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An Overview of Positive Interaction between Exercise and Mental Health

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Abstract

Brain plasticity is a complex mechanism which depends on a variety of environmental and external parameters, including physical activity. Thus, cerebral plasticity may be improved with increased physical activity as a complement to therapy or cognitive training in the case of mental health problems. Many correlations were already reported in the current literature between practice of exercise, and improvement of cognitive function, mental health and state of participants with neurodegenerative diseases. The current communication illustrates and simplifies some existing interaction between the cerebral plasticity in cortex and hippocampus; and the practice of physical activity with animal model or human participants.

Keywords: Physical activity; Cerebral plasticity; Risk factors; Cognitive impairments; Memory; Sleep

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Introduction

Physical exercise is any bodily activity that enhances or maintains physical fitness and overall health and wellness. Physical activity is executed for several personal reasons, including increasing growth and development, preventing aging, strengthening muscles and the cardiovascular system, honing athletic skills, weight loss or maintenance, and well-being [1-4]. Frequent and regular physical exercise improves and stabilize the immune system and helps in the prevention of cardiovascular disease, type 2 diabetes, and obesity [5-7]. It may also help prevent mood disorders and associated risk factors like stress and depression [5,8-10]. It has a reported positive effect on the quality and the duration of sleep; and act as a non-pharmaceutical sleep aid to treat diseases such as insomnia [11-14]. Exercise play an important role in positive self-esteem, improve mental health, augment an individual's sex appeal or body image, which has been found to be linked with higher levels of self-esteem. Childhood obesity is a growing global concern, and physical exercise may help decrease some of the effects of childhood and adult obesity [15]. Aside from the health advantages, regular physical activity benefits may include different social rewards for staying active while enjoying the environment of one's culture. Here we discussed quickly physiological and internal effects of exercise, on the brain architecture; and what are the perspective of this daily activity for mental health and research.

Multiple Effects on Mental Health and Neurodegenerative Diseases

Cerebral plasticity is the set of mechanisms by which cerebral circuits recombine to allow the establishment and maturation of synapses, cognitive functions, as well as the creation of new neural networks and the connections of these neurons. This phenomenon occurs during embryonic development and continues throughout adult life. It is the basis of the complexity of the brain, which varies from one species to another (depending on the anatomical and genetic architecture of each species), and is mainly influenced by mechanisms of learning, encoding and storage means, and evidence shows that it is favoured by multiple interactions of the brain with the environment of the subject [16]. The environment of the subject is the set of factors which have a direct or indirect influence on the psychological and physiological state of the individual [11,12,14,17-20]. The practice of physical activity has been recognized for a few decades as a protective factor for hemodynamic, cardiovascular and cognitive functions. Regardless of the age of the subject or participant, physical

activity intermittently or continuously contributes to an adequate musculoskeletal balance. It also contributes to the reduction of the devastating effects of socio-environmental risk factors such as stress, lack of sleep, and a precarious social environment on the mental health of the individual. It has been demonstrated in the literature that cerebral plasticity (the mechanism of recombination of the neuronal map affecting major functions such as memory, vision and recognition of colours), was greatly influenced by internal and external stimuli to the brain. And physical activity is one of those factors that has a pronounced impact on attention, depression, anxiety or overall well-being [21]. However, its positive interaction with cognitive functions remains a recent outcome of research in neurocognition. Yet this protective and preventive aspect of sport is already proven and recognized in research on neurodegenerative diseases, particularly Alzheimer's Disease and Parkinson's Disease [22]. The aim of this article is to show the interaction between physical activity in general and the mechanisms of cerebral plasticity and cognitive functions. Regular physical activity has a significant positive impact on cognitive function. From a psychological point of view, it is established that decreasing stress controls and prevents depression and anxiety. From a physiological point of view, at least thirty-six pathologies, including hypertension and Parkinson's and Alzheimer's dementia, are all significantly slowed down by an average of thirty minutes of physical exercise every day [23]. It is a powerful instrument for healthy aging of body and mind. In other words, in young adults (between eighteen and forty), it protects the brain from functional deficits; in those over forty, it slows down the functional losses due to aging and associated neurological issues. Empirical evidence suggests that maintaining a high level of fitness and maintenance of cardiovascular health and activity protects against the structural changes that occur with aging in the brain regions associated with memory, attention and performance tasks [21,24]. Sustained physical activity is also associated with the preservation of cognitive function in general and the prevention of dementia. By combining it with several preventive measures such as good quality sleep or the abolition of stress in lifestyle habits, the decline in cognitive function can be slowed down and even prevented in both young adults and aging adults [23,25]. For people with dementia or cognitive deficits, associated or not with neurodegenerative diseases, physical exercise seems to slow the cognitive loss just as much as a standard treatment. Several studies report a beneficial effect on oxidative stress, reduction of preclinical biomarkers in Alzheimer's disease and even slower cognitive decline [26].

It is firmly established by current empirical evidence that the hippocampus is the structure of the brain most affected by pathologies attacking memory. The hippocampus, which is part of the limbic system, is involved in systems of inhibition of behaviour, attention, and navigation. It also plays a central role in memory, which explains the memory problems and disorientation that characterize the onset of Alzheimer's disease. People suffering severe damage to the hippocampus are also likely to suffer from different types of amnesia. Yet it is also among the very rare brain components susceptible to neurogenesis in adult mammals. This production of new neurons seems influenced by the practice of physical exercise [27-30]. Recent studies of neurobiology and neurophysiology have demonstrated the anti-inflammatory effect of physical exercise on hippocampal affections occurring in localized or progressive inflammation [31]. Directly or indirectly, memory is affected much more deeply by physical activity than it is demonstrated by current literature. These studies also highlighted the link between the cognitive functions of the hippocampus and the maintenance of sustained and varied physical activity [28]. In combination with cognitive therapies, or in regular practice even in the absence of a diagnosis of mental illness, physical activity is a significant weapon against memory problems and moderate cognitive deficits.

Discussion

Further evidence with animal model of cerebral plasticity and physical activities programs

Physical activity has raised interest of clinicians and researchers, as an alternative pathway helping the improvement of prognosis in psychiatric disorders. Segal-Gavish and Al showed that, voluntary exercise increased performance in the novel object recognition test, reduced the deficit in spatial memory in the Y maze, and reversed the impairment process in social recognition memory in DN-DISC1 females. Voluntary physical activity is efficient in the reduction of cognitive deficits observed in a rodent model of neuropsychiatric disorders. Their results are coherent with many conclusions raised by several authors using different designs [9,29,32]. Many models exist to study effects of aerobic and exercise, on mental health. It was shown on the last years that, practice of physical activity reduces significantly anxiety-like behavior in rodent. Schoenfeld and Al investigated the effects of long-term wheel running on anxiety-like behavior in GFAP-TK (TK) mice, a transgenic strain with complete ablation of adult neurogenesis. After five weeks of running, they observed a reduction of anxiety-like behavior equally in both model and control. Many others articles reported same effects on depression, cognition, hippocampus changes and cognitive impairments in neurodegenerative diseases [7,15,22,28-30,33-37]. Hippocampus seems to be the brain structure mainly affects by physical activity. Similar program of exercise suggested that although running increases adult neurogenesis in animal hippocampus, new neurons are not involved in the decreased anxiety-like behavior or hippocampal activation produced by running, and so the mechanisms induced by exercise remains unclear. These facts revealed the main inconvenience which is, the difficulty to transfer acknowledge from experiments with animal to humans. Studies led with human participants reported that, acute physical activity can increase memory performance, but the qualities of the exercise necessary to promote improved memory, and the signaling pathways that mediate these effects are unknown. Brain-derived neurotrophic factor (Bdnf), noradrenergic signaling, and post-translational modifications to AMPA receptors have all been implicated in the enhancement of memory following emotional or physical arousal; however, it is not known if a single bout of exercise is sufficient to engage these pathways. Venezia

and Al demonstrated that, a single bout of treadmill exercise was insufficient to mimic the increased expression of GluR1 protein and phosphorylation at Ser845 observed following 1 month of voluntary wheel running. However, acute exercise was sufficient to increase Bdnf transcript IV messenger RNA (mRNA) expression in sedentary subjects, but not subjects housed for 1 month with a running wheel. Their findings exhibited that, high-intensity acute exercise increased total Bdnf mRNA in sedentary mice, but not above levels observed following chronic access to the running wheel. Although depletion of central noradrenergic signaling with DSP-4 reduced Bdnf IV mRNA, the effect of acute exercise on Bdnf mRNA persisted.

Conclusion and Future Perspective

Exercise have a significant effect of improvement of mental disorders, cognitive failure and mood disorders. Many evidences are reported now in current literature, and more studies should explore how the sport and physical activity affects the cerebral plasticity of humans. New technologies may serve this perspective with mixture of electrophysiological recording while patients are making exercise. Another interesting design can be a simultaneous recording of participant's clinical parameters (with EEG, EMG, ECG combined with telemedicine equipment) during their daily life, and compared after with sedentary participant's parameters to document real-time changes in brain. Cyberpsychology is also an interesting corner to investigate and translate basic findings in physical science, to clinical applications or investigations. These quasi-experimental design, are already used in few observational studies with descriptive design; in the area of biomedical engineering, psychology and neuroscience [13,38,39].

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