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SPORTS PERFORMANCE



Acute effects of a vigorous-intensity warm-up on response suppression and decision-making of football referees

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ABSTRACT

This study investigates the acute effect of physical exercise simulating a standard pre-competitive warm-up on the response suppression and decision-making of football referees. Thirty-four referees ($n = 17$ – regional level; $n = 17$ – national level) participated in the study. A Stop-Signal Task (SST) and a decision-making video test were used to evaluate the referees' perceptual-cognitive functions. The findings revealed that the vigorous aerobic exercise acutely impacted basic cognitive functions, as indicated by decreased reaction time and decreased choice accuracy. However, higher-order cognitive functions such as response suppression and decision-making did not exhibit significant changes post-exercise. Based on these results, there is no evidence to suggest that a vigorous-intensity warm-up is likely to favour response suppression and decision-making factors in the initial phases of the game. National referees showed superior response suppression abilities (shorter stop-signal reaction times and lower probability of responding to the stop-signal) than regional referees, indicating that higher-level referees possess enhanced perceptual-cognitive skills, likely influenced by their experience. Further studies are required to determine whether these variables can be acutely improved through physical exercise. In this regard, our results suggest the need for alternative strategies in pre-competitive referee warm-ups if aiming to improve perceptual-cognitive skills in the initial phases of the game.

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Cognition; executive function; physical activity; soccer; umpire; official

Introduction

Executive functions are higher-order cognitive functions defined as “a set of cognitive operations underlying the selection, scheduling, coordination, and monitoring of complex, goal-directed processes involved in perception, memory, and action” (Donnelly et al., 2016). Three core executive functions are frequently identified in the literature based on the model of Miyake et al. (2000): working memory updating, cognitive flexibility or shifting, and inhibitory control. Previous research supports a reciprocal relationship between executive functions and sport. Firstly, sports practice positively influences executive functioning acute performance (Levin et al., 2021; Oberste et al., 2019; Wilke et al., 2019, 2020) and chronic development (Contreras-Osorio et al., 2021; Hagyard et al., 2021). The acute and chronic adaptations to sports practice that account for improvements in executive functions depend on different but linked mechanisms found at the system, molecular, and cellular levels (Aly, 2020; Ferrer-Uris et al., 2022; Ratey & Loehr, 2011). In this regard, it has been reported that executive functions experience an acute enhancing effect after aerobic physical exercise, which has been broadly demonstrated across different tasks and skills (e.g., general executive function (Chang et al., 2012), inhibitory control (Levin et al., 2021; Oberste et al., 2019), and response suppression (Chu et al., 2015)). Secondly, executive function is recognized for its significant role during perceptual-cognitive processes associated with tactical decision-making, contributing to improved athletic performance

(Albuquerque et al., 2019; De Waelle et al., 2021). In addition, previous research has suggested that executive function supports decision-making processes during self-regulated exercise (Brick et al., 2016; Hyland-Monks et al., 2018; van Biesen et al., 2016). The important role of executive functions in achieving peak athletic performance may hold even greater relevance in unpredictable and complex environments (e.g., football or basketball) due to its greater complexity of stimuli. Ultimately, activities demanding greater cognitive engagement inherently challenge athlete's attention and perception and action responses (Contreras-Osorio et al., 2022; Gu et al., 2019; Tomporowski & Pesce, 2019; Zhu et al., 2020), which may assist athletes in making better decisions (Myer et al., 2016).

Inhibitory control is one core executive function (Diamond, 2006; Heilmann et al., 2022) that requires the ability to stay focused, not to initialize inappropriate behaviours derived from distracting stimuli, and to suppress responses that are no longer required. Inhibitory behaviour may play a pivotal role in athletes' decision-making processes, as it underpins information processing and behaviour control (Diamond, 2006, 2013). Football referees are athletes responsible for making judgments to ensure consistency and safety within the competitive environment, hence decision-making is considered their most important perceptual-cognitive attribute (Helsen & Bultynck, 2004; MacMahon et al., 2014; Morris & O'Connor, 2017; Plessner & Haar, 2006). The application of the advantage rule in football (Law 5; IFAB, 2023) can exemplify the evidence of inhibitory control in referees; specifically, response suppression,

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