
Brain Correlates of Effort Perception and Their Relationships to Physical Activity Engagement: An fMRI Network Analysis Approach

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Résumé

Introduction

While the neural substrates of effort-based decision-making have received considerable attention, the specific brain correlates of *effort perception* remain poorly known. As a possible neural mechanism for effort perception, it has been proposed to arise from the integration of an efference copy generated in premotor regions into sensory areas of the brain (Pageaux et al., 2016). However, this mechanism is methodologically challenging to isolate due to the coupling between physical effort production and contraction-related feedback in naturalistic conditions. Importantly, individual differences in the tendency to engage in physical activity may be grounded in distinct neural responses to perceived effort, which remain largely unexplored. This study aims to (1) Identify the neural signature of effort perception during handgrip tasks and resting-state fMRI, and (2) Determine how this neural activity relates to individual disposition towards physical activity measured by the Physical Effort Scale (PES) (Cheval et al., 2024) in a continuum of subjects from low to high Physical activity engagement.

Methods:

Forty-six participants were selected to span a broad range of physical activity orientations based on the PES, which allows characterizing their tendency to approach and to avoid physical effort (2). Functional neuroimaging was performed on a 3T MRI scanner performed on a 3T MRI scanner on the IRMaGe facility in Grenoble. The protocol included: 1) resting-state fMRI to assess functional connectivity at already known resting-state networks associated with physical exertion such as sensorimotor network, salience network, and default mode network (Cole et al., 2016); 2) an isometric handgrip task in which participants were required to exert effort at two subjective intensity levels (moderate and strong intensities) using a CR100 scale (Pageaux et al., 2016) before (control condition), during, and after the induction of transient ischemic-induced paralysis (Ischemic nerve block (INB)) using a two-chamber cuff inflated to 280 mmHg. In this latter condition, participants made the

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effort to contract their hands at moderate and intense effort levels but without muscular activation, which, based on previous evidence, modulates the connectivity between premotor and sensory cortices (Christensen et al., 2007). In other words, participants produced a physical effort without the inherent effort-related feedback arising from muscle contraction, which aimed to isolate the brain mechanism of effort perception. Preprocessing of fMRI data included motion correction, slice-timing correction, normalization, and spatial smoothing. General Linear Models (GLM) were applied to contrast brain activity between actual contraction and rest, and between control and INB conditions at both moderate and strong effort perception levels. Task-related fMRI region-of-interest (ROI) analyses focused on key nodes implicated in effort perception and motor command (e.g., supplementary motor area, primary motor cortex, anterior cingulate cortex, anterior insula, dorsolateral prefrontal cortex). Resting-state fMRI functional connectivity was assessed using FSLnets from *FSL* to examine how connectivity at networks of interest varies across the continuum of physical activity engagement.

Results

At the time of submission, the experimental phase is complete, and data analysis is underway.

Discussion:

It is expected that this study (1) will identify brain processes specifically associated with perceived effort during handgrip and resting-state tasks and (2), reveal how these processes vary across individuals with different approach tendencies toward physical activity.

Conclusion/Perspectives

Such insights would be critical for understanding why some individuals are more inclined to engage in exercise, while others are prompted to avoid it systematically. This research represents an advance proposing a potential future intervention, such as brain stimulation, to modulate effort perception and facilitate physical activity engagement.

References

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