International Journal of Education and Psychology in the Community
IJEPC
2021, 11 (1 & 2), 238-242

SHORT-TERM EFFECTS OF PHYSICAL EFFORT ON COGNITIVE ABILITIES - A BRIEF REVIEW

Corneliu-Marius Cioara •
University of Oradea, Romania

Abstract
The multiple benefits exercising has is a widely explored topic. In particular, one of the most intense studied aspects regards the relation between physical activity and cognitive functions, covering both long-term habits of practice and acute exercise influences on cognition. This paper reviews the evidence regarding the immediate effects of acute physical effort on cognitive functioning in terms of cognitive dimensions, empirical support, underlying mechanisms and possible implications.

Keywords: acute exercise; cognitive functioning; time course analysis; performance

Introduction

Sport benefits on physical health are widely recognized, many people adopting nowadays an active way of life where, among work, rest and leisure, training activities based on physical effort are more and more present in everyday life, motivated by staying health, looking good and functioning well. In line with this, lot of long-term health benefits have been reported, including improved cardiovascular function, reduced risk of various neurological diseases or protection of the brain from detrimental effects of aging (Vivar, 2015; Duzel, van Praag, & Sendtner, 2016). Aside from these, sport and physical activities benefits on psychological health and well-being proved to be a fruitful and growing line of research; empirical data show that physical exercises may serve as potential therapeutic tools in reducing the intensity of depression symptoms, enhancing

Correspondence concerning this paper should be addressed to:

• Ph.D., University of Oradea, Psychology Department, Oradea. Address: Universitatii st., No. 3, 410087, Oradea, Romania, EU. E-mail: *mariuscioara@gmail.com*

positive mood states or decreasing stress level (Ebbesen, Prkachin, Mills, & Green, 1992; Reed & Ones, 2006).

A distinct type of advantages that sport and physical exercises proved to bring are into the field of cognitive functioning. Regarding these, longitudinal studies show that people who use to practice moderate exercises, but in a constant manner and for a long period (ex. decades), where training became a daily habit, when older, have a better level of cognitive abilities compared with sedentary peers.

Having a closer look at these results, it is not clear if these differences show an improvement in cognitive functioning over time or rather a slower rhythm of the natural cognitive deterioration process. In other words, the used paradigm doesn't allow to distinguish between a potential grow in cognitive functioning and a preventing apport that work out has in slowing down the mentally getting older rhythm. But even so, irrespective of the case, the benefits are obvious and useful. Beside these, a common aspect of the previously analysed line of research is that all the mentioned studies have been focused on the long-term consequences of long-term physical training, effects that appear after decades of practice.

In this context, the present paper intends to analyse the potential immediate cognitive consequences that physical effort might have. Compared with the long-term effects mentioned before, the hypothesis regarding the effects of acute physical effort on cognitive abilities has a brief history of research.

The idea that tiredness decreases performance in any field activity is almost a truism. But is tiredness a global construct or it involves multiple facets, like physical, sensorial or intellectual tiredness? If these are not only theoretical constructs, what's the relation between them? Do they correlate? And if so, in what degree? Or conversely, are there situations when we might be physically tired, but intellectually fresh? Do we perform better or worse in a cognitive task after an intense working out session? … are just few questions that became research hypothesis. Aprioristically speaking, despite the subjective conviction that tiredness negatively affects cognitive tasks such learning, functional arguments support the idea that a good and intense brain oxygenation due to physical effort can support for an immediate better cognitive functioning. Starting from this point, scientific research searched for evidence that support the acute physical effort - cognitive functioning relation, revealing specific dimensions, explanations and potential implications of it. In line with this, the present paper intends to highlight

a few aspects regarding empirical support, cognitive benefits, underlying mechanisms and possible implications that acute physical effort may have on cognitive abilities.

What's the empirical support for the cognitive dimensions that physical effort has immediate consequences on?

Available meta-analyses reviews (Sibley & Etnier, 2003; Lambourne & Tomporowski, 2010; McMorris & Hale, 2012) reveal that the influence of acute exercise on cognitive functioning is a heterogenous one, results being highly variable from detrimental to strongly positive effects. The most consistent positive results have been found on prefrontal cortex-dependant cognitive tasks like perception abilities, attention and other executive functions, problem solving, verbal fluency, decision making, executive control etc. Aside with these, same studies report limited evidence for general long-term memory, associative and emotional memory, learning or retention of motor skills (Baso & Suzuky, 2016/2017). Considered overall, data support a small but positive significant effect of acute physical exercise on cognitive functions (Chang, Labban, Gapin, & Etnier, 2012).

How the things work? Are there any specific underlying mechanisms that stay behind physical effort - cognitive functioning relation?

It has been proposed and analysed a variety of underlying mechanisms that acute exercise influence cognitive functioning through, ranging from simple brain oxygenation to more complex and detailed explanations like brain plasticity and neurogenesis. Synthetically, the existing studies focused of two distinct but related level of analysis: neurophysiological and respectively neurochemical pathways.

Regarding the neurophysiological mechanisms, studies on both humans and rodents using modern technical procedures like electroencephalography (EEG), magnetic resonance imaging (fMRI), near-infrared spectroscopy (fNIRS) or transcranial magnetic stimulation (TMS), concluded that acute physical exercise produces specific modifications in hippocampus activity, in frontal brain regions' blood flow and also facilitates excitation and inhibition in motor cortex. Referring to the neurochemical changes that occur while working out, studies demonstrate specific involvements of neurotransmitters (like serotonin, dopamine or norepinephrine), neuromodulators, neurotrophins (like BDNF, VEGF), lactate and cortisol (for an extensive review, *see* Basso & Suzuki, 2016/2017).

Possible implications of a time course analyse of cognitive functioning post physical effort

A time course analysis of the post-exercise cognitive benefits cessation might have serious implications, considering that, besides specific differences due to variables like effort intensity and duration, subject's effort capacity, type of cognitive ability studied or subject's health or illness state, the positive effects on cognitive functioning may last up to two hours after exercising (Chan et al., 2012). Knowing this might serve as useful input in planning activities like learning or working based on cognitive tasks, in order to catch the best functional state and achieve maximal results. For professional athletes and coaches also, better predictions regarding cognitive functioning post physical effort, detailed in terms of intensity, duration and personal effort capacity, could help for a better effort dosage, deciding training plans, time-out moments in specific situations.

Are there any variables that moderate or mediate the relation?

There are many intermediate variables that influence the impact of acute physical activities on cognition. Considering the well-known general relation between arousal and performance, which support that better results are obtained in conditions of moderate arousal, extreme values (light and also extreme) being less productive, studies focused on the effects of effort intensity on cognitive functioning. The results revealed that a wide range of exercise intensity, from light to high or very high values (ex. <50 - >93% MHR), proved to produce cognitive functioning enhancement (Chan et al., 2012). Even so, it seems that different effort intensities affect distinct types of brain functions: moderate intensity trainings may be more useful for executive functions, while high-intensity exercises proved to rather influence information processing abilities. The previous mentioned relation seems to be found in healthy individuals, whereas in people affected by different disorders / diseases, the relation between effort intensity and cognitive functioning follows a different pattern (*see* Basso & Suzuki, 2016/2017 for an extensive review).

Apart of training sessions' intensity, health condition or the type of cognitive task, other factors like age and effort capacity might be interested to study. For instance, findings regarding the impact of acute exercises on cognition across the life span could reveal if benefits are similar in childhood, adults or older people; these might serve to better plan timetable for pupils, in order to better achieve information in school and deciding best moment for preparing homework.

Similarly, in is not clear if the same intensity of physical training produces similar effects in intense trained (ex. professional athletes) or sedentary people; regarding this, a Ruffier-Dickson index, that measures the aerobic resistance and the rhythm of cardiac recuperation, could generate interesting insights.

References

Basso, J. C., & Suzuki, W. A. (2016/2017). The effects of acute exercise on mood, cognition, neurophysiology and neurochemical pathways: a review. *Brain Plasticity, 2*, 127-152.

Chang, Y. K., Labban, J. D., Gapin, J. I., & Etnier, J. L. (2012). The effects of acute exercise on cognitive performance: A meta-analysis. *Brain Research, 1453*, 87-101.

Duzel, E., van Praag, H., & Sendtner, M. (2016). Can physical exercise in old age improve memory and hippocampal function? *Brain;139*, 662-673.

Ebbesen, B. L., Prkachin, K. M., Mills, D. E., & Green, H. J. (1992). Effects of acute exercise on cardiovascular reactivity. *Journal of Behavioral Medicine, 15*(5), 489-507.

Lambourne, K., & Tomporowski, P. (2010). The effect of exercise induced arousal on cognitive task performance: A meta-regression analysis. *Brain Research, 1341*, 12-24.

McMorris, T., & Hale, B. J. (2012). Differential effects of differing intensities of acute exercise on speed and accuracy of cognition: A meta-analytical investigation. *Brain and Cognition, 80*(3), 338-351.

Reed, J., & Ones, D. S. (2006). The effect of acute aerobic exercise on positive activated affect: A meta-analysis. *Psychology of Sport and Exercise, 7*(5), 477-514.

Sibley, B. A., & Etnier, J. L. (2003). The relationship between physical activity and cognition in children: A meta-analysis. *Pediatric Exercise Science, 15*(3), 243-256.

Vivar, C. (2015). Adult hippocampal neurogenesis, aging and neurodegenerative diseases: Possible strategies to prevent cognitive impairment. *Current Topics in Medical Chemistry, 15*(21), 2175-2192.