Exercise, cognitive function, and the brain: Advancing our understanding of complex relationships

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Abstract:

In recent years, scientists have shown a growing interest in the relationship between exercise, cognitive function, and the brain. The growing body of evidence supporting positive relationships is evidenced by the first mention of the beneficial effects of exercise on cognitive function appearing in the 9th edition of the American College of Sports Medicine's guidelines published in 2014.[1] The strength of this evidence is further confirmed by recommendations relative to the benefits of exercise for cognitive performance and mental health being included in the 2nd edition of the Physical Activity Guidelines for Americans, a landmark policy statement released by the U.S. Department of Health and Human Services.[2]

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Article:

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Guest editorial

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In recent years, scientists have shown a growing interest in the relationship between exercise, cognitive function, and the brain. The growing body of evidence supporting positive relationships is evidenced by the first mention of the beneficial effects of exercise on cognitive function appearing in the 9th edition of the American College of Sports Medicine's guidelines published in 2014.[1] The strength of this evidence is further confirmed by recommendations relative to the benefits of exercise for cognitive performance and mental health being included in the 2nd edition of the Physical Activity Guidelines for Americans, a landmark policy statement released by the U.S. Department of Health and Human Services.[2]

In the Physical Activity Guidelines for Americans, the cognitive performance and mental health benefits associated with regular physical activity (PA) are described as being observed generally across children, adolescents, adults, and older adults. Interestingly, both chronic exercise (i.e., long-term exercise) and acute exercise (i.e., a single bout of exercise) have been shown to provide benefits. Given that there is general acceptance of beneficial effects of exercise, researchers are now turning their attention to advancing our understanding of the nuances of these complex relationships.

The cutting-edge research being conducted in this area, is reflected in a special issue of the *Journal of Sport and Health Science* we recently edited that focused on acute exercise and cognitive function.[3] Now, we are pleased to present another special topic entitled "Exercise, cognitive function, and the brain: Advancing our understanding of complex relationships". For this special topic, we solicited submissions from top scholars in the field. We are proud to present this special topic that reflects the current focus of research in this area and explores our on understanding of the nuances of the complex relationships between PA, cognition, and brain health. It is important to point out that the research reflected here is interdisciplinary, in that the papers include finding research in the areas of exercise psychology, exercise physiology, and cognitive neuroscience. Two of the articles adopted a psychophysiological approach to examining relationships between PA/cardiorespiratory fitness and cognitive performance, and the 3rd article examined the influence of audiovisual stimulation on affect and on prefrontal hemodynamics during acute exercise. All of the empirical papers show that the questions being asked are relevant across the lifespan; the articles focus on preadolescent children, young adults, and adults. The 4th article is a review in which the authors propose and provide evidence in support of a bidirectional relationship between exercise and effortful control. Please allow us the opportunity to briefly introduce each of the papers included herein.

Pindus et al. used a neuroelectric approach to examine associations between daily PA, cognitive function, and cognitive performance in preadolescent children. They explored relationships between PA, event-related potentials (from electroencephalographic recordings), and inhibitory control as assessed by the Erickson flanker task. Their study is unique in its consideration of the fact that PA is performed in bouts as the authors considered various time spans across which to assess PA. In particular, they are interested in advancing our understanding of the importance of intensity, time, and frequency of PA bouts in predicting cognitive function and performance. Readers might be surprised at their results, which are supportive of the importance of vigorous PA, rather than of moderate-to-vigorous PA, in predicting cognitive function and performance.

Bento-Torres et al. incorporated neuroimaging measures in their assessment of the relations between PA and cardiorespiratory fitness with brain structure (from magnetic resonance imaging), and cognitive performance in younger adults. Their study extends the current literature by considering intraindividual variability, by assessing brain structure, and by using a mediational model for statistical analyses. The use of mediational models in exercise psychology research is still in its infancy, so this is a valuable direction for research. The authors' intriguing results advance our understanding of the potential role of changes in brain structure in response to moderate-to-vigorous PA as a mediator of observed benefits in cognitive performance.

Jones and Ekkekakis took a unique approach to understanding how affective responses to exercise can be manipulated through the provision of audiovisual stimulation. Importantly, they focused particularly on overweight, low-active adults who might benefit from more positive affect during exercise bouts. The authors measured affect and used infrared spectroscopy to assess the hemodynamics of the right dorsolateral prefrontal cortex in 3 conditions, while exercising for 15 min at

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the ventilatory threshold. Compared to the low immersion (i.e., watching television while exercising) and control conditions, participants in the high immersion condition (i.e., wearing the virtual-reality headset and headphones while exercising) demonstrated better affective response and lower dorsolateral prefrontal cortex oxygenation. The authors also explored differential effects for participants based on their preference for low-intensity or high-intensity exercise. Their fascinating results have implications for the promotion of PA adherence in adults who are both overweight and not meeting activity guidelines.

This special topic also includes a review in which Audiffren and André adapted the "effort hypothesis" to support a proposed reciprocal relationship between executive function/effortful control and adherence to exercise. After providing evidence for associations between executive function and effortful control; for the effects of chronic exercise on executive function and effortful control; and for relationships between executive function, effortful control, and exercise adherence, the authors propose that chronic exercise might strengthen the networks involving executive function and effortful control and that gains in executive function and effortful control might in turn facilitate adherence to future exercise engagement. This recognition of the potential reciprocal effects of exercise and effortful control on one another is important in longitudinal studies in which researchers consider how these variables relate to each other. This work may also contribute to the promotion of PA adherence.

We are excited to share these novel papers with you and thank the authors for their important contributions to our understanding of the complex relationships between exercise, cognition, and the brain. We also thank the authors for providing feedback to one another through the review process because this undoubtedly contributed to the high quality of the work presented. Thank you as well to the editorial staff at the *Journal of Sport and Health Science* for giving us this opportunity and for their support throughout the process. We look forward to the future as scientists continue to use sophisticated approaches to unravel the complexities of these intriguing relationships.

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