WORKSHOP SERIES IN

Grands Colloques initiés par l'Académie 5 de l'IDEX UCA-JEDI

Avec le soutien de l'Axe Sciences Cognitives & Computation

Decoding the sense of effort

Workshop

Nice, MSHS Sud-Est

January 21, 2021 (online)

Physical effort is omnipresent in all human actions. While engagement in activities that involve physical effort is known to improve global health and prolong life span (Reimers, Knapp, & Reimers, 2012), individuals usually do not get involved in actions requiring physical effort and favor effortless solutions (e.g. elevators, cars, remote controls, door openers rather than walking, running, biking or using their own physical energy). In fact, physical effort seems to be the key parameter that determines the choice of an action to maintain or not an ongoing action. For example, the engagement of an individual in a specific action would depend on an evaluation of the predicted costs of this action (Kurniawan, Guitart-Masip, Dayan, & Dolan, 2013; Rigoux & Guigon, 2012; Rudebeck, Walton, Smyth, Bannerman, & Rushworth, 2006). An action requiring physical effort would, therefore have less chance to be selected by elevating its cost. Similarly, this decision could be made online during the performance of an already initiated action to determine its maintenance (Meyniel, Sergent, Rigoux, Daunizeau, & Pessiglione, 2013). The decision to stop an effort would consequently occur when the cost to persevere is higher than the evaluated benefits. While the evaluation of the level of effort is very high in our daily life, there still remains unsolved questions regarding the psychophysiological mechanisms involved. First, there is still a debate about how effort perception is built in the brain. That is, which information is taken into consideration to evaluate effort? Is it simply a central mechanism involving the integration of an efference copy of the motor command into sensory areas (Christensen et al., 2007), is it a prediction of the metabolic cost required to perform the action (Shadmehr, Huang, & Ahmed, 2016), or is it based on peripheral information originating in the sensory organs responding to voluntary movements (Monjo, Shemmell, & Forestier, 2018)? A second question concerns the role of this information. While some authors believe that the perception of effort is the primary predictor of actual effort (Morree, Klein, & Marcora, 2012), others assume that it does not play a direct role in regulating effort expenditure (Meyniel et al., 2014). The aim of this workshop will be to provide a space to discuss these questions. The workshop will adopt a multidisciplinary approach (cognitive neuroscience, psychology, physiology, and kinesiology) to confront the different coexisting lines of research that have been developed on this topic in an integrative manner.

See Schedules and presentation abstracts on next pages

To participate in the workshop, please send an email to florian.monjo@univ-cotedazur.fr

To watch the workshop, please see the live stream on Florian Monjo's YouTube channel

Schedule

MORNING

9:15-9:30 Welcome Title (Jeanick Brisswalter, President of the Côte d'Azur University)

9:30-10:15 The contribution of a sense of effort to proprioception (Trevor Allen, *with the participation of Uwe Proske*) **(Monash University, Melbourne)**

10:15-11:00 How the brain signals and controls physical effort exertion (Mathias Pessiglione) **(Institut du cerveau et de la Moelle épinière, Paris, France)**

11:00-11:15 Coffee Break

11:15-12:00 Engagement of cognitive resources and exercise performance (Stéphane Perrey) **(Université de Montpellier, France)**

12:30-13:30 Lunch Break

AFTERNOON

13:30-14:15 Effort perception, what do we know so far? (Benjamin Pageaux) **(Université de Montréal, Canada)**

14:15-15:00 Information theory and the sense of effort (Alexandre Zénon) **(CNRS, Université de Bordeaux, France)**

15:00-15:45 Clinical applications of overall and differentiated ratings of perceived effort: examples from chronic respiratory disorders (Mathieu Gruet) **(Université de Toulon, France)**

15:45-16:00 Coffee Break

16:00-16:30 Tribute to Rémi Radel and his last research works (Gauthier Denis) **(Université de la Côte d'Azur, Nice, France)**

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Abstracts

The contribution of a sense of effort to proprioception

Trevor Allen[a], with the participation of **Uwe Proske**[b]
[a]Monash University Accident Research Centre; [b]Department of Physiology, Monash University

Humans are considered highly visual creatures, yet activities of daily living rely almost entirely on our proprioceptive system which, for the vast majority of us, informs our motor system with remarkable precision even in the absence of vision. The term 'proprioceptors' has been mostly restricted to receptors associated with conscious sensations, including the senses of limb position and movement, the senses of effort, force and heaviness, and the sense of balance. Despite our ability to consciously attend to these senses, we rarely do. It is no wonder then that proprioception remains relatively poorly understood when compared to the other senses. The purpose of my presentation will be to discuss our current understanding of the neural basis of a sense of effort in proprioception. How might signals of central origin be used with those originating from peripheral receptors? One recent development will be discussed which concerns the role of muscle spindles in the senses of force and effort. I will also discuss methods used by our laboratory to disturb and investigate proprioception, including muscle thixotropic conditioning, vibration and exercise-induced muscle damage and fatigue. I will identify areas of future research and highlight broader implications of this work, including those related to injury prevention, rehabilitation, exercise and sports science.

How the brain signals and controls physical effort exertion

Mathias Pessiglione
Institut du Cerveau, Hôpital de la Pitié-Salpêtrière, Paris

The purpose of effort sensation may be to prevent the exhaustion of bodily resources for unworthy goals. Many authors have thus conceived effort as a cost that the brain trades against potential benefits, when deciding whether to engage an action. In this talk, I will present pharmacological and functional neuroimaging studies that uncover some components of the brain machinery responsible for the regulation of effort exertion. First, the decision to cease and resume effort exertion is based on a cost evidence signal provided by the insular cortex. Second, the effort cost signal can be attenuated by drugs that block serotonin reuptake (i.e., classical antidepressants), such that effort exertion can be prolonged. Third, the effort cost signal can be down-regulated by the lateral prefrontal cortex, which is known to implement executive control, defined as the function that inhibit automatic reactions (like stopping effort when it hurts) to the benefit of long-term goals (like finishing a race). Executive control can therefore help with increasing performance in endurance sport; however, its excessive use can lead to mental fatigue and some forms of burnout such as the overtraining syndrome, which is characterized by an increase in effort sensation.

Engagement of cognitive resources and exercise performance

Stephane Perrey
EuroMov Digital Health in Motion (Univeristé de Montpellier, IMT Mines Ales)

Research has outlined that endurance athletes possess excellent running economy among other physiological and biomechanical determinants. Not only locomotor exercise is metabolically costly, but also neural effort requiring the brain's limited resources, continually occurs during prolonged self-paced exercise. Under the umbrella of energy saving, executive functioning capacity resting on goal-oriented behaviour may also explain differences in endurance performance. First, executive function may be predictive of endurance performance: faster runners would have better inhibitory control, not only over motor responses but also over interfering, distracting information. Further, the elite athletes through practice over years may have developed the ability to execute their patterns free of much cortical participation. Neuroimaging studies corroborate this idea, as prefrontal cortex activity is seen to decrease in elite runners. Second, effective pacing involving cognitive control and decision-making process is crucial to endurance performance. Given that endurance exercise might be seen as an effortful cognitive task that places high demands on several brain areas related to emotional, motivational and executive processing, pacing assistance would be valuable in reaching an automatic mode to divert effortlessly resources. Thus, we can assume that this strategic conservation of mental effort resources may lead to hypofrontality phenomenon.

Perception of effort, what do we know so far?

Benjamin Pageaux
École de kinésiologie et des sciences de l'activité physique (EKSAP)
Faculté de médecine, Université de Montréal; Centre de recherche de l'institut universitaire de gériatrie de Montréal (CRIUGM)

Every day, we experience effort when we perform voluntary physical and mental tasks, such as climbing the stairs or solving complex puzzles. The perception of effort is associated with voluntary actions, contributes to the sense of agency, and provides crucial information on the perceived cost of personal actions. In the context of physical tasks, perception of effort is seemingly an intuitive variable to many. However, due to a lack of precision and consistency in the definitions as well as the measurement tools used, the neurophysiology of perceived effort remains poorly understood. In this presentation, we will first introduce effort and its perception and emphasize the importance of using clear definition and instructions excluding other exercise-related sensations. Then, we will present what we know so far regarding the neurophysiology of effort perception, with a specific focus on its sensory signal(s) and determinant(s). To conclude, we will provide perspectives for future research and argue the need for a multidisciplinary approach to better understand the role of effort and its perception in the regulation of our behaviour.

Information theory and the sense of effort.

Alexandre Zenon
Institut de Neuroscience Cognitive et Intégrative d'Aquitaine, Université de Bordeaux, France; Institute of Neuroscience, Université Catholique de Louvain, Brussels, Belgium.

The precise function and neural origin of the sense of effort remain elusive. In this talk, I will expose a theory according to which the sense of effort provides individuals with a quantitative estimate of the information being processed. I will show how this hypothesis accounts for different known properties of effort and will discuss its implications and predictions. I will then detail how pupillometric data concur with this hypothesis by showing that pupil dilation across a wide range of tasks provides a robust signature of information gain.

Clinical applications of overall and differentiated ratings of perceived effort: examples from chronic respiratory disorders

Mathieu Gruet
Université de Toulon, Laboratoire IAPS UR n°201723207F, France

There is a growing interest and knowledge regarding the clinical applications of effort perception in various populations. Perceived effort may influence physical exercise intentions and has various indications, both for exercise rehabilitation and testing. While it is common to report a single overall rating of perceived exertion, it is also possible to report differentiated feelings (e.g. peripheral muscle vs. respiratory effort), notably during whole-body exercise. This can be particularly relevant in people with chronic cardiac and/or respiratory disorders who often regulate their exercise behaviors according to their respiratory sensations. As respiratory sensations such as effort to breathe and dyspnea share common descriptors in their definitions, these sensations are often reported interchangeably during exercise using a single scale (e.g. Borg scale). However, there is now accumulating evidence that many subtle sensations underlying dyspnea can be dissociated from respiratory effort and the report of qualitative dimensions of dyspnea is mandatory to shed light on their respective influence on patients' acute exercise limitation and long-term physical activity behaviors.
I will first provide a brief overview of the clinical utility of effort perception for exercise testing (e.g. prediction of peak aerobic capacity) and prescription (e.g. self-regulation of exercise intensity). Then, I will discuss the importance as well as the difficulty in dissociating sensations during physical exercise, with selected examples from various chronic respiratory disorders.

Tribute to Rémi Radel and his last research works

Gauthier Denis
Université Côte d'Azur, LAMHESS, Nice, France

This Workshop was originally planned and to be organized by Florian Monjo and Rémi Radel, collaboratively. Unfortunately, Rémi passed away in May 2019. This workshop has now also become a means to pay tribute to Rémi

and his research, including topics relative to the sense of effort. Gauthier Denis, his final PhD student, will present Rémi's final research.

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