The Benefits of **Exercise on the Mind**

Exercise has long been advocated as a way to enhance physical health, but it has also been shown to have several benefits on the mind. More recently, research has focused on how exercise can improve cognitive function. Over the past three decades, Drs Phillip D. Tomporowski and Caterina Pesce from the University of Georgia and the University of Rome, respectively, have examined the benefits of exercise on the mind. Their recent work assesses the role that skill acquisition plays in developing and maintaining cognitive function across life stages. They propose that mentally engaging physical activities have the greatest benefit for cognitive health.

xercise has long been promoted to enhance physical health, but it has also been shown to have several benefits on the mind, from improving mental health and helping to fight depression to reducing stress and increasing our overall well-being. More recently, research has focused on the benefits of exercise on the mind and the impact that it can have on cognitive function. The term cognitive function refers to multiple mental abilities and encompasses processes such as learning, thinking, reasoning, remembering, problem-solving, decision-making, and attention.

Most of the research to date has focused on how the body adapts to the demands of exercise training. Evidence from this research demonstrates that changes occur in the body following aerobic exercises and strength training. As such, several assumptions have been made on how exercise alters brain health and enhances a person's mental abilities. Many of these studies have made exercise recommendations based on the results they obtained. While it is clear that exercise can have a positive

the mind, many of these studies have failed to consider additional factors that could impact how beneficial exercise can be for cognitive function.

impact on

Over the past three decades, Dr Phillip Tomporowski at University of Georgia and Dr Caterina Pesce at the University of Rome have conducted lines of research to determine if and how

physical activity benefits cognition. This article will focus on some of the findings from their joint work, ranging from understanding the importance of physical exercise on cognitive development in children to how exercise can be a vital part of keeping the mind healthy as we age.

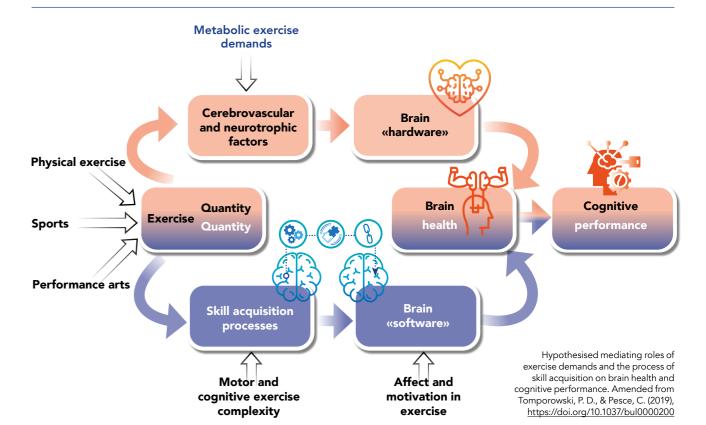
IS THERE AN 'OPTIMAL DOSE' OF EXERCISE TO BENEFIT BRAIN AND COGNITION?

Given the public health benefits gained from physical activity, researchers have tended to identify the ideal mixture of intensity, duration, and frequency to create the optimal 'dose' of exercise required for maximal mental health gains and especially cognitive gains. Researchers have found that chronic exercise that is designed to significantly alter physical fitness can also result in changes in the brain structure and function which is assumed to lead to brain adaptations that underlie cognitive processing. This approach has been used by the healthcare community to provide guidelines for exercise prescriptions for improving cognitive health.

Due to this link between chronic exercise and changes in the brain, most of the research to date that has investigated the link between exercise and cognitive function uses aerobic exercise training regimes that are typically designed to alter some aspect of physical fitness, namely cardiovascular fitness. While this approach has benefits for the brain and cognitive function, these studies have failed to look at the role that skill acquisition has in improving cognitive function.

MENTAL ENGAGEMENT DURING EXERCISE MATTERS

Alternative explanations emerged



in publications suggesting that a participant's mental engagement during physical activity might be important. A book co-authored by Drs Tomporowski and Pesce (2015) outlined how physical activity games would be ideal for enhancing children's cognition.

Physical activity games provide a unique form of enrichment that enhances children's cognitive development without decreasing the intensity of their physical activities. Cognitive and social stimulation embedded into enjoyable activities which include physical education and outdoor play have been proven to help develop executive function in children, including memory skills, flexible thinking, and self-control. Also, the researchers highlight that the skills developed during these enrichment games are positively linked to the level of physical activity later in life.

In addition to enhancing their cognition, previous research has suggested that exercise could influence a child's academic performance by mediating changes in cognitive function such as memory, flexible thinking, selfcontrol as well as the ability to reason and solve problems in new situations. While the researchers highlight that

different types of exercise can enhance cognitive processing, they also show that the direct link between exerciseinduced changes in cognition and academic performance is less clear. They also add that this problem is

be responsible for the cognitive gains elicited by exercise. These skills can be gained by every type of exercise, including physical exercises, sports, and performance arts and can result in cognitive benefits at all stages of life.

Exercising body and mind is common to physical activity, music and performance arts, which are all linked with increased cognitive function.

complex as there are several mediators and moderators that can influence the relationship between physical activity and academics.

EXERCISE, BRAIN, AND COGNITION: THE ROLE OF SKILL ACQUISITION

In their review published in Psychological Bulletin, Drs Tomporowski and Pesce examined exercise experiments comparing interventions that combined physical activity with mental engagement to interventions that did not, as well as studies drawn from sport and performance arts domains that assessed the benefits of skill acquisition on cognition. Skill acquisition is a key mechanism that may



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Skill acquisition is a key mechanism that may be responsible for the cognitive gains elicited by exercise.

Skill acquisition progresses along several stages. Practice and experience enhance motor skills as individuals acquire a more detailed understanding of the skills they are learning including when and how to use them. Also, the development of these skills can be impacted by the learner's environment and how they receive feedback. For example, several studies show that the cognitive benefits that older adults get from aerobic exercise and cognitive training are related to the skills they acquire during overextended training periods. The research team also demonstrates that the link between

exercise and learning becomes more robust when training occurs under conditions that vary from trial to trial when compared to those that remain fixed and predictable. Taken together, it becomes clear that the way skills are taught is important if it is going to benefit cognitive function.

This link becomes more apparent when you examine the relationship between sports training and the mind by looking at the cognitive function of athletes. Individuals who are trained in sports have been shown to have a better attention span and processing



speed, even when tested in a nonsport environment, demonstrating that cognitive skills developed through sports can be applied to other contexts. What's more interesting is that studies have found that these skill sets are not related to the type of sport that an athlete is involved in, although further research is needed to confirm these ideas.

Drs Tomporowski and Pesce have also demonstrated that exercise training may not be necessary at all to improve cognitive function. Although research in this area remains limited, the researchers highlight the benefit that performing arts can have on cognitive function. For example, several studies have linked music training with increased cognitive function, demonstrating that this type of training has the potential to improve several mental processes, including reading, reasoning skills, vocabulary skills, as well as spatial skills, and language acquisition. This link between music training and the mind is further supported by neuropsychological studies that have indirectly provided evidence for a relationship between music training and cognitive function.

TAKE-HOME MESSAGE

The main take-home message of the review supports Drs Tomporowski's and Pesce's hypothesis that skill acquisition through mentally engaging physical activities may explain the relationship between exercise and cognitive function. While moderate-to-vigorous exercise may be important for physical fitness, it is not essential to improve brain health. Motor skills that are learned via a wide assortment of movement activities that require relatively low levels of physical exertion promote cognitive benefits that are enduring. Regardless of exercise mode, instructional methods that motivate learners, generate appropriate performance expectancies and challenge autonomy in thoughts and actions enrich and maintain cognition. These findings apply across the life span and have implications for the advocacy of health-enhancing physical activity and physical education in public health and education settings.

Behind the Research



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Research Objectives

Drs Tomporowski and Pesce's research shows how mentally engaging physical activities reap the largest cognitive benefits.

Detail

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Bio

Phillip D. Tomporowski (PhD, University of Mississippi) is a Professor in the Department of Kinesiology at the University of

Georgia. His research focuses on the effects of physical activity on cognition. Dr Tomporowski serves on the Editorial Board of the Translational Journal of the American College of Sports Medicine.

Caterina Pesce is Professor at the Department of Movement, Human

and Health Sciences, University of Rome "Foro Italico". She serves on the Editorial Board of Journal of Sport and Exercise Psychology and Mental Health and Physical Activity.

Collaborators

- Dr Adele Diamond
- Dr Hal A. Lawson

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Personal Response

What inspired you to conduct this research?

II Tomporowski: My introduction to the Martial Arts led to improvements in physical health and changes in perceptions of my ability to meet and overcome academic challenges. Five decades ago, I asked myself the question, "how are physical and mental skills learned?" I continue to strive to answer the question.

Pesce: When I was young, I intuitively loved moving and thinking, thoughtful moving. Getting older, I learnt the theory that our ability to think emerged as a side effect of the evolutionary advantage of having a brain that was able to lead and monitor complex movement actions in a flexible and adaptive way.

Do you think we could reduce the number of people suffering from cognitive decline later in life by making mentally engaging physical activities a part of regular school curriculum?

Tomporowski: Life-span research confirms that physical activity promotes brain health and that the benefits are enduring. However, physical activity is only one of many factors that may favour cognitive functioning later in life.

Pesce: The broad array of factors that determine the maintenance of cognitive function or the rate of its age-related decline are intertwined. Thus, physical activities designed to be enjoyable and cognitively challenging should be embedded into the broader frame of children's healthy lifestyle habits to set the stage for moving steps to health in cognitive aging.

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