The effect of high-intensity interval exercise on executive performance and prefrontal cortex activation among elderlies – a fNIRS study

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Background

Cognitive decline poses a significant threat to the independence and quality of life of the elderlies [1]. Aging is intrinsically linked to the deterioration of cognitive functions [2]. However, a growing body of evidence suggests that regular exercise can offer substantial benefits in improving cognitive abilities. High-intensity interval exercise (HIE) has shown promise in enhancing cognitive functions particularly among younger individuals [3]. Executive functions are the responsibility of a brain area located mainly in the prefrontal cortex (PFC), which is closely linked to the dorsolateral prefrontal lobe. To examine the cerebral cortex, a non-invasive method such as fNIRS is currently being applied. It measures the hemodynamic response of the cortex and acquires oxyhemoglobin and deoxyhemoglobin signals. Studies using NIRS show correlations between brain activation and cognitive function. However, post exercise changes in brain activation in relation to cognitive function are still not thoroughly studied and documented in frail older adults [4,5].

Aim

The purpose of the present study was to assess acute effect of HIE on executive function focusing on underlying neural substrates.

Material and Methods

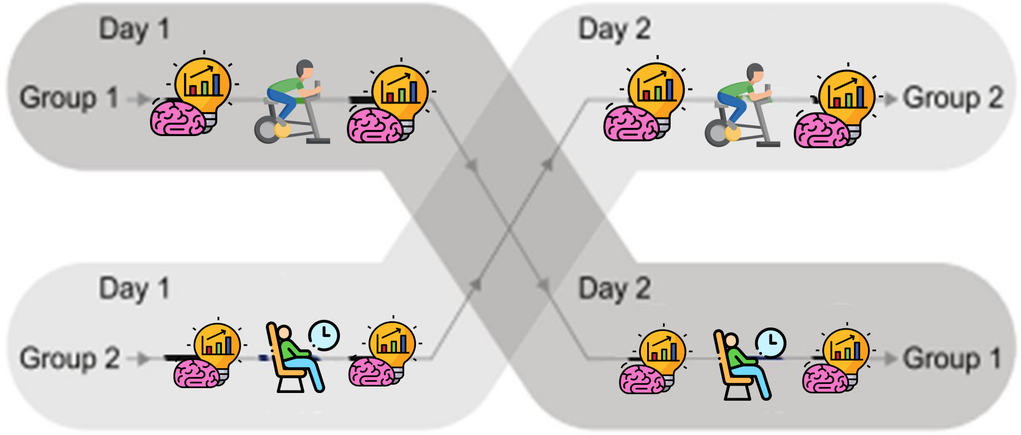

Fig. 1. Experimental protocol: experiment consisted of two sessions, control (CTL) and high-intensity interval exercise (HIE) separated by at least one week. Each trial was conducted in a randomized, counterbalanced manner, with half of participants starting with the HIE session

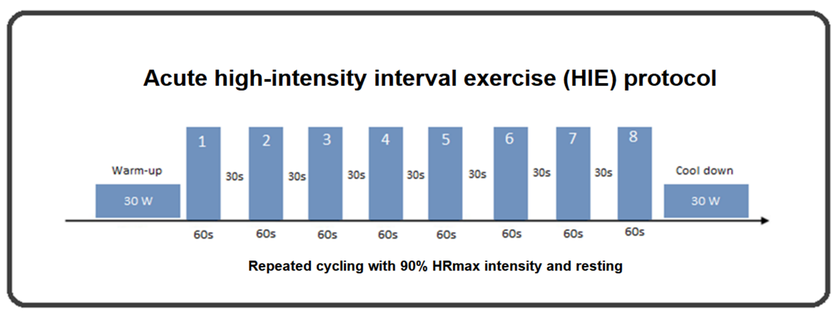

Fig 2. The HIE protocol consists of eight 60s cycling bouts at 90% of VAT corresponding to ~90% HRmax intensity and 30s resting

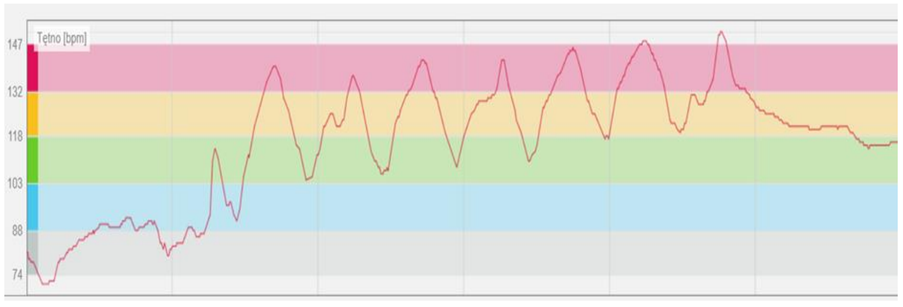

Fig 3. Heart rate response to High Intensity Interval Exercise (HIE).

References and funding

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3. S. Kujach, et al. A transferable high-intensity intermittent exercise improves executive performance in association with dorsolateral prefrontal activation in young adults. NeuroImage, 2018.
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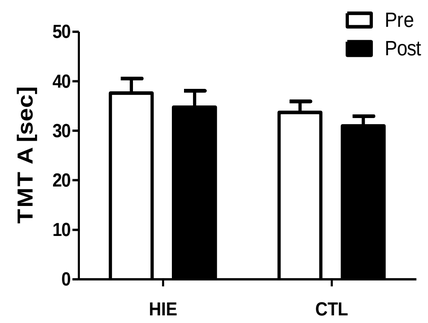
This work was supported by the Polish National Science Center under Grant No: 2019/33/B/NZ7/01980

Results



HIE contributed to a significant, shorter execution time in TMT-B test. Moreover, an increased prefrontal activation (DLPFC and MFG) has been observed following acute bout of HIE.

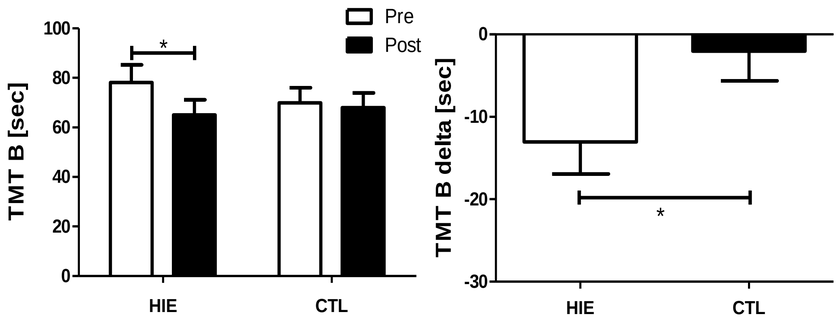


Fig 4. Effect of acute HIE and control condition on cognitive performance. Data are presented as mean; *p < 0.05.

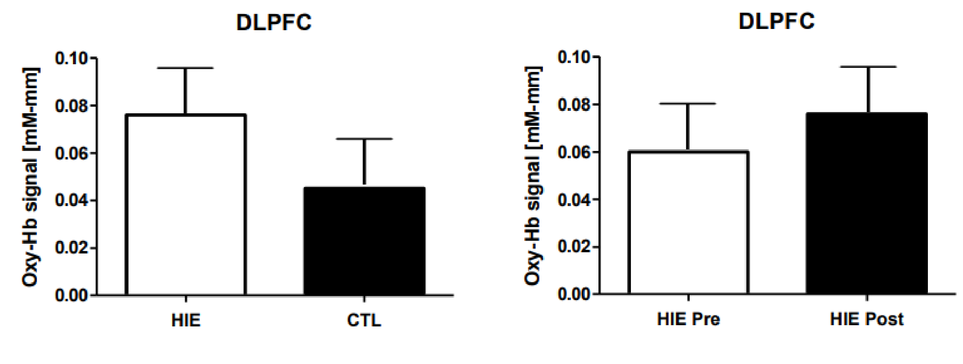


Fig 5. Individual oxy-Hb changes associated with Stroop task in dorosolateral prefrontal cortex area - DLPFC.

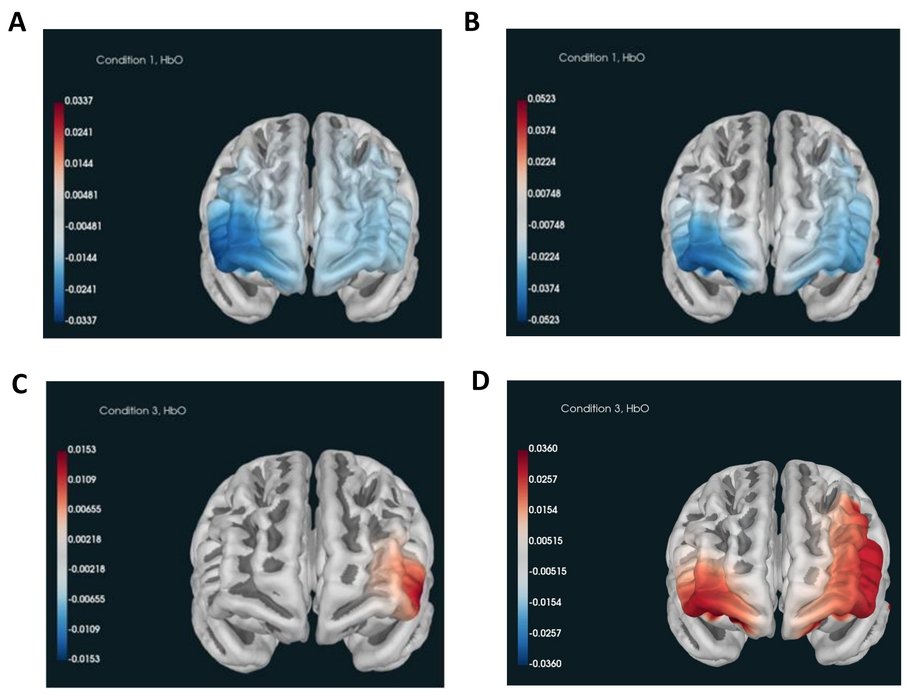


Fig 6. Effect of HIE on cortical activation patterns during Stroop task. Panel A and B represent neutral wheras C and D incongurent tasks in the representative subject.

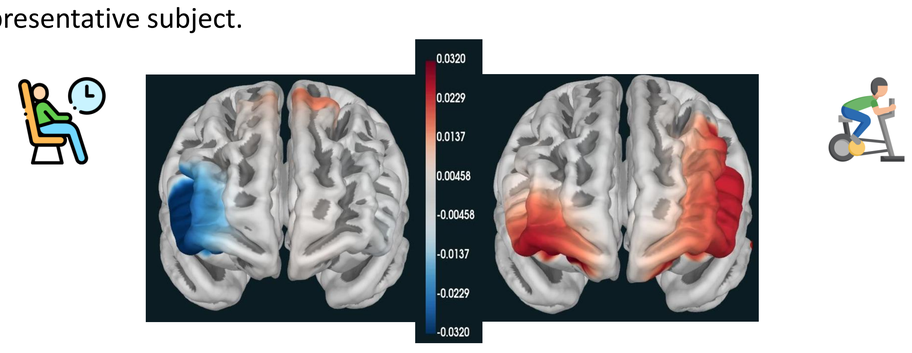


Fig 7. Cortical activation patterns after singel bout of HIE or control condition in the representative subject.

Conclusion

The results suggest that the proposed HIE protocol can effectively enhance executive functions among older adults. This cognitive performance enhancement may be attributed to increased activation in cortical areas crucial for cognitive functioning. In light of the escalating global prevalence of cognitive impairments, there is a pressing demand for comprehensive research elucidating the precise impact of targeted exercise interventions on cognitive enhancement. Our studies represent a pivotal stride towards the development of non-pharmacological therapeutic strategies for augmenting human cognitive functions.