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LETTER TO THE EDITOR

The Psychobiological Model of Endurance Performance: An Effort-Based Decision-Making Theory to Explain Self-Paced Endurance Performance

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To the Editor,

In a recent review published in this journal [1], Renfree and colleagues demonstrated the importance of considering decision-making theories to understand self-paced endurance performance. The authors aimed to examine current models/theories of decision-making in an attempt to explain the manner in which regulation of muscular work (pacing) is achieved during self-paced endurance performance. As explained by the authors, it is crucial that models explaining self-paced endurance performance take into account both internal (e.g. perception of effort, physiological responses) and external (e.g. tactical decisions, presence of competitors) factors. Interestingly, among all models presented in their review, the authors omitted to present an effort-based decision-making model recently proposed to explain self-paced endurance performance: the psychobiological model (of endurance performance) [2]. The psychobiological model has been shown to provide a valid explanation of the effects of both psychological [3, 4] and physiological [5] manipulations on endurance performance during constant-load exercise (time to exhaustion). Recently, its explanatory validity was extended to self-paced exercise where endurance performance was altered by psychological (mental fatigue) [6] and physiological (muscle fatigue) [7] manipulations. Consequently, it seems important to mention its existence in a review on decision-making theories relevant to self-regulation of pacing. Therefore, the main aim of this letter is to briefly present the psychobiological model and its sensitivity to internal and external factors known to alter self-paced endurance performance. This letter will also attempt to provide to the reader a brief alternative interpretation of the role of perception of effort in endurance performance.

The psychobiological model is an effort-based decision-making model [2] based on motivational intensity theory [8], and postulates that the conscious regulation of pace is determined primarily by five different cognitive/motivational factors:

1. Perception of effort
2. Potential motivation
3. Knowledge of the distance/time to cover
4. Knowledge of the distance/time remaining
5. Previous experience/memory of perception of effort during exercise of varying intensity and duration

Factor 2 (potential motivation) refers to the maximum effort an individual is willing to exert to satisfy a motive, and could be easily influenced by external factors (e.g. higher motivation during an event with competitors than during laboratory testing). Factors 3 to 5 are self-explanatory and can explain the end-spurt phenomenon [9] or why athletes start different races at different paces [10]. Perception of effort (factor 1) could be defined as “the conscious sensation of how hard, heavy and strenuous a physical task is” [2], and is the key determinant of this model. Indeed, according to this model, the conscious regulation of pace is primarily determined by the effort perceived by the athlete. Therefore, when perception of effort is increased by muscle [7] or mental [6] fatigue, or reduced (same perception of effort for a higher power output) by pharmacological manipulation [11], the athlete will consciously change its pace to compensate for the negative/positive effect of the experimental manipulation

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on perception of effort, thus leading to an improvement (if decreased perception of effort [11]) or impairment (if increased perception of effort [6, 7]) in self-paced endurance performance. Because the five factors mentioned above are sensitive to external and/or physiological factors known to impact endurance performance, the psychobiological model could be considered as a tool to explain regulation of self-paced endurance performance.

Contrary to the models presented by Renfree and colleagues, the psychobiological model of endurance performance postulates that the sensory signal processed by the brain to generate perception of effort is not the afferent feedback from skeletal muscles and other interoceptors [12]. Perception of effort is thought to result from the central processing of the corollary discharge associated with the central motor command [12, 13], thus explaining the alteration of perception of effort and performance when central motor command is increased to compensate for muscle fatigue [7] or central processing of the corollary discharge is altered by mental fatigue [3, 6]. Despite this theoretical difference in the underlying sensory signals thought to generate perception of effort, the models presented by Renfree and colleagues and the psychobiological model agree on the crucial role of perception of effort in the self-regulation of pacing. Therefore, it is important to understand the neurocognitive link between perception of effort and the regulation of endurance performance during self-paced exercise. Recently, a strong link between the response inhibition process (a main component of decision-making in human volition [14]) and perception of effort was suggested [6]. In this study, subjects performed 30 min of either incongruent (involving response inhibition) or congruent (non involving response inhibition) Stroop task followed by a five kilometres running time trial. Interestingly, endurance performance following completion of the incongruent Stroop task was decreased in association with an increased perception of effort. One plausible explanation provided by the authors is the similarity in brain areas involved in both mechanisms. Indeed, perception of effort, response inhibition and consequently decision-making process are known to be associated with activity in the anterior cingulate cortex and the pre supplementary motor areas [3, 4, 6]. Therefore, independently of the model/theory used to explain endurance performance, further researches on the neurophysiology of perception of effort are required to provide a better understanding of the regulation of endurance performance during self-paced exercise.

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