had an impact on lifestyle with a diminution of daily physical activity and an augmentation of sedentary behaviours [1]. Moreover, sleep quality and duration were also altered during the first week of lockdown [1]. Furthermore, the health authorities' guidelines stipulate that 150 minutes of moderate physical activity are needed to promote quality and duration of sleep [2]. To our knowledge no study evaluated those parameters during and after the great lockdown considering stratification by physical activity and sedentary levels. Thus, the objective was to determine the impact of the great lockdown on sleep quality, daytime somnolence and chronotype in active and non-active French adults.

Methods
An online national survey has been conducted. Participants were characterised by their level of physical activity and sedentary behaviour declared before lockdown and were stratified into four groups according to current French guidelines [3]: Sedentary/Active (SA); Sedentary/Non-Active (SNA); Non-Sedentary/Active (NSA); Non-Sedentary/Non-Active (NSNA). Sleep was assessed by the Pittsburgh sleep quality index [4], the Epworth sleepiness scale [5] and morningness-eveningness circadian rhythms have been determined by the Hörne and Otsberg questionnaire [6] at different periods: after 3-weeks of lockdown (P1), at the end of lockdown (P2) and one month after the end of lockdown (P3) (start: April 10, 2020; end: June 24, 2020). Participants characteristics, anthropometry, and sociodemographic variables were also reported. Since assumptions of normality and homogeneity of variances were violated, non-parametric tests and linear mixed effect models were performed.

Results
A total of 168 participants, 115 women and 53 men (age, 45.0 ± 16.0 years; BMI, 23.0 ± 3.5 kg/m2; 59% were active worker and 92% had an outdoor space) completed sleep and chronotype questionnaires. Twenty two percent were classified as SA, 24% as SNA, 38% as NSA and 34%

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as NSNA. Although no difference was found regarding sleep quality between the four groups, sleep quality was enhanced between P1 and P3 ($p = 0.001$) and between P2 and P3 ($p = 0.002$). Sleepiness score was significantly higher in the SA group than in NSA and NSNA groups ($p = 0.003$ and $p = 0.027$, respectively) but no difference was detected between periods. Regarding chronotype, no between-group differences and lockdown effects were detected between P1, P2 and P3.

Discussion

Sleep quality was improved from mid- to one-month post-lockdown independent of physical activity and sedentary profiles. This could be partly explained by a decrease in anxiety and depression state and associated with a better concordance between social schedule and individual sleep preferences [7].

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Keywords: Physical, Activity Sedentary Sleep COVID, 19

Effect of crossfit, Lesmills and resistance trainings on cardio-respiratory, endurance and body composition responses on sedentary subjects

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Introduction
The remarkable increase in the number of fitness centers worldwide has led to a curious growth in fitness trends programs such as Crossfit® (CF), LesMills® (LM) and traditional resistance (TRAD). Despite this growth, their impact on various physical and physiological parameters is still lacking so the aim of this study was to research and compare the effect of these training programs on cardio-respiratory, endurance and body composition responses.

Methods
A total of ninety-five sedentary subjects completed the study. Participants were assigned randomly into three groups: CF(n=31), LM(n=30) and TRAD(n=34). CF training was basically a High Intensity Functional Training (HIFT), LM training was a High Intensity Interval Training (HIIT), these programs were executed in affiliated CF and LM training centers and TRAD training was a personalized resistance training supervised by certified coaches. Following a strict diet, all groups were prescribed five sessions/week for 16 weeks. A battery of tests including anthropometric and performance measures (cardio-respiratory: 20m shuttle run test [SRT] [1], heart rate variability measures [HRV] [2]; Lactate removal rate [La]; Endurance: Young Men's Christian Association [YMCA] [3], 20m shuttle run test in 100% of maximum aerobic velocity [TSRT]; Body composition: Impedancemetry [4]) were carried out over three sessions: before training, after eight weeks and sixteen weeks of training.

Results
Findings indicated that impedancemetry demonstrated significant decrease in body fat percentage ($p< 0.001$, ES=0.09-0.43) and fat mass (p=0.03-0.001, ES= 0.08-0.48) for all groups every 8 weeks, also a significant increase in fat free mass only in CF ($p< 0.001$, ES=0.06-0.21) and TRAD ($p< 0.001$, ES=0.17-0.5) groups also every 8 weeks. SRT demonstrated a significant improvement in maximal aerobic capacity for CF ($p< 0.001$, ES=0.58-1.26) and LM ($p< 0.001$, ES=0.45-1.21) groups every 8 weeks, and a significant improvement in HRV for CF (p=0.006-0.001, ES=0.12-1.21) and LM (p=0.002-0.001, ES=0.07-1.27) groups after 16 weeks for param-

*Speaker

eters of SDNN, RMSSD and HRMax–HRMin. [La] showed a significant decrease in CF and LM groups each 3 minutes from zero to twelfth minute post SRT. TSRT demonstrated a significant improvement in aerobic endurance among CF ($p< 0.001$, ES=1.28-3.58) and LM (p=0.004-0.001, ES=1.16-2.31) groups every 8 weeks, YMCA demonstrated significant improvement in muscle absolute endurance in three groups (p=0.002-0.001, ES=0.84-1.73) each 8 weeks and significant improvement in muscle relative endurance only in CF group (p=0.02-0.008, ES=0.13-0.32) also every 8weeks.

Discussion

SRT results is in accordance with Murawska-Cialowicz, E.,et al.2015 [5] and Brisebois, M.F.,et al.2018 [6] who demonstrated that a CF training can elicit significant improvement in maximal aerobic capacity, Wen, D., et al.2019 [7] also summarized that independently of the type of protocol, HIIT is highly effective for improving maximal aerobic which is supported by LM training results, however, TRAD did not have an effect on maximal aerobic capacity even after 16 weeks of training [8, 9]. The findings of [La] are supported by the study of Bishop, D., et al.2008 who have demonstrated a decrease in [La] values post supramaximal test after five weeks of HIIT training [10]. Pilegaard, H., et al.1999 demonstrated that this increase in [La] removal rate is mainly due to an increase in the sarcolemmal lactate/H+ transport capacity [11]. Endurance results were also supported by the literature [12, 13] who established a positive significant effect of HIFT and HIIT trainings on endurance responses.

Conclusion

Based on these findings, we can conclude that CF and LM are effective for cardio-respiratory development, CF if favorable for developing endurance. All three programs are effective in reducing body fat, however CF and TRAD are superior in increasing muscle mass.

Keywords: Indoor training, Cardio, respiratory, Lactate removal, Endurance, Body composition

Effect of High-Intensity Interval Training and Continuous Endurance Training on Peak Oxygen Uptake Among Seniors Aged 65 or Older: A Meta-Analysis of Randomized Controlled Trials

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Introduction
Aging is intrinsically associated with a progressive decline in cardiorespiratory fitness (CRF) as measured by peak oxygen uptake (VO2peak). Improving CRF through physical activity contribute to better and healthy ageing. High-intensity interval training (HIIT) is a potent method of improving CRF among seniors, yet comparisons between this type of training and traditional endurance training (ET) are equivocal especially among older adults. The purpose of this meta-analysis was to analyze the effects of HIIT and ET on the VO2peak of seniors aged 65 years or older when compared with controls and also when the two types of training were compared with one another.

Methods
A comprehensive, systematic database search for manuscripts was performed in Embase, Medline, PubMed Central, ScienceDirect, Scopus, and Web of Science using key words. Two reviewers independently assessed interventional studies for potential inclusion. Fifteen randomized controlled trials (RCTs) were included totaling 480 seniors aged 65 years or over. Across the trials, no high risk of bias was measured.

Results and discussion
In pooled analysis of the RCTs, the VO2peak was significantly higher after ET sessions compared to controls (mean difference – MD = 1.35; 95% confidence interval –CI: 0.73 – 1.96). Furthermore, VO2peak was found significantly higher not only when compared HIIT with controls (MD = 4.61; 95% CI: 3.21 – 6.01), but also when compared HIIT with ET (MD = 3.76;

*Speaker

95% CI: 2.96 – 4.56). Nevertheless, these results were raised only from 3 studies, thus, further RCTs are needed in the future to confirm our results and to address the optimal HIIT dose required to provide benefit among older adults aged 65 or over.

Conclusion
This pooled analysis confirms that ET and HIIT both elicit large improvements in the VO2peak values of adults aged 65 years or older. Furthermore, when comparing the two modes of training, the gain in VO2peak was greater following HIIT. Overall, according to the health benefits of HIIT, clinicians are encouraged to discuss with seniors aged 65 years or older the concept of "evidence based exercise" by using an adapted and personalized HIIT programmes as part of their exercise programme to favour healthy ageing. This will also contribute to keep longer the frailer members of our society autonomous and independent in their daily life.

Keywords: Aerobic training, Endurance training, HIIT, Older adults, VO2peak, Cardiorespiratory fitness

Effect of melatonin intake combined with self-paced exercise training during four weeks of intermittent fasting on inflammatory markers and body composition in overweight-obese women

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Introduction

Several strategies including self-paced physical activity and intermittent fasting (IF) were prescribed in the management of obesity and its associated complications. Ramadan fasting is a distinctive model of IF; however, it could be associated with disturbances in nocturnal sleep time, physical activity and energy intake. These lifestyle changes affect circadian rhythm thereby lead to metabolic disorders such as inflammation and increased risk of weight gain. Exogenous melatonin (MLT) administration has been shown to improve no circadian rhythm misalignments[1], and to alleviate inflammation [2]. This study aimed to examine the effect of MLT intake combined with concurrent (endurance-resistance) training during Ramadan-IF on inflammation (i.e., c-reactive protein (CRP) and leukocytes) and body composition in inactive, overweight-obese women.

Methods

Twenty-eight obese women were randomly divided in two groups: [placebo (PLA) + exercise (PLA-EX): n=13; age= 29.38 ± 6.56 years; BMI= 31.21 ± 3,68 kg/m^2 and MLT + exercise

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group (MLT-EX): n=15; age= 35.73 ± 10.11 years; BMI= 34.46 ± 2.95 kg/m^2)]. All participants were asked to abstain from food intake from sunset to sunrise (15 hours daily) during 4 weeks. Every night, 3 mg of MLT or PLA were ingested one hour before bedtime. Under self-paced conditions, participants performed 30-45 min of moderate intensity interval training (MIIT) based on running, combined with resistance training, 3 times/week. MIIT consisted on 5-min blocks of 3 min at a rating of perceived exertion (RPE) between 5-6 on a 10-point scale, alternated with 2 min of active recovery at an RPE between 2-3. Resistance training involved 2-4 sets of 8-12 repetitions at 60-80% of individuals' one repetition maximum. Biological and anthropometric measurements were carried out two days before and after the intervention.

Results

PLA-EX and MLT-EX showed similar decrease in fat mass (-7%, $p< 0.001$ and -8%, $p< 0.001$, respectively) and total body weight (-3%, $p< 0.001$) in both groups. No changes in both groups were reported for fat free mass ($p> 0.05$). CRP levels decreased in PLA-EX (-53%, $p=0.04$) and MLT-EX (-35%, $p< 0.001$) without significant difference between groups. A similar reduction in leucocytes was observed in PLA-EX and MLT-EX (-14%, $p=0.01$).

Discussion

Physical exercise combined with Ramadan-IF improved body composition and induced weight loss which confirms findings of Tinsley et al.[3] and Stratton et al.[4]. Previous study reported that a dose of 6mg of daily MLT intake during 40 days was able to reduce levels of inflammatory mediators in obese women [2]. This discrepancy may be explained by differences in study designs, dependent variable base values and the used MLT doses.

Conclusion

The present study revealed that MLT intake was well tolerated during Ramadan-IF. Ramadan-IF combined with endurance-resistance training could be a suitable starting point to manage obesity and its related comorbidities.

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Keywords: Melatonin, Intermittent fasting, Intermittent training, Obesity, Inflammation

Effect of movement and music intervention on the behaviors, motor functions and social integration of children with Autism.

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Autism is a neurodevelopment disorder called autism spectrum disorder (ASD). Children diagnosed with autism tend to have a higher rate of movement disorders such as poor coordination, balance, gross walking skills, postural stability, and movement. Physical activity is considered as an important determinant of health status for children and adolescent to grow up healthy. The aim of the present study is to examine the impact of physical activity program, music and movement intervention on the motor, social and behavioral skills of children with autism.
16 children with autism spectrum disorder (ASD) male (n = 13,) and female (n = 3) were assigned randomly in two groups, experimental group (EG) (n = 08, mean age: 7.83 ± 1, 94 years, degrees of severity: 1.5 ± 0.58) and control group (CG) (n = 8, mean age: 8.9 ± 3.03 years; degrees of severity: 1.2 ± 0.42). All children had prior diagnosis of ASD based on the Diagnostic and Statistical Manual of Mental Disorders-Fourth Edition. 24 special training (3 sessions of 45 minutes /3 times per week/ 8 weeks). Children's enjoyment and engagement were evaluated via the Physical Activity Enjoyment Scale (PACES). Also, the Response Challenge Scale (RCS) was used to measure cognitive, affective, and motor regulation skills. Finally, the bruininks- oseretsky motor proficiency test (BOT-2) was used to asses' motor function such as balance and coordination.
The EG group improved significantly before and after the intervention (p< 0, 0001). The improvement in motor skills for the EG compared to the CG can be explained by the fact that during the training the children enjoyed the movements with the music which may explain the improvement of different symptoms for this group compared to others. After 8 weeks of intervention, the scores were significantly improved in the experimental group (p=0,005; d=1,572) compared to control group. PACES scores were very high in the experimental group (p = 0.001) compared to the control group. In this study, the experimental groups used expressive movements with music (dance therapy) which brings joy, emotion and creativity and they can often receive social or motor strategies to navigate their environment.
This study indicated that an 8-week movement and music - rehabilitation program was effective in improving motor skills, including balance (dynamic and static) and coordination in children with ASD ages 5 to 13 years.

Keywords: autism, music, movement, physical activity

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Effect of physical activity on glucose uptake by cancerous tumor: the MusculoTEP study

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Introduction

The present work raises the question of the glucose diversion to the muscle to the detriment of the tumor through physical activity. Glucose is an important energetic source for both muscular cells, involved in movement production, and tumor cells, which need more glucose intake to grow and disseminate in the organism1. Muscle mass reduction and cancer-related metabolic changes could therefore facilitate tumor energy intake. These changes may also be aggravated by cancer comorbidities, notably sleep and circadian rhythms disorders. They are reported in 38 to more than 70% of patients 2 and are associated with altered glucose metabolism 3. Exercise is considered as a major adjuvant to cancer treatment and its effect is seen on a number of levels, including metabolism and sleep4. Thus, the main objective will be to test if a single bout of moderate activity can increase glucose uptake by the muscles cells to the detriment of the tumor in the short term. A second objective will be to quantify sleep, daily activity level and rest-activity circadian rhythm (RAR) and to show if there is a link with glucose uptake.

Methods

40 Cancer patients of Le Mans Hospital will be included. A first prescribed PET-scan to measure Fluorodeoxyglucose (FDG) uptake, considered as a marker for the tissue uptake of glucose, will be realized on the first experimental session. On the next week, each participant will realize a 30 min cycling exercise at 50 to 63% of their theoretical maximal heart rate followed by another PET-scan. Patients will be given the Insomnia Severity Index 5 and an actigraph to wear on their non-dominant wrist to record their RAR during the 7 days between the 2 PET Scans. This device resembles to a wristwatch that participant wear continuously, except when they take a shower, or when they need to remove it for a short time duration. Participants were also provided with a sleep diary to complete during the two weeks actigraphy measurement. Actigraphy will allow to estimate the RAR, a major indicator of the severity of cancer-related symptoms and "status performance" in cancer survivors6. It would be then possible to moderate the effect of exercise on muscular glucose uptake depending of the presence of sleep and circadian rhythm disorders and the level of spontaneous daily activity

Analyses of FDG uptake by the muscle and tumor between the 2 PET-scans will be performed.

*Speaker

Sleep quality and quantity based on the actimetry will be estimated using the eTact® Analysis software. The RAR will be analyzed using the COSINOR regression model (TSA COSINOR, Expert Soft Technologies ©, Esvres, France). The significance level for statistical analysis will be set at $p < 0.05$.

Anticipated results and discussion

Exercise should cause a glucose derivation toward muscle preferentially. We also hypothesize that sleep quality and quantity, RAR characteristics, but also daily level of motor activity may mediate glucose uptake response to exercise. This experiment may highlight the importance of physical activity to improve cancer treatment and side effect such as fatigue.

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Keywords: Cancer, exercise, metabolism, Fluorodeoxyglucose, rest, activity rhythm

Effect of the COVID-19 lockdown on physical activity levels and sedentary behaviours: a longitudinal study

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Introduction
When the international pandemic state of Covid-19 was declared by the World Health Organization (WHO), complete lockdown was imposed from March to May 2020 in France. This resulted in restricting daily life activities by imposing to stay at home and shutting several stores and outdoor activities (< 1h). Negative effect of lockdown was observed on all physical activity (PA) intensity levels and on sedentary behaviours (SB) (3h/day) in an international study [1]. In opposite, leisure-related walking and moderate PA were increased during Covid-19 lockdown in a French and Swiss study [2]. However, these studies only used questionnaires and online surveys, before and during lockdown. The aim of this study was to investigate changes in PA and SB assessed by diaries in mid-(P1) end-(P2) and one-month after-(P3) lockdown.

Method
This longitudinal "EX-COVID" study was conducted from April 10th to June 24th using a web-based platform. On this online interface, participants reported their overall daily activities and habits on P1, P2 and P3. Changes in all PA intensities (light: > 1.6 METs; moderate: > 3 METs; vigorous: > 6 METs), SB and sleep duration were investigated through a daily activity diary (24h). Participants were grouped based on their previous (before lockdown) lifestyle habits: they were either categorized as sedentary or non-sedentary or as active or non-active, according to the WHO guidelines [3].

Results
Fifty-six participants were included for data analysis ranging in age from 19 to 78 years (M=44.96; SD=16.08), from which fourteen are men (25.5%) and forty-one are women (74.5%). They had a mean BMI of 23 kg.m-^{2} (SD=3.18).
No differences were observed between P1, P2 and P3 for sleep duration, moderate PA and vigorous PA. A significant increase in light PA was reported between P1 and P2 (12.9% vs 17.36%; p=0.018) and between P1 and P3 (12.9% vs 18.9%; p=0.002). Inversely, SB were higher at the beginning of lockdown (P1; 43.5%) than mid-(P2; 40.1%) and one-month after-lockdown (P3;

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37.8%): there was a significant decrease of sedentary levels over time ($p< 0.05$).
Over the three periods, no differences between active and non-active participants were reported for sleep duration and PA (all intensities). However, non-active participants showed significantly higher SB at P1, P2 and P3 than active persons (p=0.03). Non-sedentary participants also showed higher vigorous PA levels over time compared to sedentary participants (p=0.02), but no other differences were observed.

Discussion
From mid- to end- to one-month post-lockdown, sedentary behaviours decreased, and light physical activity increased. However, there were no changes in moderate-to-vigorous and sleep duration. Overall, lockdown did not impact physical activity, sedentary behaviours nor sleep duration in our population.

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Keywords: activité physique, sédentarité, sommeil, confinement, covid, 19

Effect of the level of vascular occlusion on muscle oxygenation at rest

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Introduction
Ischemic preconditioning (IPC) is a non-invasive therapeutic strategy used to protect organs against ischemia/reperfusion injury and could enhance athletic performance. However, a recent study reports confounding expectations about the magnitude of IPC effect due to a wide range of methodologies (O'Brien & Jacobs, 2021). Therefore, the aim of this study is to assess the effects of dose/response vascular occlusion (in mmHg) on muscle oxygenation at rest.

Methods
50 participants (males between 18 and 30 years old) were recruited and performed two sessions of resting IPC for each group (within 24h to 72h). Participants were randomly split into three groups of blood flow occlusion: group at 50 mmHg (i.e., venous return), group at 50 mmHg over the resting systolic pressure (SBP+50 mmHg) and group at 250 mmHg.
During the first session, considered as familiarisation phase to accustom the participants to IPC, anthropometric measurement (skinfolds, mass, stature) and resting blood pressure were assessed. NIRS devices (Portamon, Artinis Medical Systems, the Netherlands) were placed on left and right forearms (brachioradialis) and thighs (vastus lateralis). Finally, a pressure cuff was placed on the participant's proximal part of the left arm.
With the participants in the supine position, the protocol was as follows: 15 min of baseline, 7 min of occlusion, 10 min of reperfusion, 7 min of occlusion, 10 min of reperfusion, 7 min of occlusion and 20 min of reperfusion. During the protocol, tissue saturation index (TSI%) was recorded with NIRS. ANOVA-s were performed to assess statistical differences between periods, sessions and participants.

Expected results and discussion
The decrease in TSI% during ischemia and the hyperaemia spike should be more important in both groups over the SBP compared to the 50 mmHg group (Cunniffe et al., 2017). Moreover, the reoxygenation rate after cuff deflation should be lower in the 50 mmHg group.
However, since both SBP+50 mmHg and 250mmHg groups induce a cuff inflation over the SBP and that both intensities are used in routine, we expect that both groups will show similar results. In this way, normalised levels of TSI% after each occlusion; levels of post-occlusive reactive hyperaemia after each cuff deflation; levels of TSI% during reperfusion period should not differ between the two groups. Moreover, with occlusion over the SBP, the TSI% should be

*Speaker

higher than the 50 mmHg group during the last reperfusion period compared to the baseline (Kraemer et al., 2011).

Conclusion

To conclude, muscle oxygenation properties should be influenced by choice of occlusion level and tissue ischemia can be induced at much lower absolute pressures. Thus, an occlusion normalised to SBP should be used to prevent any injuries induced by IPC.

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Keywords: blood flow restriction, ischemic preconditioning, rest, intensity, ethical

Effects of capacitive-resistive electric transfer therapy in common regions of lower extremity injury during sports activities: A cadaveric studies.

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Background
Capacitive-resistive electric transfer therapy is a non-invasive electrothermal therapy classified as deep thermotherapy (1-4). Its use could be interesting in sport rehabilitation injuries.

Objective
Analyze the temperature change and transmission of electric current in superficial and deep structures tissues when applying different protocols of capacitive-resistive electric transfer therapy in thigh, knee and calf regions.

Study Design
Three cross-sectional in vitro studies (1,2).

Methods
5 different cryopreserved cadavers (10 legs) were included in each of the three studies conducted (thigh, knee and calf). Four interventions (high/low power) were performed for 5 minutes by a physiotherapist with experience. Dynamic movements were performed in the different regions with each intervention. Achilles tendon, musculotendinous junction, intra- extracapsular of the knee, deep and superficial part of quadriceps and biceps femoris temperature were recorded at 1-minute intervals and 5 minutes after the treatment, using invasive temperature meters placed with ultrasound guidance (1-4).

Results and Discussion: Low power applications have demonstrated a very low thermal effect ($p > 0.05$) with an important current flow ($p < 0.05$). These applications could be indicated for acute muscular pathologies or inflammatory capsule injuries. High power resistive application recorded the greatest increase in superficial, middle, and deep temperatures and current flow ($p < 0.05$), this application could be indicated for chronic pathologies. The high-power capac-

*Speaker

itive application achieves a greater increase in superficial temperature compared to low power ($p > 0.05$) (1,2). The results obtained in these three studies could serve as basic science data to justify the acceleration of the processes of muscle, tendon and capsule recovery improving cell proliferation without increasing the temperature in acute injuries and increasing the temperature and viscoelasticity of the tissues in chronic processes with this therapy.

Conclusion

The low-power protocols resulted in a very slight thermal effect at the different structures, but current flow was observed. The high-power protocols resulted in a greater temperature increase in all structures and a greater current flow than the low-power protocols. The high-power resistive protocol gave the greatest temperature increase in deep structures. Capacitive treatments (low- and high-power) achieved a greater increase in superficial temperature.

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Keywords: Cadaver, sport, lower extremity, CRet, Physical Therapy.

Effects of Diacutaneous Fibrolysis on passive neuromuscular response and mechanosensitivity in athletes with hamstring shortening. A randomized within-participant clinical trial

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Introduction
Diacutaneous fibrolysis is an instrumental physiotherapeutic technique used to treat musculoskeletal conditions causing pain and/or movement restriction. Its application seems to allow a greater depth and precision than the manual approach. However, its effects on passive muscle properties are still unknown. ***Objective***: This study aims to evaluate the immediate, and 30 minutes after, effects of a single diacutaneous fibrolysis session on contractile and viscoelastic muscle properties and mechanosensitivity on the posterior muscular chain of the lower limb in athletes.

Design
A randomized within-participant clinical trial with 66 athletes with hamstring shortening.

Methods
A single session of diacutaneous fibrolysis was applied to the posterior chain of the lower limb (treated limbs). The other limb was not treated (control limbs). Subjects were assessed with myotonometry, tensomiography and algometry before treatment (T0), after treatment (T1), and 30 minutes after treatment (T2).

Results
There were statistically significant differences between groups in stiffness on Gluteus ($p< 0.048$) and Biceps femoris ($p< 0.019$) and on Tone in Biceps femoris ($p< 0.009$) compared to the control limb. Only viscoelastic properties (myotonometry) reached statistically significant intra-group

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differences at T1 and T2 and between groups. Except for maximal radial displacement (Dm) in Gluteus, both control and experimental at T2 ($p< 0.05$) and in Biceps femoris control ($p< 0.030$). No changes were found in the mechanosensitivity.

Conclusion
Diacutaneous fibrolysis produces changes in the viscoelasticity of the biceps femoris and Gluteus without affecting the contractile capacities or the mechanosensitivity of the posterior chain muscles in athletes with hamstring shortening.

Keywords: diacutaneous fibrolysis, neuromuscular function, tensiomyography, myotonometry, pressure pain threshold, hamstring shortening

Effects of Ramadan intermittent fasting and exercise on body composition, inflammation and hepatic damage in obese Humans

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Introduction
Ramadan Intermittent Fasting (RIF) provides a unique fasting pattern recommended for obese adults [1]. However, the combined effect of exercise and RIF is not yet investigated. The aim of this study was to assess the combined effect of RIF and High-intensity interval training (HIIT) on body composition, inflammation and hepatic damage in obese men.

Materials and methods
A total 20 obese men, age: 31.8 ± 7.05 years, BMI: 33.1 ± 4.32, VO2max: 30.41 ± 3.36 performing regularly RIF, were randomized into two groups: RIF with exercise (R-EX) (n = 10) and RIF without exercise (R-NEX) (n = 10). Participants were instructed to maintain a stable diet and regular sleep throughout the study. The R-EX group performed a HIIT program on a treadmill (8 intervals of 1 min (90% of VO2max) alternating with 2 min recovery (45% of VO2max)) 4 sessions/week for 4 weeks.

Results
Both groups showed a significant decrease of weight, fat mass (FM), fat percentage (Fat%), waist circumference (WC), and C-reactive protein (CRP). However, the R-EX group showed a higher reduction of body composition (i.e., (weight and WC; $p < 0.05$); (FM and Fat% $p< 0.01$)), inflammation (i.e., CRP < 0.05) and hepatic damage (i.e., alanine aminotransferase, aspartate aminotransferase and Gamma-glutamyltransferase; $p< 0.05$, $p< 0.01$ and $p< 0.01$; respectively)) compared to the R-NEX group.

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Discussion
The reduction in food consumption during Ramadan may have led to a negative energy balance, which contributed to improve body composition [2]. However, the results obtained were more remarkable when fasting is associated with HIIT. Indeed, it is well established that aerobic exercise when fasting stimulates fat oxidation by enhancing adipose tissue lipolysis, which reduces fat and weight [3]. Moreover, the higher decrease of WC in R-EX compared to the R-NEX may be related to a greater decrease of **abdominal fat**, as well as, inflammation and liver damage [4].

Conclusion
These results showed positive effects of RIF on body composition, and inflammation. However, the combination of RIF and HIIT seems to be more effective, as well as to improve liver parameters, suggesting that this intervention can be an effective therapy to help obese people to lose weight and improve health.

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Keywords: Intermittent fasting, obesity, exercise, HIIT

Evolution of muscular oxygenation parameters during walking test in pre-term children

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Backgrounds
Premature children tend to be less involved in physical activities than their full-term contemporaries. This behaviour could be partly explained by pulmonary impairment but also by a muscular impairment. NIRS technology could offer interesting way of investigation of muscular adaptation. The aim of the study was to explore parameters of peripheral muscular oxygenation, coupled to gait characteristics, between premature (PT) and full-term (FT) children during a 6-minute walking test (6MWT).

Methods
Prepubescent children performed a 6MWT. During the test, changes in muscular oxyhaemoglobin (HbO2), deoxyhaemoglobin (HHb) and total haemoglobin (tHb) were measured with NIRS technology, positioned on subjects' calves. Gait parameters were monitored with an OPTOGAIT system.

Results
45 children (33 FT children and 12 PT children) participated in this study (mean age±SD: 4.9±0.7 and 4.6±0.9 years, respectively). Statistical analysis highlighted a decreased walking performance for PT children, with significantly lower walking distance ($p < 0.05$) than FT ones (405.1±91.8m vs. 461.0±73.3m respectively, -9%). A concomitant increase of oxygen extraction (over HHb time course) was observed from the third minute of the test ($p < 0.05$). No statistically significant difference was found for other NIRS parameters.
Lastly, the analysis of gait parameters highlighted a group effect for walking speed ($p < 0.05$) and stride length ($p < 0.01$).

Conclusion
Premature children showed decreased walking performance and greater change in peripheral muscular oxygen extraction, associated with lower walking speed and stride length. This may

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point out a muscular maladjustment and reduced functional capacities for PT children. These phenomena could be responsible of a greater muscular fatigue.

Keywords: Preterm, Walking test, NIRS, muscular oxidative capacity, functional capacity

Expérience congolaise de la lutte contre le surpoids et l'inactivité physique au cours du confinement Covid-19

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Au Congo-Brazzaville, depuis 2016 eu égard à l'augmentation de l'inactivité physique (prévalence : 29,2-29,6% selon les données de l'OMS) et des maladies chroniques non transmissibles, le ministère de la santé et celui en charge des sports et de l'éducation physique, en collaboration avec des associations non gouvernementales, ont mis en place des programmes d'intervention de grande ampleur concernant les personnes actives, incluant : activités physiques, diététique, style de vie. Ceci a abouti à Brazzaville à la fermeture tous les dimanches de l'avenue de la Corniche (longueur : 8,924 km), pour faciliter la pratique de diverses activités physiques et sportives. Avec la survenue de la pandémie de la COVID-19, une baisse de pratique a été relevée. Cependant, les effets de ladite pratique sur la composition corporelle et la tension artérielle chez les sujets ne sont pas documentés. Ceci justifie cette étude dont les résultats sont présentés dans cette communication. Au total, 31 adultes (30-59 ans) et 27 personnes âgées (65-75 ans), des deux sexes pratiquant la marche athlétique ont été inclus dans cette étude, et recrutés par contact téléphonique ou par mail. La présence des sujets sur le site principal de la pratique de la marche athlétique, l'esplanade de la Case de Gaulle (résidence de l'ambassadeur de France) et le temps t1 de démarrage des activités ont été vérifiés et enregistrés chaque dimanche pendant 6 mois au cours du confinement en respectant les mesures barrières. Après consentement écrit de chaque participant à l'étude, un talon codé a été remis avant chaque séance. A la fin de l'activité de marche pratiquée collectivement, les sujets se sont rendus auprès d'une des cinq pharmacies retenues et située à moins de 1 km du site, dotée d'appareils modernes de mesure de la fréquence cardiaque, de la tension artérielle et des indicateurs de la composition corporelle par impédancemétrie pour la collecte des données en fin de séance. La remise du talon par le participant auprès du pharmacien était la condition requise pour effectuer les mesures. Toutes les données mesurées par le pharmacien et le temps t2 de fin de l'activité relevée par le chef du collectif et remis au pharmacien, nous ont été communiquées par mail par celui-ci le jour de l'intervention. Après saisie sur Epi-Info version 6.1.0, les données ont été exportées sur Stata® version 10.0 pour traitement. Seuls les sujets dont les talons étaient retenus par le pharmacien ont été inclus dans l'étude. A l'enrôlement, il a été observé les trois premiers mois chez tous les sujets une augmentation significative du pourcentage de graisse totale ($p< 0,02$) : 10,3 ± 1,7% vs 12,5 ± 1,2%, suivie au-delà de trois mois d'une baisse significative ($p< 0,02$) : 11,3 ± 0,2% contre 12,5 ± 1,2%. L'accroissement des 3 premiers mois était plus marqué chez les personnes plus âgées (13,8%) et les femmes (13,0%). Par la suite, une diminution significative des valeurs a été retrouvée :11,2 ± 0,5% ; $\Delta = 10,4\%$. La pression artérielle systolique a accusé une réduction significative dans le temps, notamment à partir du quatrième mois chez tous les

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sujets : 134,2 ± 1,5 mmHg au début vs 130,3 ± 1,1 mmHg à 4 mois vs 126,4 ± 0,6 mmHg à la fin. Comme attendu, les personnes moins âgées et les hommes présentaient une pression artérielle systolique moins élevée respectivement 121,2 ± 0,4 mmHg et 119,6 ± 1,3 mmHg. La réduction de la fréquence cardiaque durant la période de suivi n'a été significative dans les deux sexes.

Keywords: confinement COVID, 19, marche athlétique, composition corporelle, profil tensionnel, Congo

Four weeks of detraining induced by COVID-19 reverse cardiac adaptations from eight weeks of fitness-Dance training in older adults with mild cognitive impairment

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Background
Physical training is considered as a low-cost intervention to generate cardioprotective benefits and to promote physical and mental health, while reducing the severity of acute respiratory infection symptoms in older adults. However, lockdown measures during COVID-19 have limited people's opportunity to exercise regularly and consequently have induced training cessation. Available scientific literature reported a reversal of cardiovascular autonomic adaptations (e.g., VO2max, heart rate variability (HRV)) following four to eight weeks of detraining in healthy military sailors or sedentary adults. To our knowledge there is a lack of data investigating the retainability of cardioprotective benefits after training cessation in older adults with MCI. Therefore, the aim of this study was to investigate the effect of eight weeks of Fitness and Dance training, followed by four weeks of COVID-19-induced detraining, on cardiac adaptations and physical performance indicators in older adults with mild cognitive impairment (MCI).

Methods
Twelve older adults (6 males and 6 females) with MCI (age, 73 ± 4.4 y; body mass, 75.3 ± 6.4 kg; height, 172 ± 8 cm; MMSE score: 24–27) participated in eight weeks of a combined Fitness-Dance training intervention (two sessions/week) followed by four weeks of training cessation induced by COVID-19 lockdowns. Each session consisted of 10 min of warm-up with mobilization exercises, followed by coordinative exercises (35 min), including the learning of short Dance steps with constantly changing choreographies. Afterwards, fitness Dance elements combining strength and aerobic exercises with Dance choreography were performed during 35 min. The training session ended with 10 min of whole-body stretching. Wireless Polar Team Pro and Polar heart rate sensors (H10) were used to monitor covered distance, speed, heart rate (resting HR, and avg and max HR), time in HR zone 1 to 5, strenuousness (load score), beat-to-beat interval (max RR and avg RR) and heart rate variability (HRV-RMSSD). One-way ANOVA was used to analyze the data of the three test sessions (T1: first training session, T2: last training session of the eight-week training program, and T3: first training session after the four-week training cessation).

*Speaker

Results
Statistical analysis showed that eight weeks of combined Fitness-Dance training induced beneficial cardiac adaptations by decreasing HR (resting HR, and HR avg and HR max) with $p < 0.001$, ES = 0.5–0.6 and Δ = –7 to–9 bpm, and increasing HRV related responses (max and avg RR and RMSSD), with $p < 0.01$ and ES = 0.4. Consequently, participants spent more time in comfortable HR zones (e.g., $p < 0.0005$; ES = 0.7; Δ = 25% for HR zone 1) and showed reduced strenuousness ($p = 0.02$, Δ = –15% for load score), despite the higher covered total distance and average speed ($p < 0.01$; ES = 0.4). However, these changes were reversed after only four weeks of COVID-19 induced detraining, with values of all parameters returning to their baseline levels.

Conclusion
Eight weeks of combined Fitness-Dance training seems to be an efficient strategy to promote cardioprotective benefits in older adults with MCI. Importantly, to maintain these health benefits, training has to be continued and detraining periods should be reduced. During a pandemic, home-based exercise programs may provide an effective and efficient alternative of physical training.

Keywords: pandemics, training cessation, combined training, aerobic, strength, aging, physical activity, cardiovascular health, heart rate, HRV, performance, responsiveness

Gut Microbiota and skeletal muscle cross-talk : lessons from muscle remarkable phenotypes

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Introduction
The gut microbiota represents a community of 1014 bacteria that are essential for the host' health [1]. Its alteration, called dysbiosis, impacts various organs (intestine, liver, adipose tissue) leading to numerous diseases, in particular metabolic diseases [2]. Skeletal muscle, a highly metabolic tissue responsible for our physical autonomy, also seems to be under its influence [3]. Our laboratory works on the emerging issue on the potential gut microbiota - skeletal muscle axis, and the understanding of its related mechanisms. We previously showed that gut bacteria are essential for skeletal muscle function. In fact, depletion of the microbiota reduces *ex-vivo* muscle endurance as well as muscle glycogen content, while natural reseeding normalizes all of these deleterious effects [4]. Understanding the functional relationship between these two organs also requires to analyze it in remarkable muscle phenotypes in order to reveal the nature and the extent of the relation.

Methods
we studied thus the composition of the gut microbiota, the function and structure of the gut and the mechanistic links with skeletal muscle in myostatin-deficient hypertrophic mice (KO-mstn), dystrophic mdx mice, and in humans with an original model of accelerated hypoactivity "Dry Immersion", in collaboration with the Centre National d'Etudes Spatiales.

Results
Our metagenomic analyses reveal specific microbial signatures to each muscle phenotypes studied. It suggested that the chronicity of muscle damage is a factor in the importance of the composition changes observed in the gut microbiota. Diversity markers are strongly altered in the dystrophic mdx phenotype, with a more profound modification of the bacterial composition, with specific phylum presence: Deferribacteresp; and modifications down to the genus for the Actinobacteriap and Proteobacteriap phyla. Interestingly, Muribaculaceaef family is inversely affected in our opposite phenotypes: hypertrophic (KO-mstn) and dystrophic (mdx). Moreover, in all three models, OTUs (Operational Taxa Units) related to the Lachnospiraceaef family are impacted suggesting an involvement in the muscle phenotype. After Dry Immersion, the Clostridialeso, Lactobacillaceaeo orders of phylum Firmicutesf are modified. These differential

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gut microbiotas are sometimes associated with changes in the function and structure of the intestine, the only real barrier with skeletal muscle, as well as with a reduce production of short-chain fatty acids and overexpression of Fiaf and inflammatory markers, potentially related to muscle phenotypes.

Conclusion

In overall, these results shed new light on the gut microbiota – skeletal muscle axis, which can be redefined as a reciprocal cross-talk, with clues to the underlying mechanisms. To envisage gut microbiota as a vector for improving skeletal muscle function is possible, opening up thus therapeutic perspectives for numerous pathologies affecting muscle tissue as well as sport performances.

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Keywords: gut flora, metabolism, myopathies, nutrition, performance, endurance

Handgrip strength and 6-min walk test data (6MWT) of patients with chronic hepatitis B (CHB): a case-control study

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Introduction
According to the International Classification of Functioning, Disability and Disadvantage, for each chronic pathology three stages of development should be systematically evaluated (*ie*, deficiency, incapacity, and social disadvantage). In CHB, while many studies have explored CHB-related deficiency; only four one have explored the CHB-related physical incapacity, and reported conflicting results.

Aim
To assess the handgrip strength data (*ie*, deficiency) and 6MWT data (*ie*, physical incapacity) of patients with CHB.

Methods
This was a case-control study: cases (n=27) were untreated CHB patients, and controls (n=28) were healthy participants. Collected data were: anthropometric data, handgrip strength and 6MWT data [6-min walk distance (6MWD), number of stops, oxy-hemoglobin saturation (oxy-sat), dyspnea (visual analogue scale), heart rate (HR), blood pressure]. A handgrip strength < 26 kg for men and < 16 kg for women was considered abnormal**1**. The signs of walking intolerance were: abnormal 6MWD (*ie*, $\leq$ lower-limit-of-normal), high dyspnea (dyspnea at the end (end) of the walk$>$ 5/10), oxy-sat drop > 5 points, chronotropic insufficiency (HRend$\leq$60%)**3,5,6**.

Results and discussion
Compared to the controls, the cases were more aged (37±7 vs.42±6 years, respectively), but had similar body mass indices (27.5±4.1 vs. 27.9±5.7 kg/m2, respectively). The cases and controls have similar dominant handgrip strength (40±10 vs. 42±13 kg, respectively) and don't include participants with abnormal handgrip strength, contrary to previous study which prove that low handgrip strength is associated with other liver diseases**2**. Compared to the controls, the cases had lower HRend (83±13 *vs.* 72±14%, respectively), higher oxy-sat drop (-0.4±1.4 *vs.* 0.6±1.2%, respectively), and lower 6MWD (112±11 *vs.* 100±15%, respectively). These findings are in line with those of a Saudi study**4**. Both groups had similar values of HRrest, oxy-sat, blood pressure, and dyspnea. No participants had a dyspneaend$>$ 5/10 or an oxy-sat drop > 5 points. Compared to the control group, the cases group included similar percentages of participants with a chronotropic insufficiency, but a higher percentage of participants with an abnormal 6MWD (4 *vs.* 30%, respectively).

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Conclusion
Compared with controls, cases have a marked alteration of submaximal aerobic data (*ie*, physical incapacity as shown by an abnormal 6MWD). The latter alteration is not related to muscular deficiency.

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Keywords: Chronic Liver Diseases – 6MWD – Handgrip Strength – Submaximal aerobic capacity

Impact of breast cancer chemotherapy on muscle deconditioning and fatigue: the PROTECT-01 cohort study

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Introduction

Hallmark symptoms in patients with breast cancer include exacerbated fatigue and muscle deconditioning, which impair their exercise tolerance and ultimately their quality of life [1]. In order to efficiently counteract these maladaptations with tailored exercise training, there is a need for investigations with comprehensive assessments of the physical status with different timepoints throughout the treatment. Therefore, the aim of the PROTECT-01 study is to investigate the evolution of physical status, from diagnosis to the end of the chemotherapy treatment, of patients with breast cancer [2].

Method

Eighty-seven of the 100 patients (52 ± 12 years) finished their (neo)adjuvant chemotherapy treatment and completed the study. Patients performed three visits throughout taxane-based chemotherapy: (1) before the start of the chemotherapy, (2) eight weeks after the start of the chemotherapy, and (3) after the completion of the chemotherapy (15 ± 6 weeks). Body composition (i.e. lean mass, fat mass, skeletal muscle mass) was assessed with a bioelectrical impedance analysis device. Ten maximal voluntary isometric contractions (MVC, 3s of contraction and 2s of rest) were performed to quantify force capacity and fatigability, respectively, with both handgrip and knee extensor muscles. Exercise tolerance was determined using the 6-min walk test (6MWT). Questionnaires were used to measure physical activity level (GPAQ), quality of life (EORTC QLQ-C30) and perceived fatigue (FACIT-F).

Results

Despite no change in physical activity level throughout the treatment, whole body skeletal muscle mass decreased in a linear fashion ($p < 0.05$; -1.7%), mainly localized at the trunk level ($p < 0.001$; -6.2%). In parallel, we observed a linear decrease in handgrip and quadriceps force during the treatment (-3.3% and -4.4%, respectively, $p < 0.05$) while there was no change in muscle fatigability (MVC, handgrip: _˜32.2%, quadriceps: _˜22.3%, $p > 0.15$). In fine, exercise

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tolerance, as evidenced by a reduction in 6MWT distance, also decreased linearly throughout the treatment ($p< 0.001$, -5.3%). However, subjective outcomes such as quality of life and perceived fatigue were altered substantially at mid-treatment and (-14.9% and +20.2% respectively, $p< 0.001$) with no further alterations thereafter until the end of the (neo)adjuvant treatment.

Discussion and conclusion

Preliminary results show that physical impairments develop in a linear fashion throughout the treatment, suggesting the need to initiate exercise training in parallel to the chemotherapy to counteract very early these maladaptations. Moreover, the time-course dissociation of physical outcomes (muscle mass and force) compared to the perceived ones (quality of life and fatigue) during chemotherapy treatment emphasize the need to combine objective and subjective assessments to reflect accurately the consequences of breast cancer on exercise capacity.

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Keywords: cancer related fatigue, cachexia, muscle force, exercise tolerance

Impact of competition stress on exercise cortisol response and diurnal pattern

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Introduction
Competition event, associating both physiological and psychological stress, seems to significantly alter resting responses of stress hormones such as cortisol [1-4], but it remains unclear whether the stress competition factor is able to alter itself either cortisol response to exercise or its diurnal rhythm [5]. This study evaluated therefore, in university-level soccer players, the repercussions of the same acute exercise combined or not with a competition stress on the saliva concentrations and diurnal patterns of cortisol. In parallel, mood was assessed with the positive and negative affect schedule (PANAS). We hypothesized that competition stress would lead in young male athletes to coupled alteration of cortisol and mood without abolishment of the diurnal pattern.

Methods
All procedures were approved by the local Ethics Committee and were carried out in accordance of the declaration of Helsinki. Twelve healthy, trained male volunteers (age: 21.2 ± 1.8 yr; weight: 77.9 ± 3.5 kg, height: 177.3 ± 4.0 cm), performing at the top national soccer student level, agreed to participate in the study after being informed of the nature of the experiments and gave written informed consent. The two experimental days: competition day ("match", i.e., away national university tournament soccer match) and training day ("train", i.e, simulated match in an out-of-competition day) were randomized and separated by one week, with samples taken: a) immediately after awakening between 07:00/07:30 h; b) 09:00 h; c) 12:00 h; d) between 14:00/15:00 h, just before the real or the simulated match; e) between 16:00/17:00 h, just after the real or the simulated match; f) at 20:00 h. Rating of perceived exertion (RPE) and mood was assessed with the positive and negative affect schedule (PANAS).

Results
Under each experimental, a classic circadian rhythm for cortisol was observed ($p < 0.05$), with similar post-exercise concentrations, RPE and PANAS values on the 2 days. However, on the competition day versus the out-of-competition day, cortisol values were significantly higher at 09:00 h ($p < 0.05$).

Discussion and conclusion
Our finding of an anticipatory response of cortisol on the "match" day, with higher values than on the "train" day, was in accordance with the literature. Both the lack of alterations in the PANAS schedule and in exercise cortisol response during competition highlight that well-trained

*Speaker

athletes appear to be very well adapted to the stress effect of competition. In conclusion, our data confirmed the anticipatory rise in saliva cortisol to up-come competition, but the competition stress factor did not alter either exercise cortisol response, diurnal pattern or mood.

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Keywords: saliva – competition event – steroid hormonal pattern – soccer players – circadian rhythm

Impact of level of physical activity on cortisol awakening response in morbidly obese women

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Introduction
Physical activity increases cortisol-awakening response (CAR) and reduces perceived stress in several pathologies [1] but its impact in morbidly obese subjects, especially women, remains poorly known.

Methods
According to their level of physical activity ($<$ or $>$ 1000 MET-min/week), 37 middle-age (41.4 $\pm$ 1.7 years) morbidly obese women (BMI: 46.2 $\pm$ 0.7 kg/m2) were divided into group 1 (n = 21) and group 2 (n = 16). Saliva samples were taken for cortisol analysis at awakening (coraw) and 30 min after (cor30aw), with CAR determination. In parallel, body weight and composition were determined by bioelectrical impedance, whereas quality of life, stress and depression were estimated by specific questionnaires.

Results
In group 2 ($>$ 1000 MET-min/week) vs. group 1 ($<$ 1000 MET-min/week), cortisol 30aw, CAR and lean mass expressed in % were significantly higher and fat mass expressed in kg and % lower ($p< 0.05$), whereas no change was found in the others parameters investigated. Significant correlations were found between IPAQ (International Physical Activity Questionnaire) scores and body composition and CAR, but not with stress and depression.

Discussion and conclusion
The main result of this study is that the level of physical activity influenced both body composition and CAR as demonstrated in other pathologies, but did not change quality of life, perceived stress and depression in a middle-age morbidly obese female population.

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Keywords: Cortisol awakening response, Morbid obesity, Physical activity

*Speaker

Impact of peripheral artery disease on the risk of carotid plaque instability: effect of physical fitness level.

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Atherosclerotic disease is a complex multifactorial and systemic condition that affects coronary arteries, carotid arteries and arteries of the lower limbs. Atherosclerotic plaque instability can lead to death, ischemic stroke, myocardial infarction, or acute lower limb ischemia and amputation. The pro-inflammatory and hypoxic environment of the atherosclerotic plaque promote the development of intraplaque neo-vessels that cause intraplaque heamorrhage (IPH). The most reliable *in-vivo* criterion for plaque instability detection is presence of IPH, detected by magnetic resonance imaging (MRI)1 with gadolinium injection. Plaque rupture release inflammatory factors that increase the thrombotic risk. Patients with peripheral arterial disease (PAD) associated to a carotid plaque are at higher risk of developing an unstable plaque and hypercoagulable state, probably related to low grade inflammation2. Therefore, this population would be at greater risk of ischemic cerebrovascular events2,3 However, the effects of a PAD on IPH and on the prothrombotic risk are not yet known.

Physical Activity (PA) decreases stroke's incidence and coronary arteries calcification. More precisely, PA has an impact on arterial stiffness and stenosis, but also on volume and instability of atheroma plaque2. Benefits of regular PA on morbidity, mortality, functional walking ability, blood pressure and long-term quality of life5 were previously demonstrated in PAD patients. Currently, we do not know how PAD could balance the effects of PA on IPH and pro-thrombotic risk in patients with carotid atherosclerotic plaque. Given the high rate of vulnerable carotid plaque (39.5%) observed in PAD2 patients, PA could reduce the risk of carotid plaque instability.

The Physical Activity and Carotid Atherosclerotic Plaque hemorrhage (PACAPh) study aims to evaluate the role of PA on carotid plaque instability and thromboembolic risk factors. The objective of the present study is to evaluate the impact of an associated PAD with a carotid plaque on the risk of plaque instability; pondered by their level of physical fitness.

*Speaker

This randomised 1:1, controlled, monocentric, cross-sectional cohort study involves patients with carotid atherosclerotic plaque with more than 50% stenosis, asymptomatic for more than 6 months, with no surgical indication for endarterectomy and no recent inflammatory intercurrent diseases.

The patients are divided into two groups: PAD and no PAD. Presence of PAD is based on a composite score with the anamnesis, clinical examination and measurement of the systolic pressure index (SPI), which should be between 0.9 and 1.4. Index below 0.9 is an indicator of PAD. Level of PA is determined by questionnaire (GPAQ).

We hypothesize that PAD would increase IPH, pro-thrombotic and pro-inflammatory profile whereas high level of PA would limit them.

In the absence of surgical treatment for stroke asymptomatic patients with tight carotid stenosis, moreover in the presence of PAD, PA could therefore represent a complementary therapeutic strategy to the best medical therapy6, in order to decrease the ischemic risk in this population.

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Keywords: atherosclerosis, thrombus, obliterative arteriopathy of the lower limbs, physical activity, systolic pressure index

Impact of speed and slope on the Rearfoot / Forefoot profiles

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Walking is a physical activity essential to people's autonomy and is therefore frequently implemented in physical rehabilitation. The vertical component of ground reaction force (VGRF) is a representative measure of the gait pattern due to its reproducibility (*1*). Peak 1 (loading) and peak 2 (push-off) during the stance phase can be affected by gait conditions, diseases and/or aging processes (*2*). From these two VGRF peaks, Rearfoot/Forefoot profiles can be determined in subjects with Peripheral Artery Disease under specific conditions (speed of 3.2km/h and slope of 10%) (*3*). To know the modification of these profiles according to walking conditions (grade/speed) would allow to extend the use of this model to other pathological contexts. 17 healthy young subjects (11 males/6 females) aged 21.5 ± 1.7 years performed the testing protocol. Each participant's 10 m overground walking speed (slow/comfortable/fast) was determined, (average of three attempts). Then, subjects walked on an instrumented treadmill (Zebris) with 7 different conditions in a randomized order (10% uphill and downhill grade at slow/preferential speed; flat (0% grade) slow/ comfortable /fast speed) of one minute each. As previously described, Rearfoot/Forefoot profiles were defined from peaks=peak 2 - peak 1 (Rearfoot profile if peaks< 0, and Forefoot profile when peaks> 0) (*3*).

During reference condition (comfortable speed and flat condition) the participants demonstrated a Rearfoot profile.

The repeated measures ANOVA (two ways) reveals that there is no significant difference between the two legs. On the contrary, the grade/speed interaction induced significant differences:
- The mean peaks in the uphill condition at slow and comfortable speeds (0.008, $p < .001$) are higher than in the downhill condition at slow and comfortable speeds (-0.408, $p < .001$).
- The mean peaks in the slow and comfortable speeds in downhill condition (-0.408, $p < .001$) are lower in the slow and comfortable speed in flat condition (-0.046, $p < .001$).
- The mean peaks are lower in the downhill condition at comfortable speed (-0.490, $p < .001$) compared to the slow speed (-0.327, $p < .001$).
- There is no significant difference between slow and comfortable speeds for the flat condition.

The Rearfoot profile becomes more pronounced with the increasing speed on the downhill condition and is predominant in flat and downhill conditions. On the contrary, in the uphill condition, the Forefoot profile is predominant. There are also significant differences between the downhill/flat and downhill/uphill conditions, regardless of the speeds considered, while no difference appeared between speeds in flat condition.

*Speaker

This study allows characterizing the effect of gait conditions (grade/speed) on the Rearfoot/Forefoot profiles of healthy young subjects. The Forefoot profile is considered more energy efficient while the adoption of a Rearfoot profile reveals a protective mechanism against gait instability. To know how these VGRF profiles are affected by gait conditions in healthy participants could serve as a reference and help in the clinical description of these mechanisms (reflecting gait instability) in pathological contexts and in the adaptation of physical rehabilitation in order to improve gait efficiency.

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Keywords: vertical ground reaction force, speed, grade, gait modifications

Impact of the angular variation of the trunk during a propulsion cycle using inertial measurement units (IMU)

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Introduction
Different propulsion strategies exist in wheelchair sports depending on the sport, equipment, and classification of the athlete. In athletes with high classifications, and therefore greater abdominal capacities, we observe a greater involvement of the trunk during the propulsion phase of a sprint at maximum velocity. This involvement of the trunk also varies with pushing velocity [3].
One study showed that isometric trunk strength in wheelchair athletes was not directly correlated with the acceleration as the latter depended on rolling resistance [2]. But in this study, the dynamic action of the trunk was not measured during propulsion. For this reason, it would be interesting to study the influence of trunk movements during propulsion in sports requiring more mobility such as wheelchair basketball.

Hypotheses
The flexion/extension angular variations of the trunk (FEVT) have an impact on the variations in velocity.

Material and methods
Protocol: 13 elite female wheelchair basketball players participated in our study. Trunk analysis was done during a repeated sprint test. The athletes ran six 20 m sprints successively in a straight line with 20 seconds of recovery between each. The athletes used their own sports

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wheelchair. IMUs were placed on the spokes of each wheel as well as on the frame of the wheelchairs [1]. In order to measure angular variations of the trunk, an IMU was placed in the center of the back at the spine level, between T2 and T8.
Data processing: Propulsion cycles were determined as a split between two minimum peaks in the velocity data of the right and left wheels. The FEVT was obtained by calculating quaternions with the IMU's 3 axes. A reference position was identified at the start of the recording in which the subject stood still with his back straight.

Preliminary results and discussion
We observed a correlation between the mean acceleration per pushing phase and the size of the FEVT (p=0.015). No correlation was observed between the size of FEVT and the mean deceleration per recovery phase (p=0.103).
We did not find any correlation between the classification of athletes and the size of FEVT (p=0.068). Indeed, among the 5 athletes with a high classification (big point), only one had a smaller FEVT compared to the athletes with a little classification (small point) (n=8).
However, on average big points had a greater FEVT than small points (21.52 $\pm$ 6 and 14.7$\pm$2.6, p=0.00017) as seen in the literature.

Conclusion
FEVT amplitude seems to differ according to classification however differences are not systematic.
The movement of the trunk during wheelchair propulsion appears to be beneficial in order to accelerate without increasing the deceleration during the recovery phase. This could indicate that trunk strength, when used, is beneficial to performance, bringing further insight to the study of Vanlandewijck et al. (2011) [2].

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Keywords: wheelchair, sport, biomechanics, trunk, sprint, propulsion

Inertial Measurement Unit to measure and evaluate work load in gymnastics

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Introduction

Artistic Gymnastics is a complex physical activity which consists in performing acrobatic movements on different apparatus. The training load of high-level athletes is very important both in terms of volume (around 30 hours / week) and in terms of intensity. In this context, the quantification of the training load is essential whether it is for the planning of the competitions or the reduction of injury. Today the most used method is to consider the number of hours of training and the perceived intensity (Foster 1996).

In the one hand, this quantification is possible in an ecological situation for a certain number of sports such as walking, running, or cycling. It is possible to measure certain variable of interest such as time (Stopwatch), distance (Meter) or speed (Radar) to quantify this load.

On the other hand, for gymnastic activities, these measurements are more complex. The tools used in other activities are not transferable to gymnastic activities: movements take place in the 3 planes of space and rotations happen in the 3 axes of the body.

Methods

We identified some characteristic movements on each apparatus. 10 voluntary male and female gymnasts of regional and elite level performed these basic gymnastic skills, being equipped with IMU sensor placed on the chest and filmed with a camera. We used Movesense sensors which allows us to obtain linear acceleration and angular velocities in the 3 axes of space (256 Hz / $\pm$ 8g).

A program allowed us to synchronize mechanical signal of the IMU and the movement captured by the camera and therefore to conclude about the direct and consistent correlation between both signals.

We identified the most relevant mechanical parameters to account for the movement performed by the gymnasts based on our spatiotemporal synchronized signal

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Results and discussion
Many types of movement combine linear and angular acceleration. However, there is a dominant part of angular acceleration when the locomotor limb is the upper body (Bars, rings, pommel). On these apparatuses, we will focus on Z and X gyroscopic data to count the number of gyrations. When the locomotor limb is the lower body (Floor, vault, beam), we will focus on Y and Z linear acceleration to count the number of elements.
The implementation of a linear acceleration threshold value following a calibration jump, as well as a time window to differentiate the different elements from each other allows us to refine our data.
The current results in relation to the discriminant variables allow us to detect and count the number of impulses / receptions, which therefore corresponds to the number of elements in linear displacement as well as the number of gyration and therefore elements for apparatus with circular movements. It is also possible to calculate a time between 2 peaks and therefore obtain a realization time or a rotational speed.

Conclusion
To date we are only able to perform element counting. The rest of the project will therefore focus on analyzing the signals of the different elements and developing our analysis tool and therefore build a mechanical signature database specific to each element. Considering that the code of points currently identifies more than 1000 difficulties, this step will require the use of a matrix intelligence to facilitate the processing and the acquisition of a large amount of data. The acquisition work is already underway.

References
Foster, 1996

Keywords: IMU, Quantification, Load

Influence of stroke rate on core stability and rowing ergometer performance

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Introduction
" Core Stability " (CS) is defined as " the ability to control the position and motion of the trunk over the pelvis to allow optimum production, transfer and control of force and motion to the terminal segment in integrated athletic activities " [1]. In rowing, high boat speed is achieved by generating high forces, which are efficiently transmitted from the feet to the hands, and through the trunk [2]. Trunk control is therefore a key technical element in rowing. The stroke rate is an essential variable for performance and training planning [3]. There would be optimal stroke rates for each rower. Above and below this optimal rate, coordination would decline. Training strokes rates range from 18-20 through to competition rates (greater than 32). The aim of this study was to assess the influence of rowing on kinematic and neuromuscular parameters of trunk and rowing ergometer performance.

Methods
Fourteen high-level rowers were recruited (21.8 ± 2.4 years old; 1.82 ± 0.08m; 78.3 ± 6.3kg). Each performed 3 sets of 12 strokes at 20, 26 and 34 spm in this order on a mobile ergometer (RowPerfect 3, Care, Netherlands). These stroke rates are typically used during training or during competition. The mean values of neuromuscular activation during the propulsion phase of the rectus abdominis, external obliques, spinal erectors, gluteus maximus and medius were determined (Trigno™, Delsys, Natick, MA, USA) and normalized (MVC). Two inertial units were used to quantify the angular range of motion of the extension of the spine (STT, San Sebastian, Spain). The force applied to the ergometer handle and the stroke length were also measured (Biorow, London, UK). To investigate the effect of cadence on these parameters, repeated measures ANOVAs followed by post-hoc tests were performed.

Results
Mean trunk muscle neuromuscular activity increased significantly ($p < 0.01$) between 20 and 26 spm (17 ± 9 vs. 21 ± 12% MVC), 26 and 34 spm (21 ± 12% vs. 26 ± 15% MVC) and 20 to 34 spm (17 ± 9 vs. 26% ± 15% MVC). These increases were noticeable in the external obliques (20 ± 7 for 20 spm vs. 31 ± 13 % MVC for 34 spm) and spinal erectors (31 ± 15 for 20 spm vs. 49 ± 24% MVC for 34 spm). The handle force, trunk extension as well as stroke length were not significantly different.

*Speaker

Discussion
Increasing stroke rate has an impact on neuromuscular activity of the trunk muscles and therefore requires a greater involvement of the trunk extensors, agonists of the propulsion movement, and external obliques, lateral stabilisers of the trunk. These neuromuscular CS parameters are modified according to the stroke rate even if the kinematic parameters of CS, technical and performance parameters were not influenced. It is likely that the transfer and control by the trunk of the force produced by the feet is different depending on the stroke rate.

Conclusion
The stroke rate therefore influences some parameters of core stability. Training plans for rowers should take these into account when quantifying the training load. In addition, this greater neuromuscular activity of the trunk extensors at high stroke rates could be linked to the high number of back injuries [4]. It wouldbe interesting to analyse more precisely the power developed by the trunk.

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Keywords: Rowing, Core Stability, performance

Is Blood Flow Restriction Training effective to improve muscle strength and physical performance in older adults? A systematic review and meta-analysis.

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Introduction
Resistance training is essential to maintain the general health status of the older adults, and to avoid adverse conditions such as sarcopenia or frailty. In addition, muscle strength and physical performance have been described as predictors of falls, morbidity and mortality, which ultimately entail a high economic cost to the health care system [1].
Blood flow restriction training (BFRt) consists of the application of a compression cuff proximal to the limb, while training the target musculature with low loads. In this way, partial restriction of arterial flow and occlusion of venous flow is achieved [2]. The physiological mechanisms behind BFRt are not yet clearly understood. However, it is believed that increased metabolic stress due to tissue hypoxia and metabolite concentration may be key to the increased anabolic response [3]. The aim of this study is to assess the effectiveness of the BFRt in improving muscle strength and physical performance in older adults.

Methods
A systematic review and meta-analysis of RCTs was carried out. PubMed, Cochrane Library, and Web of Sciences databases were systematically searched. PEDro scale and the Risk of Bias 2 tool were used to assess the methodological quality of the studies. Inclusion criteria were articles with healthy participants older than 60 years. Exclusion criteria were interventions lasting less than 8 weeks were excluded, and combination of BFRt with other techniques.

Results
The search strategy found a total of 222 studies. After reviewing inclusion and exclusion criteria, 8 articles were finally included in the meta-analysis, with a total of 248 healthy older adults. The main results of the study showed a significant improvement of BFRt against the control group in muscle strength (SMD = 0.47; 95% CI = 0.02, 0.93; Z = 2.04, P = .04; I2 = 69%) and non-significant in physical performance (SMD = 0.38; 95% CI = -0.05, 0.81; Z = 1.72, P = .09; I2 = 33%).

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Discussion

As we are concerned, this is the first article whose aim is to analyze the effectiveness of BFRt in older people in terms of muscle strength and physical performance. In view of the results, it can be observed that an improvement in muscular strength will not always imply an increase of the same magnitude in physical performance. The BFRt could be a good alternative to increase muscle strength in those people in whom it is inconvenient to train with high loads, as in the case of some elderly people. Due to the high heterogeneity of the studies, both in the characteristics of the sample, in the training protocols, in the variables measured and in the control group, it is difficult to generalize the results of the study.

Conclusion

BFRt could be an interesting alternative to high-intensity resistance training for improving muscle strength in older people who cannot perform high-load exercises. Better quality and longer-term studies are needed to confirm these results.

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Keywords: Blood flow restriction, Physical performance, Elderly

Mechanical, cardiorespiratory, and muscular oxygenation responses to sprint interval exercises under different hypoxic conditions

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Repetition of short "all-out" exercises ($\leq$ 30 s) car generate gains in performance similarly to conventional training protocols but with a lower volume. Recently, sprint exercises in hypoxia have been found to promote additional stress and to generate gains in performance in a short-time window. Among these methods, training with blood flow restriction (BFR) has become popular over the years. BFR training generates local hypoxia within skeletal muscles and/or limits venous return according to the occlusion pressure exerted. This training modality appears consistent in generating additional physiological stress during exercise bouts or during recovery. However, although these training methods seem favorable to adaptations, studies are needed to compare and understand the acute physiological stress they generate. The present study compared the acute effects of all-out sprint interval training (SIT) performed with bilateral blood flow restriction or under systemic hypoxia (HYP) on cardiorespiratory responses and muscular oxygenation. According to a cross-over study, twelve recreational athletes completed a SIT session consisting of five long sprint exercises (30 s) interspaced by 4 min rest periods. Participants were subjected to partial BFR60 (_˜60% of absolute occlusive pressure) of the lower limbs during the two first minutes of the recovery periods, to gravity-induced BFR (G-BFR) (1), exercised in a hypoxic room (FIO2≈13%), or were no subjected to additional stress (CON). G-BFR consisted of tilting an ergocycle at 90º to position the heart below the lower limbs and thus to generate ischemia. We analyzed maximal and mean power (Pmax and Pmean), time to achieve peak power (tPmax) and fatigue index (FI). Gas exchanges and muscular oxygenation were measured by metabolic cart and NIRS, respectively. Heart rate (HR) and peripheral oxygen saturation (SpO2) were continuously recorded. Results showed that SpO2 was lower for HYP and decreased in the last sprints for all the conditions. Cardiorespiratory parameters, RPE, Pmax, Pmean, tPmax and tissue saturation index were lower in G-BFR. No effect of condition was found on FI. BFR60application induced a decrease in gas exchange rates, which increased after its release. Muscle blood concentration was higher for BFR60. For HYP, performance variables were unaffected but mean and maximal oxygen consumption and muscular oxyhaemoglobin availability decreased. Pmax and Pmean decreased after each sprint excepting between sprint four and five. tPmax increased between the three first sprint and sprint five. RPE increased throughout the exercises. Finally, O2 utilization increased in the last two sprints. Thus, BFR60 promotes higher blood accumulation within working muscles, suggesting that BFR60 may additionally affect training adaptations by trapping metabolites. Both HG

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and G-BFR induced local hypoxia with higher level for G-BFR when considering both exercise sessions and recovery periods. Further studies are needed (i) to compare the effects of these protocols on field performance, (ii) to precisely evaluate the degree of stress generated by each condition, even if high values for both BFR and hypoxia have been used based on literature for this kind of exercise, and (iii) to examine cellular adaptations since the mechanisms of action may be different. (1) Preobrazenski et al. (2020). Appl Physiol Nutr Metab Physiol Appl Nutr Metab 45:641–649.

Keywords: Skeletal muscle, occlusion training, hypoxia, sprint interval training, performance

Reducing thermal perceptual and physiological strains during exercise in a warm ambient temperature improve cognitive performance after physical exercise.

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Context
Many occupational groups, such as workers, often perform challenging tasks in warm environmental situations. This excessive heat stress imposes physiological and perceptual strains on human body, that causes deleterious effects on physical performances. Indeed, excessive increase of body core temperature during exercise has a negative impact on psycho-physiological functions and exercise performance. Strategies that can prevent excessive heat stress and reduce thermal strain during exercise are therefore of great importance. Therefore, a decrease in skin temperature is essential to improve working conditions, to reduce work stress and to prevent accident risks. To achieve such objectives, personal cooling systems have been designed to become effective tools to reduce heat stress while someone is working or training in a warm environment.

Aim
Since the effect of cooling on cognitive performances is still unclear, the present study was designed to assess the effects of wearing a cooling vest during a strenuous exercise in a warm environment and in a subsequent cognitive test.

Method
Sixteen young males participated in this study. The participants were invited to perform a 30-min exercise on the stationary bicycle at 70% of their maximal heart rate in a climate chamber. During the exercise, these subjects wore a cooling a garment prototype and during one of the session the device was activated (ON-mode) and during the other session it was deactivated (OFF-mode). The ON-OFF sessions were systematically randomised. The climate chamber was

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set at a dry-bulb temperature of 30∘C±1∘C and 60% ± 2% of humidity. During exercise, tympanic temperature and heart rate were measured and the physiological stress index (PSI) was calculated. After exercise cessation, the subjects performed a Stroop task to measure inhibition abilities.

Results
A significant main effect of time was found for temperature with a different pattern depending on condition. We found that tympanic temperature increased during exercise in both sessions but with a larger amplitude in OFF than in ON condition. Also, HR was significantly higher during exercise and at the end of recovery in OFF than in ON condition (120.9 ± 11.8 vs 110.4 ± 7.1 beats/min, $P < 0.01$, respectively). Also PSI significantly increased during exercise in both conditions ($F_{7,30} = 323.05$, $P < 0.001$) but the magnitude was higher in OFF than in ON condition (interaction condition*time; $F_{7,210} = 6.04$, $P < 0.001$). T-test comparisons revealed a significantly lower reaction time during the inhibition task in the Stroop test in the ON vs the OFF condition (672.61 ± 115.91 vs 724.43 ± 127.34 ms; $P < 0.01$; respectively).

Discussion and conclusion
Our results show that wearing a cooling jacket during a strenuous exercise in a warm environment reduced the physiological strain during both exercise and recovery and improved cognitive processes (inhibition abilities) after exercise.

Keywords: Physiological strain, Warm temperature, Cooling vest, Cognitive abilities, Physiological responses

Relationship between muscle recruitment and neuromuscular function of the Gluteus Maximus in dynamic knee valgus during un single-legged drop landing in female athletes.

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Introduction
ACL injuries are present in impact sports nowadays. These generally occur with an increased of knee valgus angle. One of the sporting gestures in which the most significant increase in dynamic knee valgus has been observed is during the reception of a jump. Currently the incidence of ACL injury is two to eight times greater in females. (1). This value is not only due to the increase in the number of federated female athletes over the last decade, but also due to a physiological increase in knee valgus. For this reason, previous study has studied, in males, the relation between the knee valgus and some parameters of the neuromuscular response as stiffness, maximal muscular displacement or contraction time, in Gluteus Maximus (2).
The aim of this study is to see if there is a relationship between knee valgus angle and muscle recruitment and neuromuscular function of the Gluteus Maximus.

Methods
A total of 20 female athletes participated in this study, in which muscle recruitment was measured using Surface Electromyography (mDurance), of the Gluteus Maximus, in both legs, during the dynamic movement of the Unilateral Dropp Jump (UDJ) simulating the reception of the jump. The valgus angle collected by video camera during the UDJ was analysed using Kinovea. The maximal muscular displacement (Dm) or contraction time (Tc), was measured using Tensomiography and the stiffness was measured with Myotonometry (Myoton Pro).

Results
A total sample of 20 active and healthy collegiate female athletes was recruited for this study. Characteristics of the sample were 22.26±4.59 years, 55.3±5.7kg weight, 1.69±0.05m height and 22.33±1.3 body mass index. A 64.2% (n=13) of the sample practiced sport three times per week, a 20% (n=4) four times per week and a 15,8% (n=3) five times per week. The most representative sport was soccer with 40.1% (n=8), followed by basketball with 20% (n=4). The

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75% of the sample were right-legged. The knee valgus peak average for the entire sample was 11.5±6.5 and 10.9±6.8 for dominant and non-dominant limbs, respectively.
Strong and significant correlation was found between muscle recruitment of Gluteus Maximus. But not statistically significant correlations were obtained in the neuromuscular function parameters such as, stiffness, maximal muscular displacement or contraction time.

Discussion
Through this study we can see that Gluteus Maximus muscle recruitment can influence the valgus angle, and this should be taken into consideration in the prevention and/or rehabilitation of ACL injuries. Moreover, knowing that TMG and MMT evaluate the isolated neuromuscular response of a muscle, uninvolving the central nervous system, we can see the importance of this in the control of dynamic knee valgus comparing with sEMG.

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Keywords: Knee valgus, ACL, Muscle recruitment, Neuromusuclar function, Gluteus Maximus.

Relationships between sports club participation and physical fitness and body mass index in childhood

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Introduction

Physical fitness (PF) is a determinant of health.(1)The aim of this study was to examine the relationships between sports club (SC) participation and PF, and body mass index (BMI) in children.

Methods

The population included 15,625 children (8,029 boys and 7,596 girls) divided into aged groups (5-6, 7-8 and 9-10 years). PF was assessed with the Diagnoform® tests which included, a cardiorespiratory endurance shuttle run-walk self-regulated for 6 minutes, standing broad jump, speed (30-m), hopscotch and flexibility tests. The PF quotient (scored on 100) that considered the results of the different Diagnoform® tests was calculated and gave the general PF.(2) Height and body mass were assessed, and BMI was calculated. Children were ranged by BMI class (*i.e.* underweight, normal-weight, overweight and obese). SC participation and the sport most practiced by the child were documented. The sports were classified into categories based on the educational goal and the official program of French Physical Education (CA1, CA2, CA3, CA4). CA1 includes track and field, swimming, triathlon and cycling; CA2 includes canoeing-kayaking, equitation, ice sports and sailing; CA3 includes dance and gymnastics; and CA4 includes team sports (soccer, basketball, handball, hockey, etc.), combat sports (boxing, martial arts, fencing and wrestling) and racket sports (badminton, tennis and table tennis). The normality of the distribution was verified with a Shapiro-Wilk test. The equality of variances was assessed with Levene's test. To analyse the differences ANOVA (analysis of variance) was executed. When significant differences were obtained, a Bonferroni *post-hoc* test determined where the differences lay.

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Results
Older children scored better in the PF components than younger children ($p < 0.05$), except for flexibility. Boys scored better in the PF components than girls, except for flexibility and coordination ($p < 0.05$). Obese children had the lowest PF and SC participation (48% of children classified as obese practiced in a SC *vs* 55 to 58% for the others BMI class). The variation in PF between obese and normal-weight children expressed in percentage was greater at 9-10 (18%) than 5-6 years (14%).
Boys were more often in SC than girls ($p < 0.001$). The children who practiced in SC had better general PF than those who did not. CA1 and CA4 sports seemed to be associated with a better general PF compared to CA2 and CA3 ($p < 0.05$). CA1 and CA4 had better cardiorespiratory endurance ($p < 0.001$). CA4 had greater muscular strength and speed ($p < 0.001$). CA3 showed the greatest flexibility ($p < 0.001$).

Discussion
The promotion of preventive health projects for primary school children seemed to be crucial to increase PF and SC participation and to combat the burden of overweight and obesity. The SC dropouts (children classified as obese and girls) need to be targeted for future projects. Our results also suggested the importance of acting as soon as possible to build positive attitudes about sport to ensure children's future health because the differences are growing up with the growth between the children who practices in SC and the dropouts of SC participation.

Conclusion
Among 5- to 10-year-old children, fewer girls practiced in SC than boys, SC participation was lowest for children classified as obese. CA1 and CA4 sports seem to increase PF level.

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Keywords: physical activity, children, BMI, gender

Reproducibility of the Portamon NIRS device after induced muscle ischemia at rest

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Introduction
Near-Infrared Spectroscopy (NIRS) is an innovative and non-invasive technology used to investigate muscular oxygenation through several indicators. NIRS technology has been used for more than 20 years to investigate the effects of physical activity on muscular oxygenation (Van Beekvelt, 2002). Thanks to their small size and their wireless connectivity NIRS devices are convenient to use both at rest or during exercise. Moreover, it offers an easy way to assess hemodynamic response. However, muscular oxygenation levels appears to be variable between participants. So, it could be particularly interesting to investigate the reliability of Portamon NIRS devices inter- and intra-participants.The aim of this study is to evaluate the reproducibility of the Portamon NIRS device on two separate occasions after induced muscle ischemia.

Methods
For this study, 15 participants (males between 18 and 30 years old) were recruited and performed two sessions of resting ischemia and reperfusion periods (within 24 hr to 72h). Anthropometric measurement and resting blood pressure were assessed. Then, NIRS devices (Portamon, Artinis Medical Systems, the Netherlands) were placed on left and right forearms (brachioradialis) and thighs (vastus lateralis). Finally, a pressure cuff was placed on the participant's proximal part of the left arm. With the participants in the supine position, the protocol was as follows: 15 min of baseline, 7 min of occlusion, 10 min of reperfusion, 7 min of occlusion, 10 min of reperfusion, 7 min of occlusion and 20 min of reperfusion. The occlusion intensity was 250 mmHg. During the protocol, tissue saturation index (TSI%) was recorded. Data collected by NIRS were filtered. ANOVA-s and measures of reliability were performed to assess any statistical differences between periods, sessions, or subjects.

Expected results and discussion
Baseline measurements of TSI% should be reproducible for both arms between sessions of a single participant. However, TSI% should not be reproducible between participants because of different adipose tissue thickness (ATT) (Van Beekvelt, 2002) and various volumes, levels and types of physical activity (Perrey & Ferrari, 2018). Intra-subject left arm (occluded) measurements of both hyperaemia and deoxygenation levels after induced ischemia should be reproducible between sessions, but not between the three occlusions periods as ischemia periods induce greater oxygenation level during reperfusion period (Cunniffe et al., 2017). Right arm responses to cuff inflation should be reproducible between sessions and occlusion periods.

*Speaker

Conclusion
Muscle oxygenation measured by NIRS devices should show a good reproducibility between sessions for a single session. However, training status, ATT or occlusion intensity should show a large intersubject variability for muscle oxygenation.

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Keywords: blood flow restriction, ischemic preconditioning, rest, reproducibility, reliability

Subtyping non-specific low back pain, a protocol presentation

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Non-Specific Low back pain (NSLBP) is a significant public health problem representing _˜90% of the total LBP diagnosed. However a lot of variability exist between patients [1], which makes difficult providing adequate treatment. Some studies already shown discrepancy among biomechanical and neuromuscular variables in the NSLBP population [2]. Amongst them, the excursion and mean velocity of the Center of Pressure, which increase in NSLBP people during short term cyclic movements [3, 4] and muscle activation of back and abdominal muscles, which present higher and more variable patterns of activity in NSLBP participants when compared to healthy controls. This study aims to subtyping NSLBP patients based on these variables.

30 healthy and 80 participants with chronic or acute NSLBP will be recruited. Postural recordings and different trunk movements, at preferred and maximal speeds, will be executed. All the conditions will be performed with eyes closed. During the experiment, kinetic (force plate), kinematic (full body set of 46 markers, including 8 clusters placed on the spine) and muscle activity (high density surface electromyography (hdEMG) of paraspinal muscles activity from both side of the spine, and bipolar EMG of the rectus abdominis, external obliques), will be recorded (fig. 1).

Subgroups of participant will be achieved with pattern identifier algorithms, like the latent class analysis [2], on the variables of interest. It is a type of algorithm that works by identifying relation between multiple variables and a set of discrete latent variable, in our case the possible subgroups in our population. This unsupervised learning modelling technique will be set to detect up to 10 subgroups, i.e. the different values of the latent variable. In order to reduce chance

*Speaker

of local solutions a 500 random seed points will be used. The resultant models will be examined for the degree of contributions of each variable incorporated and also for residual correlations within classes. The model presenting the lowest Bayesian Information Criterion score will be chosen. Following this procedure, variables with low discrimination contributions ($r^2 < 10\%$) will be removed to reduce the number of parameters and increase the power of the model. If time allow, other modelling techniques will be used to test against the results from the latent class analysis in order to find the best possible fit.

Sanitary restrictions have delayed data acquisition which is currently underway. We expect to find at least 4 subgroups that will span from healthy to the NSLBP group [2]. Doing so will help us understand the underlying characteristics of each subgroup. We expect that subgrouping NSLBP patients will improve the diagnostic to find the most appropriate treatment to provide to patients [5].

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Keywords: Low Back Pain, High Density EMG, Decomposition EMG, Mocap, Biomechanics

The Impact of Physical Activity and Musical Therapy on Children with Autism Spectrum Disorder

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Background
Autism spectrum disorders (ASD) are often identified through motor and behavioral disorders which can cause a major influence on children's development and their families.
The complexity of this pathology requires a precise analysis of several physiological, neurodevelopmental, genetic, and psycho-affective factors. To solve this problem, a large variety of interventions are proposed. Acute physical activity and music therapy could have a beneficial effect on ASD children autism (*i.e.* improving the self-esteem and the social skills) as reported in previous studies (Woodman et al., 2018 ; Bremer et al., 2020).
Previous studies were interested in the effect of music therapy on socials skills with attempts to improve communication disorders without focusing on cardiovascular adaptations to exercise. Other works investigated the effect of a standard physical activity on the cardiorespiratory, motor, and autonomic profile. To the best of our knowledge, only few studies explored the effect of exercise or music therapy on sub-maximal aerobic capacity through TM6.
The aim of the present study examined the effect of physical activity and music therapy on sub-maximal aerobic capacity through a Field test (TM6) in ASD children. We hypothesized that physical activity induced higher improvement in heart rate, physical performance, SO2 values than music therapy of the ASD children, and this improvement depends of the degree of impairment of children.

Methods
Forty-Three children with ASD (aged from 4 to 14 years) in two special school where recruited on the basis of the severity of their symptoms and the type of therapy used.
The children of the first school (n=23) practiced adapted physical activity program. The children of the second center (n=20) took part in a music therapy program.

Results
Compared to pre-test, post-test heart rate decreased more in physical activity group throw the first minute of the test ($p< 0.05$), ($p< 0.01$) for the second, third and fourth minute. There was a significant effet of program: Greater distance was achieved by the physical activity group (402.3±34.0 m) compared to control group (353.7 ±43.0 m). Higher oxygen saturation values were observed in the physical activity group before and after the TM6 test (87.7±6.7 %, 84.1±7.0 %, respectively) compared the music therapy group (83.4±10.5 %, 80.1±10.1 %, respectively)

*Speaker

Conclusion

The higher performance observed in the physical activity group during the six-minute walk test concerning heart rate, distance and oxygen saturation can be explained by the presence of physical exercise in the daily lives of ASD children.

Physical activity seems to be more effective in our subjects. This study is the first to verify the effect of degree of impairment on distance traveled. The decrease in SO2 values of both groups suggests that there is a significant use of oxygen to check and assess the latter's need in ASD children to accomplish the TM6, the psychic condition of the child (fear, stress, anxiety) before and during the test may be one of the causes which contributes to assigning similar values. Garde et al. (2013) showed a low values of SO2 in children with obstructive sleep apena, one of the major sleep problems in ASD children which could explain the values found in our study.

Keywords: Physical Activity, Music Therapy, Autism, Children Six, minute walking test

The influences of sports club participation and the type of sport on components of physical fitness and corpulence in adolescents and young adults

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Physical fitness (PF) is a powerful marker of health in adolescents and adults. The purpose of this study was to see the links between age, gender, corpulence, and sports club participation (SCP) on PF. The population included 49,988 participants (23,721 girls and 26,267 boys) who were divided into five age groups (11-12, 13-14, 15-16, 17-18 and 19-21 years) which were chosen because they represent grade levels in schools and universities in France. Height and body mass were assessed and body mass index (BMI) was calculated. Participants were ranged by BMI class (*i.e.* underweight, normal-weight, overweight and obese). PF was assessed with the Diagnoform® Tonic tests that included a cardiorespiratory endurance shuttle run self-regulated for 3 minutes, coordination (cross test), power (standing broad jump), speed (30-m), muscular strength (maximum push-ups knee on the ground) and flexibility (modified Schober test) tests. SCP was also documented. The practiced sport was collected. The sport most represented in each of the four categories (CA1, CA2, CA3, CA4) of the Official Bulletin of French Physical Education was separately identified for girls and boys. CA1 was represented by swimming, CA2 by horse riding, CA3 by dance and CA4 by soccer (sport most practiced by boys) and basketball (sport most practiced by girls). The effects of age, gender, BMI class and SCP were tested. Older participants scored globally better than younger participants ($p < 0.05$) with gender differences according to PF components. Boys' PF increased with age at a faster rate and was better than that of girls, except for flexibility ($p < 0.001$). For girls, a decrease was observed in endurance where girls in the 11-12 age group had better endurance than girls in the 17-18 group ($p < 0.043$), speed and flexibility at 17-18 years. Girls scored better on coordination until 15 years ($p < 0.001$), after which boys became better ($p < 0.01$). For girls, SCP decreased with age until 17-18 years ($p < 0.001$). SCP also decreased for boys but only between 11-12 and 13-14 years. SCP was greater for boys at every age ($p < 0.001$). Obese participants had

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the lowest PF ($p < 0.001$) and SCP whereas normal-weighted participants had the best PF (p < 0.001). SCP seems to increase PF, indeed, the performances of participants without sports club membership were always lower than that of participants with membership, regardless of the PF component ($p < 0.001$). Team sports seemed best for improving PF ($p < 0.05$), except flexibility (for which dancers performed better). Moreover, there were significantly more underweight and normal-weight individuals among dancers and riders compared to those in other sports ($p < 0.05$). Obesity was significantly more prevalent among basketball players compared to dancers, horseback riders, and soccer players ($p < 0.05$). The promotion of SCP is essential for French youth because it may be a way to combat the burden of overweight and obesity and increase health. Adolescents who do not practice in sports clubs may become more physiologically frail adults. The clubs should thus consider revising their offer by proposing adapted sport to accommodate club dropouts (overweight and obese participants and girls).

Keywords: physical activity, BMI, gender

Relationship between force and electromyographic signals complexity during a fatiguing task

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Introduction

Outputs of physiological systems exhibit constant fluctuations which can be investigated according to their temporal structure. In this regard, several measures derived from non-linear methods (i.e. recurrence plots, entropies or fractal dimensions estimations) generally clustered under the name of "complexity measures", have been applied to various physiological signals. Within the scope of neuromuscular system, it is well-known that the appearance of neuromuscular fatigue induces a decrease of EMG signal complexity acquired during submaximal voluntary contractions [1]. More recently this finding has been extended to force signals, indicating that fatigue impairs the ability of the neuromuscular system to adjust motor output quickly and accurately in response to task demands [2]. However, the existence of a potential link between the loss of complexity measured from the EMG signal of a single muscle and the loss of complexity of the force signal produced by a whole muscle group, is not clear. Accordingly, the aim of this study was to explore the relationship of the fatigue-induced loss of complexity between force and EMG signals. To this end, we used the percentage of determinism (DET), related to the regularity of a time series, from the recurrence quantification analysis (RQA). We hypothesized that the fatigue-induced increase of DET, reflecting a loss of complexity, will be correlated between force and EMG signals.

Method

Twenty-eight participants (12 men and 16 women) performed intermittent isometric contractions (8s of contraction / 4s of rest) of knee extensors at 50% of the maximal voluntary force until exhaustion. Neuromuscular fatigue was quantified using pre-post changes in maximal voluntary force. Surface EMG was recorded from *vastus lateralis* muscle. DET was computed from EMG and force signals acquired during submaximal contractions.

Results and discussion

Mean time to task failure was 392 ± 295s. During the fatiguing task, maximal voluntary force decreased significantly ($p < 0.001$) indicating the appearance of neuromuscular fatigue. Preliminary signals processing showed a significant increase of DET during the fatiguing task for both force and EMG time series confirming the fatigue-induced loss of complexity for neuromuscular signals reported in the literature. However, no significant relationship was observed between the

*Speaker

loss of complexity computed from force signals and that measured from EMG signals. Complementary analyses are currently performed to investigate the influence of the selection of input parameters (e.g. dimension, delay, radius) for RQA computation. The choice of input parameters and the potential effect of signals pre-processing will be discussed.

Conclusion

Although RQA is often overlooked to quantify the complexity of force signals, our preliminary results highlight the interest of this method to quantify fatigue-induced loss of complexity of these signals. Contrary to our hypothesis, the loss of complexity of force signals does not appear to be correlated to the loss of complexity of EMG signals. This suggests that both signals provide unique information and may thus be complementary to characterize fatigue-induced changes in the complexity of neuromuscular system.

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Keywords: recurrence quantification analysis, exercise, related fatigue, complexity

Fatigability of plantar flexors following continuous and intermittent contractions

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Introduction

Muscle fatigue is commonly defined as any exercise-induced reduction in the ability to generate muscle force or power (1) and is generally quantified as the decrease in short-duration maximal voluntary contraction (MVC). Muscle fatigue is known to be task-dependant. It has indeed been demonstrated that, for a similar contraction duration and intensity, voluntary isometric intermittent contractions (INT) induce less muscle fatigue than continuous ones (CON) (2). It has also been shown that CON contractions performed with various feedback control, until task failure (TF), resulted in a similar MVC loss despite different endurance times (3). Thus the question arises of whether the INT modality of contraction remains less fatiguing than the CON one when the muscle effort is performed until TF. Accordingly, the aim of the present study is to determine the impact of CON and INT contractions performed until TF, on muscle fatigue and fatigability (ability to maintain a high level of torque).

Methods

Sixteen healthy volunteers participated in two experimental sessions. Subjects sustained a 1-min MVC of the ankle plantar flexors before (pre) and after (post) CON or INT (15s on/5s off) isometric contractions at 40% MVC, performed until TF. Muscle fatigue, generated by the fatiguing exercises, was quantified by the MVC loss, while muscle fatigability was assessed by the torque loss during the sustained MVC. Percutaneous electrical nerve stimulations (doublet at 100 Hz) were delivered at rest (before and after the sustained MVC) and superimposed to the 1-min MVC (at 3 and 58 s) in order to discriminate the nervous (voluntary activation, VA) and muscular (potentiated doublet) alterations induced by the fatiguing exercises.

Results

A similar MVC loss was observed after both fatiguing exercises (CON = -27.4 ± 9.9 % MVC pre *vs.* INT = -24.8 ± 10.6 % MVC pre; $p = 0.48$), despite a greater muscle workload for INT (+311%) compared to CON contractions ($p < 0.001$). VA and potentiated doublet were reduced to a similar extent after both fatiguing exercises. On the contrary, the torque loss during the 1-min MVC was significantly greater solely after the CON exercise (pre = 38.2 ± 9.9 % MVC, post = 53.9 ± 14.1 % MVC, $p < 0.001$). Likewise, the VA loss during the 1-min MVC was greater only post-CON exercise.

Discussion

The similar MVC loss following CON and INT exercises suggests that these two contraction modalities generate a similar alteration in maximal torque generating capacity, despite a differ-

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ent exercise workload. Moreover, the nervous and muscular alterations responsible for muscle fatigue seem to be similar for both exercises. On the other hand, as regards the fatigability, we observed a greater 1-min MVC loss after the CON compared with the INT exercise. This bigger fatigability could be mainly attributed to neural alterations, since the VA loss during the 1-min MVC, was greater after the CON than the INT exercise.

Conclusion

INT and CON plantar flexors contractions performed at moderate intensity and until TF induce a similar amount of muscle fatigue. Muscle fatigability appears to increase after CON exercise while it remains unchanged after INT one. The different evolution of these two parameters proves that fatigability is a paramount aspect, in addition to MVC loss, to provide a more detailed description of neuromuscular alterations generated by muscle efforts.

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Keywords: Muscle fatigue, Muscle fatigability, Intermittent contraction, Continuous contraction, Plantar flexors

Characterization of hamstrings neuromuscular fatigue and critical torque in comparison to quadriceps muscles

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Introduction
In contrast to quadriceps (knee extensors, KE), hamstrings (knee flexors, KF) neuromuscular fatigue is not well characterized. If one study compared these two muscle groups following exercise matched for intensity, exercise time to task failure was drastically different [1], which is known to affect neuromuscular fatigue etiology [2]. Therefore, the purpose of this study was to characterize KF neuromuscular fatigue, compared to KE muscles, during all-out exercise in order to match both exercise time and intensity between muscle groups.

Methods
On separate days, twelve healthy men (26 ± 3 years) performed 60 KE or KF maximal isometric voluntary contractions (MVC) over a 5-min period (3 s contraction, 2 s relaxation). Central and peripheral fatigue levels were quantified via changes in preexercise to postexercise voluntary activation (VA) and potentiated twitch torque (Ptw), respectively, as evoked by supramaximal electrical stimulation of the nerve (KE) or muscle (KF). Neuromuscular function was evaluated before and immediately after exercise in both conditions. Critical torque (CT) was determined as the mean torque output of the last 6 contractions, whereas *W'* was calculated as the area above CT.

Results
Pre-exercise MVC was significantly greater in KE compared to KF (295 ± 50 Nm *vs* 119 ± 26 Nm, respectively, $P < 0.001$). During the 60-MVCs protocol, MVC decreased to a greater magnitude ($P < 0.001$) in KE (-67 ± 9%) compared to KF (-51 ± 10%), indicating that KF were more fatigue-resistant. More specifically, peripheral fatigue was greater in KE compared to KF (Ptw, -69 ± 15% *vs* -55 ± 10%, $P < 0.01$), while central fatigue only developed in KE (VA, -25 ± 28%) with no change in KF compared to preexeercise values. These discrepancies between muscle groups affected key parameters of the torque-duration relationship. Indeed, *W'* was 8 times greater in KE compared to KF (8111 ± 2073 Nm.s *vs* 1001 ± 696 Nm.s, $P < 0.001$) while CT was 52 ± 9% greater in KE compared to KF when expressed in absolute units (97 ± 26 Nm *vs* 60 ± 12 Nm, $P < 0.001$). Time to reach CT was shorter in KF condition (39th MVC)

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compared to KE (45th MVC). No correlation was observed between KE and KF for MVC (r^2 = 0.14, P= 0.24) or Ptw (r^2 = 0.14, P= 0.66).

Conclusion

The present study documented substantial differences in neuromuscular fatigue etiology between KE and KF muscles while matched for exercise duration and intensity (all-out). KF developed less peripheral and no central fatigue following the 60-MVCs protocol compared to KE. Despite this observation, absolute CT was lower in KF due to their substantial lower force capacity compared to KE. The absence of correlation observed between KE and KF fatigue parameters suggests no interrelation in fatigue etiology between KE and KF muscles within individuals, and therefore, highlights the need to investigate specifically hamstrings muscle fatigue (e.g. to better understand hamstrings injuries).

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Keywords: Hamstring, Neuromuscular fatigue, Quadriceps, Exercise, Critical force

Neuromuscular fatigability during repeated sprints assessed with an innovative ergometer.

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Introduction
Repeated sprint ability is an integral component of team sports. To date, there is no consensus on the respective contribution of central and peripheral alterations in neuromuscular fatigability (NMF) in such exercise, partly due to methodological considerations, as the time required between exercise cessation and fatigability evaluation (usually 30-180 s) (Collins et al. 2018), or the lack of individualization in exercise modalities (e.g. a given number of sprints inducing various performance fatigability levels/etiology between participants). To circumvent this limitation, an instrumented cycle-ergometer was developed to allow NMF to be assessed with no delay after a sprint. This study aimed to evaluate fatigability development and its etiology during and immediately after a cycle repeated sprint exercise performed until a given performance fatigability threshold.

Methods
Sixteen healthy males (24±6 yr, 71±10 kg) completed a repeated-sprint exercise (RSE) on a custom semi-supine bike (10-sec sprint / 28-sec recovery) until a 30% decrease in sprint mean power (Pmean) was reached. Maximum voluntary contraction of the quadriceps (MVC), central alterations [voluntary activation (VA)] and peripheral alterations [high-frequency doublet (DB100), twitch (Pt)] were evaluated before (pre), immediately with no delay after each sprint, at the end of the test (i.e. task failure, TF) and 3 min after. Sprints were expressed as a percentage of the total number of sprints to task failure (TSTF). Individual data were then extrapolated at 20, 40, 60 and 80% TSTF to be compared between participants. Repeated measure ANOVAs and Holm correction for post-hoc tests were performed.

Results
Participants completed 9.7±4.2 sprints before reaching a 30% decrease in Pmean, from a maximal Pmean of 585±85 W. Post-sprint MVCs were decreased from 20% to 60% TSTF and then plateaued (pre: 345±56 N, 20%: 296±57 N, 60% 247±55 N, 100%: 233±57, F(2.91, 37.81)

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=51.7, p< 0.001). DB100 and Pt decreased from 20% and plateaued after 40% TSTF (respectively, F(2.09, 27.10)=53.9, p< 0.001, ηp 2 = 0.81, pre-TF = -33 ± 10% and F(2.26, 29.37)=62.5, p< 0.001, ηp 2 = 0.83, pre-TF = -45 ± 13%). VA was not significantly affected by repeated sprints until 60% TSTF (pre-TF = -6.5±8.2%, χ2 (6) = 16.45, p=0.036). Unlike peripheral parameters, VA recovered within 3 min after the RSE (p=0.042).

Conclusion

During a RSE, the decrease in Pmean and MVC were first concomitant to peripheral alterations up to 40% TSTF and central alterations was only observed in the second part of the test while peripheral alterations plateaued. The distinct recovery kinetics in central versus peripheral components of fatigability further confirm the necessity to reduce traditional delays in NMF assessments following this type of exercise.

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Keywords: intermittent exhaustive exercise, central alterations, peripheral alterations, transcranial magnetic stimulation, peripheral nerve stimulation

Effects of age on neuromuscular fatigue: comparison between isometric, dynamic and cycling tasks

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Introduction
The effects of ageing on neuromuscular fatigue has been extensively studied during local (i.e. single-joint) isometric and dynamic fatiguing tasks. However, the age-related differences have not been directly compared between single-joint isometric and dynamic tasks, nor with locomotor (cycling) tasks with similar duty-cycle and workload. The aim of the present study was to investigate performance fatigability during isometric, dynamic and locomotor fatiguing tasks across age.

Methods
Preliminary data were used for the present abstract. Thirteen healthy young men (60 yr) and five very old men (> 80 yr) randomly performed three testing sessions: an isometric (ISO) and a dynamic (DYN) quadriceps intermittent fatigue tests on an isokinetic dynamometer and a similar test on a validated cycle (BIKE). The quadriceps intermittent fatigue test consisted of stages of 75 contractions (0.8-s on/0.8-s off; for ISO and DYN) or 120-s cycling at 37.5 rpm (BIKE). For all testing sessions, increments were calculated relative to the participants' body weight using device-specific equations (5% of body weight for ISO and DYN, 0.3 W.kg-1 for BIKE). Performance was quantified as the total number of stages performed and performance fatigability as the loss in maximal knee extensors (KE) isometric force. Central and peripheral components of neuromuscular fatigue were evaluated using percutaneous electrical nerve stimulation and the interpolated twitch technique to calculate muscle voluntary activation (VA%) and amplitude of the potentiated resting twitch (TwPOT) as index of contractile function.

Results and Discussion
Performance decreased with age for all the tests ($P < 0.05$). For the young men, performance was greater for BIKE (10.6±2.4 stages) than ISO (8.6±1.9 stages) and DYN (6.6±1.4 stages, all $P < 0.001$). For old and very old men, ISO (old: 6.5±1.7 stages; very old: 4.9±1.1 stages) and BIKE (old: 6.4±1.5 stages; very old: 4.1±0.9 stages) were both significantly higher than DYN (old: 3.5±1.1 stages; very old: 2.2±1.0 stages; all $P < 0.05$). No difference was found for the

*Speaker

old and very old in ISO *vs.* BIKE (all P> 0.05). Performance fatigability showed a significant age effect, but not session effect nor session × age interaction. Post-hoc analysis indicated that the loss in maximal force was significantly higher in young men (-29.8±12.6%) than very old men (-19.5±10.4%; P=0.006) but not old men (-25.7±10.5%; P=0.176) independent of the test. Decrease in TwPOT showed significant age effect, but the post-hoc analysis showed no differences between the young (-44.2±25.0%), old (-32.0±15.1%) and very old (-32.8±13.2%). Finally, difference in VA% was similar across sessions and ages (3.8±7.3%, 2.8±5.3% and 0.8±6.1% for young, old and vey old men, respectively). Those results were probably influenced by the low number of participants included in this preliminary analysis.

Conclusion

Those preliminary results suggest different performance and fatigability across ages, with young adults performing better and tolerating a larger amount of fatigability, mainly from peripheral contractile factors. The completed dataset with a sufficient number of participants will elucidate the interaction between age and fatiguing task.

Keywords: ageing, fatigue, interpolated twitch technique, neuromusuclar function.

Does exercise modality affect the differences in time to task failure and fatigability between children and young adults? A systematic review and meta-analysis.

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Introduction
Several studies investigated differences in task to time failure (TTF) and fatigability (i.e. the objective changes in performance during and/or after a physical task) between children and adults. While the current literature suggests that children present lower level of fatigability and longer TTF, the lack of consistency in the experimental designs prevent a robust interpretation of the data. Moreover, it is unclear how the type of exercise (e.g. whole-body versus isolated) may influence the reported differences in children versus adults regarding TTF and fatigability. The aim of this study was to systematically compare TTF and performance fatigability between children and adults and assess the potential influence of exercise modality.

Methods
This review was pre-registered on PROSPERO (CRD42020184549). Studies were searched using three databases (Medline, SPORTDiscus, Cochrane Library) and were included in the review if they met the following PICOS criteria: i) studies that compared children (< 18 years old) versus adults (18–35 years old); ii) studies with a fatiguing protocol (whole body, e.g. cycling or running, or isolated, e.g. isometric contractions); iii) studies assessing fatigability (i.e. evaluated by changes in muscle force and/or power and/or velocity during and/or after the exercise) and/or TTF (i.e. evaluated by a time to exhaustion or a total number of repetitions needed to reach a certain amount of fatigability); iv) cross-sectional and longitudinal studies. The quality assessment of all included studies was performed using the modified Newcastle-Ottawa Quality Assessment Scale. Meta-analytic statistical comparisons between children and adults were made regarding outcomes of interest, i.e. TTF and indices of fatigability. A separate meta-analysis investigated the influence that the type of exercise may have on the reported differences in TTF and fatigability between children and adults.

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Results
Among the 4468 records identified, 54 studies met the inclusion criteria. Children have longer TTF than adults [0.95 (95% IC: 0.25,1.65), p = 0.008]. The type of exercise has an influence on these differences, with children presenting longer TTF when isolated [1.28 (95% IC: 0.68,1.88), p< 0.001] rather than dynamic [-0.18 (95% IC: -2.78,2.41), p=0.88] exercises are used. Children are less fatigable than adults [-3.06 (95% IC: -3.80,-2.33), p< 0.001], independently of the type of exercise being performed. The results present a high heterogeneity (I2 ranging from 84.8–91.8).

Discussion
Our results confirm that children present longer TTF than adults. There is an effect of exercise modalities on the observed differences in TTF. While we also demonstrated lower level of fatigability in children, the interpretation of this results lacks robustness since statistical analysis were made on absolute data, and ongoing statistical analysis are performed on relative values to allow an appropriate interpretation of the fatigability data. High heterogeneity was observed in the meta-analytic comparisons, suggesting variability in the protocols of pooled studies. Ongoing moderation analyses are performed to investigate variables that could partly explain this heterogeneity. Future studies should target protocols that help to understand how exercise modalities interact with the differences in TTF between children and adults.

Keywords: muscle fatigue, endurance, children, adolescent

HIITing the brain in individuals with obesity: influence on cerebral oxygenation and affective valence during exercise

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Background

Physical activity is a cornerstone for the management of obesity. Owing to, in part, lower pleasure, this population however perform very little exercise.[1] From a physiopsychological standpoint, left and right prefrontal cortex (PFC) activation are thought to be related to positive and negative affects, respectively.[2] Moreover, larger left PFC oxygenation during exercise is associated with higher cardiorespiratory fitness (CRF).[3] In individuals with obesity, high-intensity interval training (HIIT) is more effective on improving CRF than traditional moderate-intensity continuous training (MICT).[4] The influence of exercise training on PFC oxygenation and affective response to exercise in individuals with obesity is, however, currently unknown. Owing to the greater reported cardiocirculatory effects of HIIT *vs* MICT, we hypothesized a larger improvement in left PFC oxygenation profile and a more positive affective response to exercise in participants undertaking an 8-week HIIT program compared to MICT.

Methods

Twenty individuals with obesity were randomized to MICT [50% peak work rate (WRpeak)] or HIIT (1-min at 100% WRpeak/1 min of rest; both n=10: 45-min duration, 3 sessions/week, 8 weeks). Before and after exercise training, participants completed an incremental ergocycle exercise test. Near-infrared spectroscopy and the Feeling Scale assessed both PFC oxygenation and affective response to exercise, respectively. Effect size for the main findings (cerebral oxygenation and affects) was calculated with a Cohen's d test.

Results

Exercise training improved CRF in MICT and HIIT, but increases in WRpeak (20±13 *vs* 32±14W) and peak O2 uptake (% predicted: 10±7 *vs* 16±7%) were greater after HIIT ($p< 0.05$).

*Speaker

Only HIIT led to larger increases in left PFC oxyhemoglobin (from 9±6 to 14±10 μmol, d=0.54) and hemoglobin difference (from 7±6 to 10±7 μmol, d=0.46) concomitantly with enhanced affective valence (from 0.7±2.9 to 2.2±2.0, d=0.60; all $p< 0.05$) at exercise intensities exceeding the second ventilatory threshold. Exercise training-induced **c**hanges in left PFC oxygenation (e.g. hemoglobin difference) were associated with those in exercise tolerance [e.g. WRpeak (% predicted), r=0.46] and post-exercise training affective valence scores (r=0.45; both $p< 0.05$).

Discussion and conclusion

Promoting adherence to physical activity is a formidable challenge in individuals with obesity. Our study shows that HIIT proved specifically effective in enhancing left PFC oxygenation and affective response to exercise in this population. Implementing this modality in exercise training programs may therefore have relevant implications for the management of obesity, since greater affective response to exercise is thought to be associated with future commitment to physical activity [5].

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Keywords: Affect, exercise, obesity, obesity management, spectroscopy, near, infrared.

Beneficial effects of HIIT and/or linseed oil supplementation to limit obesity-induced oxidative stress

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Background and aim
Obesity is a complex medical condition characterized by excess body fat, leading to impaired health and increased mortality rate. Unhealthy dietary habits (i.e. high intake of energy-dense foods and low intake of food rich in micronutrients and bioactive compounds) and physical inactivity/sedentary lifestyle are the main causes of obesity. The excessive fat accumulation in adipose tissue increases reactive oxygen species (ROS) production through different mechanisms and subsequently promotes systemic oxidative stress (OS) (Manna and Jain, 2015). High-intensity interval training [HIIT] (Groussard et al., 2019) and linseed oil [LO] supplementation (Tamtaji et al., 2020) are known effective strategies for reducing obesity-induced oxidative stress. This study objective was to determine whether the HIIT-LO combination might potentiate their effects to prevent obesity-induced oxidative stress in a rat model of obesity.

Methods
Eight-week-old male Wistar rats fed a high fat diet (HFD: n = 48; 43.3% fat to induce obesity [including 4% of sunflower oil], 17.3% proteins and 39.4% carbohydrates) were subdivided in four groups: HFD (control), LO, HIIT, and HIIT+LO. An additional group of Wistar rats fed

*Speaker

a low-fat diet (LFD: n = 12; 11.5% fat, 19.8% proteins and 68.7% carbohydrates) was included. LO supplementation consisted in replacing 2% of sunflower oil in the HFD with 2% of LO. For HIIT, rats ran on a treadmill (0∘ slope), 4days/week for 12 weeks (6 sets of 3 min at 10m.min-1 followed by 4 min at 18 m.min-1). Epididymal (visceral) and subcutaneous adipose tissue, gastrocnemius muscle, liver, and plasma samples were collected to measure OS stress markers (advanced oxidation protein products [AOPP], oxidized low-density lipoprotein [oxLDL]), antioxidant system markers (superoxide dismutase [SOD], catalase, glutathione peroxidase [GPx] activities), and pro-oxidant enzymes (NADPH oxidase [NOx] and xanthine oxidase [XO]) activities.

Results

Compared with the LFD, the HFD altered the pro/antioxidant status in the various studied tissues, excepted for muscle (significant increase in plasma AOPP, oxLDL, SOD and CAT activities, significant increase in SOD activity in liver and decrease in epididymal tissue). LO supplementation induced beneficial effects in liver by upregulating the activity of the antioxidant CAT and by decreasing the activity of the prooxidant NOx. HIIT alleviated the HFD negative effects in liver by reducing SOD and NOx activity. In addition, the HIIT+LO combination potentiated their actions by up-regulating SOD activity in subcutaneous tissue.

Conclusion

HIIT and LO supplementation have independent beneficial effects on the pro/antioxidant balance. Additionally, their association promotes SOD activity in subcutaneous tissue.

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Keywords: Linseed oil (LO), high intensity interval training (HIIT), high fat diet (HFD), obesity, oxidative stress (OS).

The occurence of breakpoint in calf muscles deoxy[heme] is related to the duration of an incremental treadmill walk test in children with obesity

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Introduction
Recent study has found that cardiorespiratory fitness and fatness explain different components of cardiometabolic risks in preadolescent children. To reach VO2max, treadmill walking tests have been used in youth with obesity (Breithaupt et al., 2012). Physiological limitations of non-cardiorespiratory origin (such as muscle factors) might occur at high intensities in youth with obesity (Ratel et al., 2006) and explains that VO2max is difficult to reach during a progressive treadmill walk test. NIRS (near-infrared spectroscopy) can be easily combined with mouth gas analysis to study the relationships between whole body gas pulmonary gas exchanges and hemodynamic muscle responses during exercise. The relative intensity from which the increase in deoxy[heme] slows down in response to increased muscle work has been called "breakpoint" (BPdeoxy[heme]). In boys, the timing of BPdeoxy[heme] measured at the vastus lateralis correlated with the number of stops completed during the 20m shuttle run test (Kume et al., 2018) suggesting that running aerobic performance is partly determined by the muscle O2 extraction capacities. However, these measurements has never been conducted using an incremental treadmill test to determine VO2max in youth with obesity.

Purpose
To compare the pulmonary gas exchanges and calf muscles hemodynamic responses between VO2 plateau achievers and non-achievers in children with obesity.

Methods
26 children with obesity (11.6±1.7 y) performed an incremental treadmill walk test to exhaustion during which pulmonary gas exchanges and muscle hemodynamic responses at the medial head of the right gastrocnemius were measured continuously. The occurence of a VO2 plateau was considered when the VO2 slope increased by less than 50% of the expected increase between two

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consecutive 1-min intervals. If any, BPdeoxy[heme] was determined for each subject using piecewise double-linear regression models. The relationship between the timing of BPdeoxy[heme] and the test duration was also studied.

Results
BPdeoxy[heme] was detected in 21 out of 26 participants and occurred at higher intensity in the VO2 plateau group compared to the non VO2 plateau group (89±9 vs 81±13 %VO2, $p< 0.01$), despite no significant differences in clinical characteristics and peak cardiorespiratory data. Furthermore, the timing of BPdeoxy[heme] was strongly correlated with the duration of the test ($r=0.74$; $p< 0.001$).

Conclusion
In many children with obesity, a premature calf muscle deoxygenation could prevent the achievement of VO2max during treadmill walk tests. Therefore, we conclude that treadmill walk tests are of limited interest when assessing VO2max.

Keywords: Children with obesity, muscle NIRS, incremental test, VO2max, muscle deoxygenation

Effect of bariatric surgery on cardiorespiratory fitness in morbidly obese women

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Introduction
Severe obesity is associated with numerous comorbidities and increased morbidity and mortality rates [1]. As maximal oxygen consumption (VO2 max) is the gold standard to assess exercise capacity but also an important independent predictor of cardiovascular risks and general mortality, a clear description of the impact of bariatric surgery on this parameter is crucial. Therefore, this study evaluated the cardiorespiratory fitness before and after the bariatric surgery. We hypothesized that bariatric surgery in short-term would not increase in VO2 peak (absolute as well as indexed to body mass or fat-free mass).

Methods
Thirteen morbidly obese women (age: 36,7 ± 2,3 yr; weight: 110,5 ± 3,6 kg, BMI: 42,1 ± 1 Kg/m2) awaiting a bariatric surgery agreed to participate in the study after being informed of the nature of the experiments and gave written informed consent. In the 4 weeks before and 6 to 8 weeks the after surgery, body composition was determined by bioelectrical impedance. Then, they realized an incremental cycling test conducting to VO2 peak with 15 W increment each minute until exhaustion. VO2 peak was defined by the presence of at least 2 of the 3 criteria: respiratory ratio $\geq$ 1,1, age-predicted maximal heart rate, inability to maintain pedaling frequency $\geq$ 60 rpm.

Results
All parameters of body composition were reduced between before versus after surgery bariatric: body weight was reduced by 12,7 % (110,5 ± 3,6 versus 96,4 ± 3,4 kg; $p < 0,001$), BMI (41,8 ± 1,1 versus 36,7 ± 1,1 kg/m2 ; $p < 0,001$), Fat Mass (44,7 ± 0,8 versus 42,7 ± 0,9 % ; $p = 0,002$), Fat mass (49,6 ± 2,2 versus 41,5 ± 2,2 kg ; $p < 0,001$), Fat Free Mass (60,9 ± 1,6 versus 54,9 ± 1,4 kg ; $p < 0,001$) and Muscular Mass (57,8 ± 1,6 versus 52,1 ± 1,3 kg ; $p < 0,001$). At maximal exercise, there was only a decrease in absolute VO2 peak (2186,2 + 102,0 versus 1900,4 ± 90,9 ml/min ; $p < 0,001$) without any change in VO2 peak per kg, per kg of Fat Free Mass or per kg of Muscular Mass.

Discussion and conclusion
The results in body composition are in accordance with the literature with, however less important decrease in all parameters. For aerobic exercise capacity, previous study showed controversial results with either an increased [2]. unchanged, or decreased [3] VO2 max. In our study, the

*Speaker

evaluation of body composition and VO2 was made only 6 and 8 weeks after surgery bariatric, i.e before the resumption in physical exercise, while in others studies these evaluation was carried out later, from 3 months after surgery bariatric. It seems therefore that the post-surgery testing time and physical activity could play an important role in the evolution of these parameters. In conclusion, our finding confirmed that, in short term after surgery bariatric, weight loss in obese patients was not associated with an increase in maximal aerobic exercise capacity.

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Keywords: Bariatric surgery, cardiorespiratory fitness, VO2, obesity

Effects of different aerobic training modalities on peptide myokines levels in obese children

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Background
Preptin and irisin are two recently discovered such peptide myokines which play multifactorial functions in the regulation of homeostasis and energy metabolism (1). Studies investigating serum irisin and preptin in obese individuals are thus far somewhat equivocal. Results from several studies suggested that irisin levels were elevated (2, 3) decreased (4), and did not change in following chronic exercise training. Conversely, preptin levels are reported elevated in following chronic exercise training (5). Conversely, preptin levels are reported elevated in following chronic exercise training (6).Given to the differences in results and the paucity of investigations on these myokines, further study is required to investigate the changes in serum irisin and preptin levels and their protective role in obesity following exercise, as well as the influence of training intensity on their responses. This seems especially warranted in children, as obese children have the potential to become obese adults and have greater risk for developing cardiometabolic and CVD comorbidities. Therefore, this study aimed at identifying the effects of continuous low- to moderate-intensity exercise training (LMIT) and moderate to high-intensity exercise training (MHIT) on serum irisin and preptin levels among obese boys.

Methods
Thirty-nine male children with obesity (age: 13.4±0.8 yr) were randomized to either LMIT group (n = 13), MHIT group (n = 13), or non-exercise control group (CON, n = 13). Interventions groups performed three supervised sessions per week for 10 weeks, whereas participants in the CON group were required to continue their current lifestyle habits. Anthropometry measures, estimated maximum oxygen uptake (VO2max), irisin, preptin and lipid profile were assessed at baseline and after 10 weeks in the three groups. Serum irisin and preptin were analyzed by an ELISA kits (ZellBio GmbH, Germany) according to the manufacturer's guidelines.

Results
Irisin and preptin levels decreased ($p < 0.001$) in the LMIT and MHIT groups when compared to the CON group. Body mass and body mass index (BMI) z-score decreased in both training groups (LMIT and MHIT; all $p = 0.001$). Body fat percentage also decreased in the LMIT (p

*Speaker

= 0.001) and MHIT (p = 0.026) groups. VO2max significantly increased in the LMIT (p = 0.001) and MHIT (p = 0.001) groups; the LMIT group noted a significant increase in VO2max when compared to the MHIT group (p < 0.001). No significant changes were detected for lipid profile in all groups.

Conclusion

The present study indicates that both LMIT and MHIT exercise training modalities were equally effective in reducing irisin and preptin levels in obese male children, while MHIT led to greater improvements in overall fitness. In addition, we demonstrated a significant association between changes in these myokines and body composition changes. There is a paucity of knowledge of the impact of exercise training on irisin and preptin levels in obese children. In light of the overall similar impacts of LMIT and MHIT, based on our findings, we recommend that incorporating exercise training in the prevention and management of the childhood and adolescence obesity seems warranted and may be useful in the clinical context for pediatric obesity. Further studies with different types of exercise modalities, such as high intensity interval training and resistance training, are needed to confirm the findings of the present study.

Keywords: Adiposity, Aerobic exercise, Energy homeostasis, Metabolic peptides, Teenagers

Cardiopulmonary exercise testing combined with echocardiography and response after a cardiac rehabilitation program in chronic heart failure patients

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Background
Exercise training is strongly recommended to increase exercise capacity and consequently quality of life in chronic heart failure (CHF) patients. The magnitude of improvement of peak oxygen consumption (VO2) is highly variable between patients and a lack of response to exercise training has been described as a predictor of poor prognosis.
The aim of our study was to evaluate the efficiency of an experimental approach combining cardiopulmonary exercise testing (CPET) and echocardiography to improve personalized care of CHF patients.

Methods
Forty-one CHF patients (88% male, 57± 12yrs, under optimized medical treatment) referred to cardiac rehabilitation (CR) were recruited to perform CPET-echocardiography before and after 20 exercise-training sessions.
Patients underwent 2 CPET-echocardiography using a ramp protocol (10 watts/min) on a semi-supine bicycle. Measures were performed at rest, at the ventilator threshold 1 (VT1) and at peak exercise for VO2, CO2 output, ventilation, heart rate, blood pressures, cardiac output, left ventricular (LV) filling pressure (E/A, E/e'), LV global strain, LV ejection fraction and pulmonary pressure.
Cardiac rehabilitation program included exercise training (ET), patients' education, diet and psychosocial counseling. The ET combined endurance (continuous form, 2 sessions/week and interval form, 3 sessions/week) and resistance sessions.

Results
After the ET, VO2 peak increased from 16±5 to 20±6 ml/kg/min ($p < 0.05$) and the median value of the VO2 peak gain was 17%. The peak of cardiac output increased from 6.5±2.8 L/min

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to 7.4±3.0 L/min ($p < 0.05$) without significant increase in LV end-diastolic volume, LV filling and pulmonary pressures.
Non-responder' patients (VO2 peak gain < 17%) had a lower weight, suffered more frequently from ischemic cardiomyopathy, had beta blockers therapy and a higher increase of pulmonary pressure at baseline. CPET baseline measures were non-discriminant.

Conclusion
Our results suggest that the combination of CPET with echocardiography may be used to define different response to ET phenotypes and therefore be used to improve personalized care. Further studies are needed to determine the most appropriate ET for non-responder patients.

Keywords: cardiac rehabilitation, heart failure, echocardiography

Physical activity and thromboembolic risks: role of monocytic tissue factor in patient with carotid atherosclerosis plaque.

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Atherosclerosis is a multifactorial and inflammatory vascular disease. The inflammatory environment of the atherosclerotic plaque induces the liberation of pro-inflammatory and pro-thrombotic mediators, such as the tissue factor (TF) in artery wall. Plaque instability can lead to plaque rupture that the release huge amount of pro-inflammatory factors into the circulating blood, leading to the activation of the extrinsic pathway of coagulation1. The elevated low-grade inflammation in atheromatous patients may stimulate TF expression on the surface of circulating monocytes2, increasing the thrombotic risk of these patients. This is illustrated by a hypercoagulability compared to healthy subjects. Moreover, TF expression of activated monocytes is also increased in pro-inflammatory monocytes (*vs* anti-inflammatory). In this context, we previously shown that physical activity (PA) decreased the rate of pro-inflammatory monocytes in patients with carotid plaque3. Thereby, we hypothesize that PA intervention could limit the prothrombotic risk, measured by coagulation profile, of atherosclerotic patients through decreased TF monocytic expression.
Eighty patients with asymptomatic carotid atherosclerosis plaque $> 50\%$ will be recruited and randomized either in control or PA groups. The PA group follows 6 months individualized home-based PA intervention aiming to increase by 30% their daily step count compared to baseline and using a connected FitBit activity tracker and its mobile application. PA patients will be called twice a month to provide advices and to set new goal for next 2 weeks. Control group does not change its lifestyle. In both groups, the blood coagulation profile using rotative thromboelastometry and formation of clot *ex vivo* is evaluated at inclusion and at the end of the study, in 3 different conditions. The first condition is in native blood. The second is native blood with addition of TF and should provide information of the coagulation response to plaque rupture. The third is in native blood with addition of LPS-activated monocytes (or monocytes incubated in buffer as control) leading to increased monocytes TF expression to understand the role of monocytic TF in the modulation of the thrombotic risk. These 3 conditions are also done on blood from healthy subjects. Monocytes TF expression is measured by flow cytometry.

*Speaker

We present here the results on the first 10 patients that completed the study (5 in the PA group and 5 in the control group). Coagulation time is reduced with TF (condition that simulate plaque rupture) whatever the group or the time point, confirming in this population that risk of thrombosis and subsequent brain ischemic event is increased after plaque rupture. Control group decrease the coagulation time in both TF and buffer conditions after the 6 months but not the PA group. This suggests that PA may blunt the increase of thrombotic risk in patients with carotid plaque. Effect of LPS-activated monocytes was tested on the native blood of 5 patients and 6 healthy subjects. LPS-activated monocytes added on native blood increase TF monocytes expression and induce a faster coagulation either in patients or in healthy subjects. These first results suggest that the monocytic TF may have a role in the increased thrombotic risk of patients with carotid plaque and that PA could reduce this risk.

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Keywords: Coagulation, atherosclerosis, thrombus, physical activity, PACAPh study

Long-duration exercise induced cardiac fatigue in trained adolescents assessed by left ventricular strains and myocardial work

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Purpose
In adults, numerous studies reported that long-duration exercise such as long-distance triathlon or ultra-marathons induced cardiac damages associated with an impairment of cardiac function. While longitudinal and cross-sectional studies have reported cardiac chronic adaptations induced by endurance training in child and adolescent athletes, no study has still investigated the acute effects of a prolonged endurance exercise on the adolescent's heart using both echocardiography and myocardial cardiac damage biomarkers. The present study investigated the acute cardiac consequences of a long-duration (i.e. > 5h) adventure race in adolescent athletes using speckle tracking echocardiography to assess left ventricular (LV) strains, twisting mechanics and myocardial work, an novel interesting tool which take into account cardiac afterload.

Methods
Twenty male trained adolescents aged 14 to 17 yr volunteered to participate in a simulated competitive long-duration adventure race of 68.5 km including 41 km of mountain biking, 13.5 km of trail running and orienteering, 7 km of kayaking and 7 km of in-line skating. Heart rate (HR) was continuously recorded during the race. Blood samples were collected before, after, and 24 h after the race to determine the time course of troponin I (cTnI) considered as a myocardial damage biomarker. Echocardiography were conducted before and after the race to assess LV systolic and diastolic functions, myocardial regional strains, twisting mechanics and myocardial work using speckle tracking echocardiography.

Results
The mean completion time of the race was 05:38 ± 00:20 h and mean HR during the race was 83 ± 5 % of maximal HR. cTnI concentration significantly increased after the race (0.001 ± 0.002 *vs.* 0.860 ± 0.020 ngdL-1, p < 0.001) and returned to baseline within 24 h. Stroke volume (68.7 ± 16.7 *vs.* 66.9 ± 12.8 mL), ejection fraction (75.1 ± 5.4 *vs.* 76.8 ± 4.3) and global longitudinal

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strains (-20.4 ± 1.6 *vs.* -20.5 ± 2.2) remained unchanged after the race ($p > 0.05$) while global myocardial work decreased (2080 ± 250 *vs.* 1781 ± 334 mmHg%, $p < 0.01$) strongly suggesting a decreased of intrinsic myocardial contractility properties. From short-axis analysis of the LV, apical and basal circumferential strains decreased (-22.0 ± 3.2 *vs.* -19.7 ± 2.9 % and 26.7 ± 3.4 *vs.* -25.0 ± 3.9 %, respectively, $p < 0.05$ for all). Apical rotation also decreased (5.5 ± 2.5 *vs.* 4.1 ± 1.7 deg, $p < 0.01$) inducing a decreased of twist (8.6 ± 3.3 *vs.* 6.3 ± 3.3 deg, $p < 0.01$) suggesting that stored energy during systole is less important after the race. Global diastolic function was affected after the race with a significant reduction of LV untwisting rate (-91.0 ± 19.0 *vs.* 56.4 ± 29.1 degs-1, $p < 0.001$), an indicator of LV relaxation.

Conclusion
Using novel advances in echocardiography, our results demonstrated for the first time that a high-intensity endurance exercise of more than 5 hours altered significantly the function of the growing heart of trained adolescents. This is supported by the transient increase in the cTnI concentration and by the altered cardiac function, characterized by depressed and delayed myocardial regional strains and reduced LV twist, global myocardial work and myocardial diastolic function. These results raised the question of the long-term effects of practicing such long-duration races, especially when these races are started early during childhood and then adolescence.

Keywords: young athletes, myocardial damage, left ventricular twisting mechanics, speckle tracking echocardiography

Induced contraction of hindlimbs is associated with a cardiac output-dependent increase in cerebral blood flow. A rat study.

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Introduction

Previous studies reported that increased cardiac output (CO) contributed to the increase in cerebral blood flow (CBF) that is observed during physical activity involving a large muscle mass such as cycling activity1. The regular practice of such physical activity and the resulting repeated elevation of CBF is largely suspected to contribute to its beneficial on cognition2. Nevertheless, too much people exhibit sedentary behavior. Stimulated contraction has been proposed as a potential substitute to physical activity to improve brain function3,4. However, the effect of induced contraction of a large body mass on CBF has never been explored. Therefore, the present study examined whether induced acute contraction of hindlimbs in rats reproduces the effect of physical activity engaging a large body mass on CBF.

Methods

Experiments were performed in artificially ventilated chloral hydrate-anaesthetized rats. Heart rate (HR), blood pressure (BP), end-tidal pCO2 and CBF were recorded before (10 min), during (30 min) and after (10 min) stimulation of lumbar roots according to parameters resulting in bilateral posterior limb contraction (100 Hz, 0,2 ms, 5x motor threshold, 6s ON, 3s OFF). Sham rats (no stimulation) were run in parallel. Changes in CBF were measured in the sensorimotor cortical area representing the right hindlimbs using laser Doppler flowmetry. End-tidal pCO2 was kept around 35 mmHg by adjusting the ventilation rate in order to avoid hypercapnia-induced CBF elevation. Atenolol (10 mg/kg, penis vein) was administrated 10 min before the onset of stimulation.

Results and Discussion

A progressive time-dependent decrease in CBF was observed in sham rats (-7 % for maximal changes as compared to control values, n=4). A significant time-dependent increase in HR and CBF that reached 120 % and 185 % of prestimulation values were respectively observed after 30 min of stimulation (n=7). Cessation of stimulation resulted in a rapid (within 10 min) recovery of HR and CBF. Atenolol fully prevented stimulation-induced tachycardia but only partially reduced its effect on CBF. Thus, CBF increased by 38% in atenonol-treated rats (n=6). BP was not modified by stimulation. The results with atenolol indicated that both neuronal hyperactivity and increased CO contributed to CBF elevation in cortical area representing stimulated

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muscles. As increased CO observed during induced contraction reflects activation of sympathetic nervous system by mechano- and metabo-sensitive muscle afferent fibers (exercice presssor reflex)5, our results identify the amount of muscle mass activated as an important factor in CBF elevation evoked by involuntary contraction. Notably, according to our model of stimulation, activation of the muscle afferent fibers is consecutive to both muscle contraction and stimulation of the ventral spinal roots.

Conclusion

Induced contraction of a large body mass is associated with a CO-dependent CBF elevation. The ongoing research aims at investigating the effect of acute stimulated hindlimbs on CBF in cognition-related brain regions and then the effect of chronic stimulated hindlimb contraction on cognition.

Keywords: electrical stimulation, cardiac output, cerebral blood flow

Objective definition of athlete's heart

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Introduction
It is well documented that, the important cardiovascular demands induced by intense chronic physical activity led to chronic cardiovascular adaptations regrouped under the term "Athlete's heart" (1). An athlete is defined as a subject who train above 60% VO2 max more than 6 hours per week for at least 6 months aiming for performance Nevertheless, this definition is empirical. For the moment, there is still no study which has clearly demonstrated the minimal amount of physical activity which is needed to induce this remodeling. Even if there are norms for ECG and echocardiographic to evaluate the "athlete's heart" (2,3), some diagnosis difficulties can appear due to this empirical description.
The aim of our study is to objectively define the athlete's heart, to try to define an eventual threshold of physical activity (PA) from whom these adaptations can significatively appear.

Methods
372 males subjects between (18 to 35 years old) were included in a retrospective and multicentric study. Subjects were divided in 4 different groups according to the number of hours of PA per week: elite athletes (EA), +10 hours / competitive athletes (CA), 6 to 10 hours / leisure athletes (LA), 4 to 6 hours / inactive athletes (IA), 0 to 4 hours. During the medical check-up, all included subjects filled out a questionnaire on PA, got a medical examination, a rest ECG, and a rest echocardiography. The relationship between the amount of PA and different ECG and echocardiography characteristic was evaluated by an exploratory approach of the data.

Results
The preliminary results shows that the first characteristic difference tend to appear between the CA and LA/IA for the structural and functional adaptations (Left ventricular mass index (LVMi), left ventricular end-diastolic and systolic diameter index (LVEDDi/LVESDi), left atrial (LA) and right atrial (RA) surface, $p< 0{,}05$). The difference increases between the EA and all the other groups for the structural, functional, and electrical adaptations: left ventricular wall thickness (LVWT), LVMi, bradycardia, incomplete RBBB,...($p\leq 0{,}001$).

Conclusion
The results indicate that the first signs of cardiac remodeling appear among the CA, from 6 hours of PA per week. This cardiac remodeling is positively correlated with the increase of PA amount as the characteristics of athlete's heart are more pronounced among the EA. However, further analysis will be necessary to confirm these results and identify the impact of intensity and the type of PA on this remodeling.

*Speaker

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Keywords: Athlete's heart, physical activity, sport, athlete

Impact of acute partial-body cryostimulation on cognitive performance, cerebral oxygenation, and cardiac autonomic activity

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In sports medicine, the use of partial-body cryostimulation (PBC, exposition of the body except the head to a very cold air) has gained popularity for its systemic effects on the organism, in particular to accelerate the post-exercise recovery process. However, despite the plethora of studies conducted in the last decade, the physiological underpinning of PBC is not well known, and in particular its effects on the central nervous system and most particularly on cognitive function. Based on the neurovisceral integration model, heart rate variability (HRV) and executive functions are linked through the prefrontal neural function while the vagal control of the myocardium is related to the prefrontal cortex activity. Previous studies evaluating the link between cardiac parasympathetic activation (measured through HRV indices), and performance of executive functions, revealed that a higher vagal tone was associated with better executive functioning. On the contrary, decreased HRV indices of parasympathetic activation and increased sympathetic activation were linked to reduced performances of executive functions. Brain oxygen availability also plays a major role in cognitive performance and increased cerebral oxygenation seems to be related to better executive function. Amongst the few studies conducted so far, a decrease in core body temperature following body exposure to cold would have a detrimental effect on cognitive performance including executive functions. However, most of these studies evaluated cognitive performance during or following long-duration exposures to cold, such as two hours in 10 ∘C cold air or after cold water immersion. Therefore, the aim of the present study was to examine the effect of a single 3-min PBC session on executive cognitive performance with a particular focus on the inhibition process.
The effects of a 3-min PBC exposure was assessed on cognitive inhibition performance and the possible implications of parasympathetic cardiac control and cerebral oxygenation. In a randomized controlled counterbalanced cross-over design, eighteen healthy young adults (nine males and nine females) completed a cognitive Stroop task before and after a single session of PBC (3-min exposure at – 150 ∘C cold air) and a control condition (3 min at room temperature, 20 ∘C). During the cognitive task, HRV and cerebral oxygenation of the prefrontal cortex were measured using heart rate monitoring and near-infrared spectroscopy methods. We also recorded the cerebral oxygenation during the PBC session.

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Stroop performance after PBC exposure was enhanced (562.0 ± 40.2 ms) compared to pre-PBC (602.0 ± 56.4 ms; $P < 0.042$) in males only, accompanied by an increase in HRV indices of parasympathetic tone (RMSSD and HF; $P < 0.05$) , in greater proportion in males compared to females. Effect size of the difference from Pre to Post-PBC for HF revealed a very large effect in males (Hedge's $g = 2.0$) whereas a small effect was found in females (Hedge's $g = 0.35$). During PBC, cerebral oxygenation decreased in a similar proportion in males and females but the deoxyhemoglobin (ΔHHb) remained higher after exposure in males, only.
These data show that a single PBC session enhances the cognitive inhibition performance on a Stroop task in males, partly mediated by a greater parasympathetic cardiac control and greater cerebral oxygenation. The effects of PBC on cognitive function seem different in females, possibly explained by a different sensitivity to cold stimulation.

Keywords: Partial, body cryostimulation, Cerebral oxygenation, Heart rate variability, Cognition, Cognitive performances, Executive functions

Psychology - Education sciences

Does personality predict physically active lifestyle after pulmonary rehabilitation among patients with chronic respiratory diseases?

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Introduction
Pulmonary rehabilitation (PR) aims to promote the adoption of an active lifestyle. Unfortunately, its effectiveness on behavior change remains limited since 2/3 of patients are insufficiently active 6 months following the program [1]. Therefore, there is a need to identify the factors involved in physical active lifestyle maintenance. Personality traits, defined by the Five-Factor Model, may motivate the adoption of an active lifestyle in non-pathological individuals. For example, low neuroticism and high conscientiousness are related to higher physical activity and lower sedentary behaviors (SB) [2,3]. To date, little is known about these associations in chronic obstructive pulmonary disease (COPD) population following a clinical intervention. Thus, this study aimed to investigate the role of personality in maintaining an active lifestyle in COPD patients after PR program.

Methods
87 COPD patients were included during a 5-week inpatient PR program (67.80 ± 8.83 years). Personality was assessed at the start of the PR (T1). Physical activity was evaluated through 3 variables: moderate to vigorous physical activity (MVPA), walking time and activities of daily living (ADL). MVPA, walking time, ADL and SB were assessed at T1 and 6 months after PR (T2) using self-reported questionnaires.

Results
The independent sample t-tests show that patients who increased their level of SB between T1 and T2 had higher levels of agreeableness compared to those who decreased it [$t(86) = 2.5$, $p = < .01$, *Cohen's d* $=.57$]. In addition, multiple regression analyses reveal that high agreeableness was associated with an increase of ADL ($\beta=.13$; $p< .05$) between T1 and T2 independently of sex, age and severity of illness.

Discussion
Our results suggest that COPD patients with high agreeableness are more likely to increase both their amount of ADL and SB after pulmonary rehabilitation. These results are consistent

*Speaker

with a previous longitudinal study showing that low agreeableness predicts ADL limitations in old adults four years later [4]. Moreover, it has been shown that agreeableness had a positive association with SB in elderly [3]. Contrary to our expectations, personality does not appear to be involved in the maintenance of MVPA and walking time following PR.

Conclusion

This study highlights that investigation of personality is a promising perspective to understand the evolution of sedentary behaviors and activities of daily living after pulmonary rehabilitation. Additional research is necessary to identify what are the most appropriate interventions and behavior change techniques for each personality trait in order to offer specific support to vulnerable patients.

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Keywords: Personality, Health Behavior Change, Pulmonary Rehabilitation, COPD, Physical Activity, Sedentary

Additional physical education sessions during 21 days of thermal spa healthcare care: a 1 year follow-up pilot study

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Introduction
The purpose of this pilot study was to examine the feasibility of a study analysing the maintenance of engagement in physical activity of a group of non-active older adults included in additional physical education sessions, in a thermal spa resort, within their habitual care. Indeed, physical activity is rarely added to the thermal treatment (Falagas et al., 2009). The three weeks usually prescribed for a thermal treatment could be an excellent opportunity to include physical education sessions within healthcare care (King; 2006). We hypothesized that after a physically active period of thermal treatment, a group of non-active participants would continue to perform their acquired level of physical activity after their return home.

Methods
A cohort of 42 non-active participants (70.4 ± 4.5 yr), 33 women and 9 men, voluntarily participated in this study at the beginning of their 21-day thermal treatment. Together with their standard thermal care (5 to 7 health treatments per day), adapted physical education sessions (brisk walking and gymnastic maintenance sessions) were provided to them for 3 weeks (12 sessions individually tailored, four per week, 1 hour per session). Measurements were established during the period of 21 days (T1 at the beginning and T2 at the end) and during the follow-up, after the end of the thermal period, T3 (+ 15 days), T4 (+ 2 months), T5 (+ 6 months) and T6 (+ 1 year). At T1 and T2, anthropometric measurements (Height, weight and BMI), health-related quality of life (SF-36), volume of physical activity (QAPPA), psychological questionnaires (ISP-25, POMS-f, BREQ-2), flexibility (upper and lower limbs) and the 6-minute walk test (maximal distance, heart frequency, VO2max) were evaluated. During the follow-up, only health-related quality of life and the volume of physical activity were evaluated.

Results
The results indicated that the participants' volume of physical activity (median / IQR) was higher at T2 (1650 / 780), T3 (1590 / 845), T4 (1280 / 645), T5 (1440 / 960) and T6 (1280 / 1560) as compared to T1 (480 / 465). At T6, 64 % of the participants still had a higher volume of physical activity than at T1. In addition, there was a change to the health-related quality

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of life components during the follow-up. Furthermore, the participants improved their physical fitness components (BMI, flexibility, 6MWT distance, VO2 max) and their psychological parameters (global self-esteem, physical self-worth, intrinsic motivation and mood states) at T2 as compared to T1.

Discussion
It is likely that the physical and psychological status of participants at the end of the intervention were better and may support their engagement in an active lifestyle. The effects of the intervention and the maintenance of an adequate volume of physical activity by most of the participants might have enabled them to perceive an improved general health and physical function.

Conclusion
This strategy to maintain physical activity engagement appears to be feasible in a population of thermal care non-active older adults. This work demonstrates the feasibility of a study conducted to maintain physical activity engagement after a thermal treatment.

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Keywords: exercise, aging, fitness, physical education, health

A mobility program for seniors : ADYMA

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Background
Keeping seniors active and independent by physical activity (PA) practice can improve health and well-being (WHO, 2020) and reduce health risk in this population (McPhee et al., 2016). During the Covid-19 pandemic, some studies showed that engaging in PA over time-frames similar to those of the Covid-19 pandemic could lead to improvements in both anxiety and depressive symptomology in seniors (Callow et al., 2020).Interventions that promote PA among seniors appear to be effective between 3 and 12 months (Grande et al., 2020). Few studies have combined psycho-social and accurate monitoring of activities of daily living by accelerometers in a free-living condition and a follow-up of several months.

Objectives
Two groups of seniors (mobility program group; n=42 vs no participation in the mobility program group; n=31)living in aged care residences were compared to measure the impact of a ten-month mobility program on psycho-social and behavioral variables.

Method
Participants (N=73) were seniors living in four different aged care residences.
Measures Both groups will complete a long version questionnaire on psychological and social factors, and they will wear an accelerometer (GT3x® was worn for seven days for at least 10 hours) at the beginning of the intervention and at the three-month mark, and at the end of study. They will also answer a short version questionnaire on a monthly basis. Only the mobility group participated in a ten-month multimodal exercise program (i.e., gymnastic, urban and nature walks) in a free-living condition.The long version questionnaire include: 1) demographic, 2) adaptation of an aged person in their residence, 3) sense of social belonging, 4) social provisions, 5) personality, 6) geriatric anxiety, 7) vigour and 8) physical self-esteem. In the short version the dimensions 2 and 5 are not measured. Intervention content to experimental group according to Behaviour Change Taxonomy (Michie et al., 2010) included seven behavior change technique: goal setting, action planning, social support, feedback, monitoring, shaping knowledge, and instruction on how to perform the behavior.

Results
The different ANOVAS revealed no significant differences between the two groups, on the sedentary and PA behaviors, and on the psycho-social factors, except at Time T2 on 3 dimensions: acceptation, privacy and relationships with others. The analysis showed contradictory results on these dimensions: the control group present higher scores than the ADYMA group. Two

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main explanations and limits can be discussed: an imbalance of subjects between the 2 groups and several interruptions of the PA program. Moreover, the promotion of PA needs to be accompanied by a program to reduce sedentary lifestyles in this population.

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Keywords: seniors, mobility program, self, esteem, anxiety, personnality

Self-control as a mediator between executive functions and physical activity

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Physical inactivity is a leading cause of mortality with 5 million deaths per year1. Despite intentions toward physical activity, people often fail to translate it into behavior2. This discrepancy could results from difficulties to overcome daily motivational conflicts which oppose goals toward physical activity to desires toward sedentary behaviors3. Self-control permits motivational conflicts resolution, however features of self-control (in)effectiveness remain unknown. Executive functions (i.e., inhibition, working memory, cognitive flexibility) have been suggested as predictors of self-control (in)effectiveness and health behaviors. Precisely, self-control could mediate the relation between executive functions and health behaviors. The only study that tested this assumption found unsupportive results4, but (a) did not evaluate the role of executive functions separately; (b) only investigated one (criticized) dimension of self-control (i.e., trait self-control), ignoring more contemporary and situational dimensions; and (c) did not consider physical and sedentary activities as outcomes. Thus, we aimed at (1) comparing the predictive weight of each executive functions on contemporary and situational self-control dimensions; and (2) evaluating the mediated effect, through self-control dimensions, of executive functions on physical and sedentary activities. A priori power analysis revealed that a minimal sample size of $n = 280$ was required to reach 90% power for all planned analyses. This well-powered cross-sectional study recruited 591 participants on a single session of 45-minutes experiment including three distinct executive functions tasks, and questionnaires for assessing the self-control dimensions (i.e., trait self-control, state self-control, attention control, inhibitory control, activatory control) and physical and sedentary activities5,6. The ongoing path analyses are used to test our assumptions. The expected results will shed some light on the cognitive processes underlying self-control (in)effectiveness. We will also be able to specify which executive function, and which self-control dimension, is the most strongly associated with physical and sedentary activities.

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Keywords: self, control, executive functions, physical activity

Climate Change, Physical Activity and Sport: A Systematic Review

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Introduction
Climate change impacts are associated with dramatic consequences for human health and threaten physical activity (PA) behaviors. The aims of this systematic review were to present the potential bidirectional associations between climate change impacts and PA behaviors in humans and to propose a synthesis of the literature through a conceptual model of climate change and PA.

Methods
Studies published before October 2020 were identified through database searches in PubMed, PsycARTICLES, CINAHL, SPORTDiscus, GreenFILE, GeoRef, Scopus, JSTOR and Transportation Research Information Services. Stud- ies examining the associations between PA domains and climate change (e.g., natural disasters, air pollution, and carbon footprint) were included.

Results
A narrative synthesis was performed and the 74 identified articles were classified into 6 topics: air pollution and PA, extreme weather conditions and PA, greenhouse gas emissions and PA, carbon footprint among sport participants, natural disasters and PA and the future of PA and sport practices in a changing world. Then, a conceptual model was proposed to identify the multidimensional associations between climate change and PA as well as sport practices. Results indicated a consistent negative effect of air pollution, extreme temperatures and natural disasters on PA levels. This PA reduction is more severe in adults with chronic diseases, higher body mass index and the elderly. Sport and PA communities can play an important mitigating role in post-natural disaster contexts. However, transport related to sport practices is also a source of greenhouse gas emissions. Conclusion Climate change impacts affect PA at a worldwide scale. PA is observed to play both a mitigation and an amplification role in climate changes.

Keywords: climate change, sustainability, global warming

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Effects of self-control fatigue on sprint performance in elite athletes

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In track and field sprints, athletes need to perform an optimal start due to its significance in the total race time. Two processes influence sprint start effectiveness: a) the control of movement initiation to prevent disqualification; b) the ability to initiate movement (i.e., force production) as fast as possible after the start signal. Authors proposed that the first process requires an inhibitory self-control effort to resist early starting urge, while the second requires this self-control effort interruption to permit movement initiation1. According to the strength model of self-control, a first act of self-control reduces self-control efficiency for a subsequent one. Past studies found that self-control fatigue (also called ego depletion) increases sprint false starts' occurence1. Moreover, self-control fatigue has been shown to alter motor task performance2. However, false-start are rare in elite athletes, and past studies never investigated the effects of self-control fatigue and its three components (i.e., resources, motivation and capacity change) i) on the ability to initiate movement as fast as possible after the start signal (sprint-start reaction time) and ii) on force production during the sprint. Then, this study aimed to investigate the effects of self-control fatigue on determinant of start and sprint acceleration performance in elite athletes. We hypothesized that i) start reaction time will be higher, and ii) ability of force production during the acceleration phase of the sprint will be deteriorated in the self-control fatigue condition compared to the control condition. We recruited French regional-level sprinters who performed 80-m running sprints after i) self-control fatigue condition (i.e., after having performed a go/no-go task fatiguing inhibitory self-control), and ii) a control condition (i.e., after having performed a go/no-go task not fatiguing inhibitory self-control). Self-control resources and motivation changes were assessed thanks to self-reported differences scores, between before and after the cognitive tasks (i.e., scores = aftergo/no-go tasks - before go/no-go tasks). Inhibitory self-control capacity change was assessed thanks to inhibitory performance change through the cognitive tasks (i.e., inhibition decrease rate). Ability of force production during the acceleration phase was assessed from the rate of rise of the muscle's EMG activity and from force-velocity

*Speaker

profile and its related parameters. Force-velocity profile was calculated from velocity-time data recorded by a radar device (Stalker® ATSII, Texas, USA)3. Electromyographic activity was recorded from lower limb muscles using surface electrodes. Reaction time was provided by a Browser Timing System synched with an acoustic starting signal. Results (under treatment) may provide a better understanding of the relation between self-control fatigue and sprint start and race performance, and pave the way to implement self-control training in sprint training.

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Keywords: ego depletion, force velocity relationship, inhibition, reaction time, acceleration

Mental imagery and tennis: beneficial effect of a service routine for expert players.

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Cette étude, réalisée en condition écologique, a pour but de tester les effets d'une routine de préparation au service combinant une respiration profonde, un nombre de rebond de balle personnalisé et standardisé, et de l'imagerie mentale visuelle focalisée sur la trajectoire de la balle et la zone cible que le joueur souhaite atteindre

Keywords: Imagerie mentale, tennis, routine

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Modelling the dynamics of power balance in team sports : a notational analysis system

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Introduction

While much research has focused on characterising and assessing the tactical intelligence (Gréhaigne, 2018) of football players at the individual level, there is less work on the collective aspect of team intelligence. One of the main characteristics of collective intelligence (Bates & Gupta, 2017; Kurvers et al., 2015) is the ability to articulate individual decisions (Kermarrec & Bossard, 2017) to shift the balance of power in one's favour.

The objective of this study was to model the dynamics of the balance of power in order to inform us about the collective tactical intelligence of each team as a complex system (Duarte et al., 2012).

Methodology

Notational analysis consists of assessing players' tactical behaviours in a game situation - thus ecologically valid - by assigning points based on the action performed (van Maarseveen et al., 2017). We used the video recording of an international match (Portugal 1-0 France on 14/11/2020) in its entirety to collect data for the analysis of the internal logic embodied by "the dynamic relationship between the practitioner and the situation" (Dugas, 2011, p. 13).

For this purpose, we rely mainly on two indicators of collective performance:

- The Progression Index (Pi) gives us information on the evolution of the balance of power during the match based on the transition zones within which possession of the ball passes from one team to the other. It is calculated for each action according to the number of zones crossed (0 to 4) and the height of the loss of the ball at the transition. The Pi takes a value between -7 (loss of the ball in its own box when the ball had been recovered in the opponent's box) and +7 (for the opposite situation, the most favourable to the attack). The Pi of the attacking team and that of the defending team are symmetrical.
- The Expected Transitions (xT) reveal the efficiency of the team in using the ball during offensive transitions (Gesbert, 2014). They are based on the relationship between the situation that is more or less favourable to the recovery of the ball, and the result of the action that follows. A matrix is used to evaluate the collective behaviour of the two teams in transition (direct or indirect play) in relation to the outcome of the action. This result is scored according to a seven-level grid ranging from a "quick loss of the ball" (0 points) to a "goal scored" (10 points).

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Results

The first results indicate a very balanced power ratio over the whole match (0.162*), which is particularly consistent with the score (0-1). The data also allow us to identify the phases of spatial domination during the game. We observe that the only goal of the game is scored during a period of dominance for the winning team, while the losing team takes the lead during the last third of the game.

In order to objectify the complexity and efficiency of collective decisions, the sole recourse to the eye of the expert seems no longer sufficient (Rein & Memmert, 2016; Wu et al., 2020). On a macroscopic scale, this phenomenon can be enlightened by in vivo game theory (Dugas & Collard, 2009).

Conclusions and perspectives

Today, large quantities of information about football matches are collected manually by analysts in real time. But more and more specialised companies are developing automatic digital tools, based on algorithms, in order to more easily feed the Big Data of sport. The model we propose would fit perfectly with player video tracking systems, able to record their position and behaviour for comparison with available databases.

*The equilibrium point is at 0.

Keywords: Tactics, Intelligence, Football, Decision, Dynamics

The coordination between crew members of double-handed foiling catamarans: A partnership with the boat or an enslavement of the crew members?

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Understanding team coordination in naturalistic sports setting is a current challenge in sports science. Most studies in this area have focused on interactions between players in team sports (e.g., Soccer, Futsal, Rugby). In these sports, the material environment is considered as a stable context surrounding the players, constraining their individual and collective behavior, without being transformed by them. Recent studies on rowing have shown that when a part of the material environment is sensitive to the teammates' behavior (e.g., the rowing boat), this part of the environment plays a mediating role in the team coordination (R'Kiouak et al., 2016).
On double-handed foiling catamarans, the small weight of the boats and the reduced wetted area, makes the boat extremely sensitive to the crew members behavior. Furthermore, the boat is sensitive to the natural environment (i.e., wind and waves) and this relation is functional. In short, the technical characteristics of these boats produce a "privileged situation" to study team coordination in a naturalistic setting involving a shared sport equipment.
The goal of the study was to characterize the team coordination leading to a stable flight on double-handed foiling catamarans, within the enactive and phenomenological approach of the Course of action framework (Theureau, 2006). We followed four crews of double-handed foiling catamarans during training sessions. The data collection consisted of video-recording of the sailors' behaviors during training session, and of retrospective self-confrontation interviews. Four contrasted case studies were designed from the collected data for an in-depth comparative analysis.
Together, the four case studies reveals two different strategies of the crew members to control the flight: (a) regulating the possibilities for action of the partner, (b) regulating the possibilities of movement of the boat. However, given the technical characteristics of the boat, no strategy guarantees a stable flight. These results highlight the intertwined relations between the possibilities for action of the crewmembers and the possibilities of movements of the boat.
We discuss the notion of team coordination on a foiling boat, with the boat playing an active role in the regulation of the possibilities for action of the crew members. In some circumstances, the boat "enslaves" the crew members by reducing their possibilities for action. In other circumstances, the boat frees the crew members' activity by extending their respective possibilities for action. As a practical implication of these results we suggest that to control the flight of a double-handed foiling catamarans, crew members should be aware of the consequences of their own actions on both the opening/closing of the possibilities for action of their partner, and on the opening/closing possibilities of movements of the boat.
Keywords: Team coordination, Course of Action, Enaction, Shared Affordances, Sailing, Hydrofoil

*Speaker

Athletes' injuries occurrence and stress level: The predicting role of temporal evolution of the quality of the coach-athlete relationship in intensive handball training centers

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Introduction

The understanding of psychosocial mechanisms involved in the occurrence of sport injuries has emerged as a major issue in sport psychology (Ivarsson et al., 2016). Based on the stress-injury model (Williams & Andersen, 1998) recent studies considered interpersonal processes such as the quality of the coach-athlete relationship (CAR) as potential antecedents of sport injuries occurrence. However, although CAR is considered by some authors as a dynamic process (e.g., Jowett & Poczwardowski, 2007), most studies have used cross-sectional designs not allowing for the exploration of temporal changes. In order to develop this line of research, the present study propose to explore the role played by the evolution of the quality of the CAR in athletes' injuries occurrence and stress level. To our knowledge, no study has examined this topic. Jowett (2017) conceptualized the CAR through the 3Cs' model, considering that the quality of this relationship is based on the three dimensions of closeness (e.g., emotional support), commitment (e.g., involvement) and complementarity (e.g., cooperation), and that these dimensions may impact affective factors (e.g., stress) (Roux & Trouilloud, 2021 for a review). Based on these elements, we assumed that the temporal evolution of the quality of the CAR negatively predicts athletes' injury rate and stress level.

Method

211 handball players (Mage = 15.49, SD = 0.98, 58.3% of men) involved in intensive training centers completed the French version of the CART-Q (Jowett & Ntoumanis, 2004) and REST-Q (Martinent et al., 2014) on three occasions (i.e., in early, mid, and late season). Moreover, an athletes' injury rate has been calculated through the ratio of the number of days the athlete was injured to the number of days of training in the whole season.

Results

First, multilevel growth models were conducted to identify CAR growth coefficient for each athlete. Then, multiple regressions revealed that the temporal evolution of athletes' perception of the CAR quality negatively predicts their injury rate over the season (β = -.12, p< .05) and stress levels at the end on the season (β = -.17, p< .05), after controlling for previous injuries and baseline stress level.

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Discussion
Results of this study suggested that the temporal evolution of the quality of the CAR may impact athletes' injury rates and stress levels over a one-season period. Additional analyses will be presented during the congress to explore whether perceived stress act as a mediator of the relation between quality of the CAR and athletes' injury rates. Moreover, because this study is the first to empirically explore this topic, more works are encouraged to confirm these results among various populations and contexts.

Conclusion
This study suggests that the quality of the CAR may act as a psychosocial determinant of sports injuries and provides stimulating perspectives on this topic.

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Keywords: coach athlete relationship, temporal evolution, sport injuries, stress

Impact of innovative technologies to deal with thermal stress in aerobic performances of Paris 2024

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This communication focuses on individualized and digital management of strategies that help athletes cope with a hot environment.
The thermal discomfort caused by hot-dry or hot-wet climates can have negative effects on human performance. The 2024 Summer Olympic and Paralympic Games will take place in Paris's hot summer period, possibly exposing athletes to severe environmental stressors. In addition to technical, tactical, physical and nutritional preparation, Olympians and Paralympians need an optimal psychological state to turn in their best performances, especially in terms of emotional control, concentration and motivation. Yet, the heat can have many negative effects on these factors. In addition, athletes from certain disciplines (e.g., road cycling, marathon, 50 kilometers race walk) could also be exposed to the phenomenon of urban heat island, which is a kind of heat accumulation phenomenon in which temperatures in urban areas are markedly higher than those in surrounding areas (Matsumoto et al., 2017). Better understanding of the negative effects of the heat and the strategies to manage them might be crucial for competitors, coaches and their teams in Paris.

To reduce the effect of TC exposure on the increase in core body temperature and thus the decrease in exercise performance, some studies have explored cooling interventions (for a review, see Bongers et al., 2017). These studies have dealt with before (pre-), during (per-), after (post-) or a combination of these interventions. However, given the disadvantages of certain conventional interventions and the complexity of implementing them during sports competitions, other less invasive and easier to implement techniques should be considered to avoid the inconvenience of overly restrictive or embarrassing cooling interventions and yet maintain the psychological benefits.

A series of studies has dealt with subjective body cooling through menthol, which stimulates the cold receptors and induces a cool feeling (Mündel and Jones, 2010). Other techniques such as mental techniques might avoid the downside of a menthol intervention while maintaining its psychological benefits for motivation and performance. These can be used to manage thermal stress and create a cold feeling that could help athletes to psychologically deal with the thermal environment. The techniques of mental preparation are useful to manage stress during compe-

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tition, but it might be worthwhile to examine the classic mental preparation techniques (i.e., goal setting, arousal regulation, mental imagery, positive self-talk, mindfulness) to determine which ones would be most appropriate for coping with climate stressors. The purpose of this communication is to examine how the management of the timing and intensity of physical cooling techniques and selected psychological strategies could be planned in an individualized and numerical manner.

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Keywords: Thermal discomfort, aerobic performances, motivation, cooling interventions, heat, strategies

Moving with someone happy makes you happy

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Introduction
When two people interact together, they communicate emotions to each other through multiple modalities. By feeling an emotion, people tend to produce movements that are mimicked by their interlocutors, which can induce the same emotion in them. This phenomenon of emotional contagion is an essential component of social interaction but remains under-studied (Hatfield et al., 1994). The present study aimed to identify emotional contagion of joy and sadness through changes in movements of each person with Individual Motor Signatures (IMS; a new method of motion analysis and visualization able to capture subtle differences in the way each of us move, seen as a kinematic fingerprint; Slowiński et al., 2016).

Method
We elicited two different emotions (joy, sadness and a neutral control emotion) in 30 individuals grouped in fifteen dyads, using an autobiographical memory paradigm, before they performed a socio-motor improvisation task (e.g., the Mirror Game). Each member of a dyad interacted with his/her partner feeling the same emotion (congruent conditions) and different emotions (incongruent conditions). We extracted the IMS of all participants under each emotional condition. Participants completed a self-report emotion before and after each motor task. The variables of interest were, for all participants, the intensity of the felt emotions and the similarity indexes between IMS with and without emotional congruence for joy and sadness.

Results and discussion
The result of intensity scores of felt emotions indicated that participants felt the target emotions (joy and sadness) in the corresponding condition from the beginning to the end of the motor task ($p < .001$). Comparing the similarity indexes between IMS with and without emotional congruence, results showed a significant difference between both conditions for joy and sadness. In other terms, the IMS of the participants in a neutral emotional state were closer to those of their dyad's partners when the latter felt joy and sadness compared to when they were neutral. Thus, the "neutral participants" mimicked the movements of their joyful and sad partner. Furthermore, results showed that, in addition to modifying their movements, the participants in the neutral condition felt their partner's emotion, highlighting the phenomenon of emotional contagion. Finally, the interaction of joy with sadness showed a tendency for contagion led by the positive emotion.

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Conclusion
Our study constitutes the first step in modeling and discriminating emotional behavior of moving individuals during social interactions, leading to possible ways of cognitive behavior therapies. In pathologies where bodily emotional expression and empathy are impaired, extraction of Individual Motor Signatures from patients' emotional behavior during interaction could be a novel pathway for indexing psychopathologies in diagnostics and outcome measures of rehabilitation programs.

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Keywords: emotional contagion, movement, individual motor signature, mirror game

Automatic affective reactions elicited by physical effort: a virtual reality study

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Introduction
The involvement of automatic processes in the regulation of physical activity behaviors is now widely accepted. Numerous studies testing these automatic processes have shown that physical activity cues attract attention, trigger positive affective reactions, and produce approach tendencies, especially in the most active people (see Cheval & Boisgontier, 2021 for an overview). Yet, these measures were based on computerized reaction-time tasks in which participants have to associate affective evaluations (e.g., positive words) toward the concept of physical activity (i.e., pictures or words related to physical activity). On the contrary, no study has assessed the automatic affective responses tendencies automatically triggered during an actual physical activity performance. Because the perception of effort may influence automatic reactions (Cheval & Boisgontier, 2021), developing tasks to capture automatic affective evaluations while individuals actually engage in physical activity is needed. The aim of the present study is to develop a task under virtual reality to assess the automatic affective evaluations elicited during an actual physical effort. To reach this goal, we draw an original experimental framework using an immersive and ecologically valid set-up involving a whole-body exercise task under virtual reality.

Methods
This experiment will used a within-subject design with 4 conditions: 1) rest (10% of VO2 reserve), 2) light exercise intensity (30% of VO2 reserve), 3) moderate exercise intensity (50% of VO2 reserve) and 4) vigorous exercise intensity (70% of VO2 reserve). Specifically, while cycling at various levels of physical effort, participants will quickly evaluate the neutral faces (from FaceGen) that will appear in the virtual environment. Participants will complete 3 runs of 7 min, with a 5-min break in between, for a total of 31 min. In each run, participants will complete a series 30-s period of a given physical effort level (i.e., 6 by 30-s bouts). Overall, participants will have to evaluate three times 21 different faces that will be presented under the four levels of physical effort (i.e., rest, light, moderate, and vigorous exercise intensity), leading to a total of 252 trials. To evaluate each presented face, they will use their left and right handlebar buttons and a Visual Analogue Scale (VAS) ranging from 0 "not at all pleasant" to 10 "extremely pleasant", displayed below the face presented in the virtual environment.

Results and Discussion
Based on the theory of effort minimization in physical activity (TEMPA; Cheval & Boisgontier, 2021), we hypothesize that increased level of physical effort will be associated with more negative evaluation of the neutral faces. Moreover, we hypothesize that usual level of physical activity

*Speaker

will moderate this effect – the increased negative evaluation of the neutral faces associated with higher level of effort will be less pronounced among physically active participants.

Conclusion
This experiment should provide a new task allowing to measure automatic affective reactions while participants engage in physical activity.

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Keywords: Physical effort, effort minimization, physical activity, automatic processes, virtual reality

An ideomotor illusion in the rubber hand illusion: when ideomotor processes participate to body awareness

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Introduction

The present study investigates the role of self-initiated movement and of the anticipation of its tactile consequences on the construction of a body awareness. The theoretical framework of this presentation is based on ideo-motor theories (James, 1890 ; Hommel, 2001) which postulates that controlling an action is based on the anticipation of its outcome. From a methodological point of view and to explore the construction of a body awareness, we used the Rubber Hand Illusion's (RHI) protocol (Botvinick & Cohen, 1998). The latter consists in stroking a false plastic hand, visibly placed before the participant, with paint brush. At the exact same time, the experimenter also strokes the participant's hidden real hand. Rapidly, when the fake hand and the participant's real hand are synchronously stimulated, a sense of ownership towards the false plastic hand is induced in the participant.

Until then, ideo-motor theories have never been used to explain this illusion and have been even less used to understand the mechanisms that underlie body awareness (sense of ownership and sense of agency). Our presentation will argue in favor of the use of these theories in this field of research and it will be based on a modified version of the RHI's procedure.

Method

In this regard, participants were all presented with a passive and an active version of the RHI (within-subject factor). During the passive version, participants only observe the experimenter stroking the fake plastic hand. In the active version, the participant strokes by himself the false plastic hand. The second modification of the RHI's procedure, applied for every participant, concerns the fact that the paint-brush stroking the fake hand is not actually really touching it, in sum there is only the intention of stroking the fake hand without contact. The strength of the induced illusion is measured through 1/ a questionnaire filled in by the participants 2/ the time to feel the illusion and 3/ proprioceptive drifts (i.e., the difference between the felt location of the participant's real hand before and after the induction in the illusion).

Results

The preliminary results (16 participants) seem to highlight the induction of a stronger illusion in the passive condition than in the active one. However, the most outstanding result is to have

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managed to induce an illusion in the illusion successfully. Indeed, a large majority of the participants reported that they were feeling as if the fake plastic hand was stroked from a distance, both in the active condition than passive condition.

Conclusion

This result confirms the hypothesis that ideomotor mechanisms are involved in the construction of body awareness. Indeed, anticipating the sensory effects of a movement on one's own body, even if there is no real sensory feedback towards the hand executing the stroking movement, is sufficient to create a sense of ownership towards the false plastic hand.

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Keywords: rubber hand illusion, ideomotor theory, body awareness, sensory feedback, sense of ownership

Modelling the activity of expert ecuyers: "contact" as a manifestation of sensorimotor empathy

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Introduction
One of the main challenges in the study of high-expertise sports practices is to access to the very embodied dimensions of human activity, linked to the perceptual experiences of the practitioner. The central question that arises is that of the place of sensorimotor subjectivity (Thompson, 2005) and sensorimotor empathy (Chemero, 2016) among experts during their practice.
The aim of this study was to analyze the activity of expert ecuyers belonging to the "Cadre noir de Saumur" during work in hand training sessions of horses called "sauteurs". These horses are specifically trained to perform the traditional airs above the ground of the Cadre noir. This context offered privileged situations to study the very embodied dimensions of the activity and the relevance of the concept of sensorimotor empathy to understand the ecuyer's practice.
This study was carried out within an enactivist and phenomenological approach of human experience. This epistemology constitutes the background of our theoretical and methodological framework, the Course of action research program (Theureau, 2015).

Methods
First, one hundred work in hand training sessions with the horses were video-recorded. Second, the ecuyers were confronted with the videos during retrospective self-confrontation interviews, and prompted to verbalize their experience. We also kept a field diary to collect ethnographic notes. Third, the data were qualitatively analysed according to the methodological procedure of the course of action framework.

Results and discussion
The results show that the core element of the ecuyers' expertise is their perceptual experience of their "contact" with the horse, which manifests their "sensorimotor empathy". The contact allows the ecuyers to perceive and to predict the "tendencies of the situations", to regulate the energy of the horse and its balance, and to act "at the right time". The phenomenological and analytical description of the contact reveals that it cannot be limited to managing the tension of the reins, as it is assumed in the technical culture of riding. The contact dynamically aggregates a set of perceptions and actions (the "codes") that includes the sensations "in the hand" and the body of the ecuyer, the management of the horse's energy, its balance and its emotional state. From the ecuyers' experiences, establishing a good contact implies to establish a connection with the horse by "entering its own world", and continuously making inferences about its feelings and intentions. The contact is therefore experienced as "intersubjective" by the ecuyers, depending

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on the joint action of the ecuyer and the horse at every moment.
This process of sensorimotor empathy at work in high-level sport therefore leads us to reconsider the often too technical or mechanical approaches to activity in expert practices.

Conclusion
To conclude, thanks to their multiple experiences and their dispositions, the ecuyers have developed sensorimotor empathy allowing them adaptability and efficiency in various situations. So generally speaking, it seems important to us to consider this sensorimotor disposition that experts have in all sports practices, to better understand their activity and also to open up training opportunities.

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Keywords: sensorimotor empathy, enaction, high level sport, embodied communication, contact, horse human interactions, Course of action, phenomenology

Effect(s) of a motor interface used to navigate a virtual environment on cybersickness, presence and age

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Introduction

The use of Virtual Reality (VR) technology is growing despite cybersickness being a recurrent issue hindering a wider use. Theories around sensory integration try to provide relevant explanations about the cause of cybersickness (e.g., the neural mismatch theory, Reason and Brand, 1975). Externals and internals factors could be responsible for cybersickness (Servotte et al., 2020). Since aging is degrading our sensory perceptions, differences between young and older individuals might be visible in cybersickness and presence responses. However, Pala et al. (2021) did not find any significant differences in presence and cybersickness ratings between young and older adults using a HMD, whereas, according to the review made by Weech et al. (2019), cybersickness would rather depend on "presence". Presence and sensory integration could be related as they are dependent to individual perception. In VR, the virtual environment (VE) is mainly perceived through visual inputs. Visually dependent individuals and the elderly tend to rely more on visual inputs than others (Eikema et al., 2012). Consequently, individual characteristics such as perceptual style could influence responses to VR exposure. Lastly, Seay et al. (2002) found that controlled navigation in a driving simulator ("passive" passenger versus "active" driver) increases presence and reduces simulator sickness. Therefore, active navigation could enhance perception thereby improving presence while reducing cybersickness. This paper studies the effect(s) of a joystick on navigation control in a virtual environment on cybersickness and presence (as dependent variables) in relation to age and perceptual style. Regarding Weech et al. (2019) review, we may formulate the following hypotheses: cybersickness is expected to be lower and presence to be higher in the active condition compared to the passive condition; cybersickness and presence are expected to be higher and lower in older individuals; cybersickness and presence are expected to be respectively lower and higher for visually dependent individuals whatever their age.

Method

The experiment consisted in immersing young and older individuals on two separate days to several VR exposures. The same VE was presented 3 minutes, 5 times each day. On the first day, individuals' perceptual style was assessed using a modified rod and frame test. On one of the two days, they would control their navigation in the virtual environment using a joystick. On the other, their navigation path would be pre-recorded with no navigation control. These

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two conditions are respectively labelled as "active condition" and "passive condition". In both conditions, individuals were standing on a force platform wearing a head mounted display (HTC Vive). After each VR exposure they had to fill the cybersickness questionnaire (Kennedy et al., 1993) and after each day the presence questionnaire (Witmer & Singer, 2004). Participants were instructed to collect "coins" in the active condition, but they get no feedback about the traveled distance on the path. Conditions were presented randomly. The trajectory of the center of pressure was recorded during each trial but these data will be presented over the next year.

Results

The experiment is in process and results will be presented at the conference. An ANOVA with condition, age and group as factors, and cybersickness and presence as dependent variables will be used to analyze the results.

Keywords: virtual reality, age, presence, cybersickness, navigation, perceptual style

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