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"Impact Of Physical Exercises On Brain Functions"

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Introduction:

This article reveals the brain functions related to the exercises. We have seen so much research and publications, viz., physical fitness, cardiovascular fitness, health fitness, etc., benefited from physical activities. Some of the activities enlighten, even morally, ethically, and socially. Physical exercise is any bodily activity that enhances or maintains physical fitness and overall health and wellness. It is performed for various reasons, including strengthening muscles and the cardiovascular system, honing athletic skills, weight loss or maintenance, and merely for enjoyment. Frequent and regular physical exercise boosts the immune system and helps prevent the "diseases of affluence" such as heart disease, cardiovascular disease, Type 2 diabetes, and obesity. It may also help prevent depression, help to promote or maintain positive self-esteem, improve mental health generally, and augment an individual's sex appeal or body image, which is 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. Health care providers often call exercise the "miracle" or "wonder" drug, alluding to the wide variety of proven benefits that it can provide.

In most countries, two to four hours of light activity are recommended during working hours. This includes walking and standing.

Brain Function:

Physical activity has been shown to be neuroprotective in many neurodegenerative and neuromuscular diseases. Evidence suggests that it reduces the risk of developing dementia. The Caerphilly Heart Disease Study followed 2,375 male subjects over 30 years and examined the association between regular physical exercise and dementia. The study found that men who exercised regularly had a 59% reduction in dementia when compared to the men who didn't exercise.

In addition, a 2008 review of cognitive enrichment therapies (strategies to slow or reverse cognitive decline) concluded that "physical activity and aerobic exercise in particular, enhances older adults' cognitive function".

In mice, exercise improves cognitive functioning via improvement of spatial learning, and enhancement of synaptic plasticity and neurogenesis. In a 2009 study, scientists made two groups of mice swim a water maze, and then in a separate trial subjected them to an unpleasant stimulus to see how quickly they would learn to move away from it. Then, over the next four weeks they allowed one group of mice to run inside their rodent wheels, an activity most mice enjoy, while they forced the other group to work harder on mini-treadmills at a speed and duration controlled by the scientists. They then tested both groups again to track their learning skills and memory. Both groups of mice improved their performances in the water maze from the earlier trial. But only the extra-worked treadmill runners were better in the avoidance task, a skill that, according to neuroscientists, demands a more complicated cognitive response.

The mice that were forced to run on the treadmills showed evidence of molecular changes in several portions of their brains when viewed under a microscope, while the voluntary wheel-runners had changes in only one area. According to an author of the study, "our results support the notion that different forms of exercise induce neuroplasticity changes in different brain regions."

Furthermore, anecdotal evidence suggests that frequent exercise may reverse alcohol-induced brain damage.

There are several possibilities for why exercise is beneficial for the brain. Examples are as follows:

- Increasing the blood and oxygen flow to the brain;
- Increasing growth factors that help neurogenesis. and promote synaptic plasticity - possibly improving short and long term memory;
- Increasing chemicals in the brain that help cognition, such as dopamine, glutamate, nor epinephrine, and serotonin.

Physical activity is thought to have other beneficial effects related to cognition as it increases levels of nerve growth factors, which support the survival and growth of a number of neuronal cells.[53]

Depression

Further information: Neurobiological effects of physical exercise & Antidepressant effect and Exercise-induced euphoria

Physical exercise, particularly aerobic exercise, has pronounced long-term antidepressant effects and can produce euphoria in the short-term. Numerous systematic reviews suggest that regular aerobic exercise (at sufficient intensity and duration) has comparable antidepressant efficacy to standard pharmaceutical antidepressants in treating depression. Consequently, current medical evidence supports the use of aerobic exercise as a treatment for depression. The bimolecular basis for exercise-induced antidepressant effects is believed to be a result of increased neurotrophic factor signalling, particularly brain-derived neurotrophic factor. Continuous exercise can produce short-term euphoria, colloquially known as a "runner's high" in distance running or a "rower's high" in crew, through the increased biosynthesis of at least three euphoriant neurochemicals: anandamide (an endocannabinoid), β - endorphin V (an endogenous opioid), and phenethylamine (a trace amine and amphetamine analog).

Sleep:

A 2010 review of published scientific research suggested that exercise generally improves sleep for most people, and helps sleep disorders such as insomnia. The optimum time to exercise *may* be 4 to 8 hours before bedtime, though exercise at any time of day is beneficial, with the possible exception of heavy exercise taken shortly before bedtime, which may disturb sleep. There is, in any case, insufficient evidence to draw detailed conclusions about the relationship between exercise and sleep.

According to a 2005 study, exercise is the most recommended alternative to sleeping pills for resolving insomnia. Sleeping pills are more costly than to make time for a daily routine of staying fit, and may have dangerous side effects in the long run. Exercise can be a healthy, safe and inexpensive way to achieve more and better sleep.

The **neurobiological effects of physical exercise** are numerous and involve a wide range of interrelated neuropsychological changes. A large body of research in humans has demonstrated that consistent aerobic exercise(e.g., 30 minutes every day) induces persistent beneficial behavioural and neural plasticity as well as healthy alterations in gene expression in the brain; some of these long-term effects include: increased neuron growth, increased neurological activity (c-Fos and BDNF signalling), improved stress coping, enhanced cognitive control over behaviour, improved declarative and working memory, and structural and functional improvements in brain structures and pathways associated with cognitive control and memory. The effects of exercise on cognition have important implications for improving academic performance in children and college students, improving adult productivity, preserving cognitive function in old age, preventing or treating certain neurological disorders, and improving overall quality of life.

People who regularly participate in aerobic exercise have greater scores on neuropsychological function and performance tests. Examples of aerobic exercise that produce these changes are running, jogging, brisk walking, swimming, and cycling. Exercise intensity and duration are positively correlated with the

release of neurotrophic factors and the magnitude of nearly all forms of exercise-induced behavioural and neural plasticity; consequently, more pronounced improvements in measures of neuropsychological performance are observed in endurance athletes as compared with recreational athletes or sedentary individuals. Aerobic exercise is also a potent long-term antidepressant and a short-term euphoriant; consequently, consistent exercise has also been shown to produce general improvements in mood and self-esteem in all individuals.

The term **brain fitness** reflects a hypothesis that cognitive abilities can be maintained or improved by exercising the brain, in analogy to the way physical fitness is improved by exercising the body. Although there is strong evidence that aspects of brain structure remain plastic throughout life, and that high levels of mental activity are associated with reduced risks of age-related dementia, scientific support for the concept of "brain fitness" is limited. The term is virtually never used in the scientific literature, but is commonly used in the context of self-help books and commercial products. It first came into play in the 1980s, and appeared in the titles of self-help books in 1989 and 1990.

Contents

Overview:

Brain fitness is the capacity of a person to meet the various cognitive demands of life. It is evident in an ability to assimilate information, comprehend relationships, and develop reasonable conclusions and plans. Brain fitness can be developed by formal education, being actively mentally engaged in life, continuing to learn, and exercises designed to challenge cognitive skills. Healthy lifestyle habits including mental stimulation, physical exercise, good nutrition, stress management, and sleep can improve brain fitness. On the other hand, chronic stress, anxiety, depression, aging, air pollution, decreasing estrogens', excess oxytocin, and prolonged cortisol can decrease brain fitness as well as general health.

As of 2010, there was insufficient evidence to recommend any method of preventing age-related memory deficits or Alzheimer.

Neurogenesis:

Neurogenesis is the creation of new neurons. The more active a particular brain cell is, the more connections it develops with its neighbouring neurons through a process called dendritic sprouting. A single neuron can have up to thirty thousand such connections, creating a dense web of interconnected activity throughout the brain. Each neuron can then be stimulated directly through experience (real or imagined) or indirectly through these connections from its neighbours, which saves the cell from cell death.

Physical exercise boosts the brain's rate of neurogenesis throughout life, while mental exercise increases the rate at which those new brain cells survive and make functional connections into existing neural networks. Both physical exercise and the challenge from mental exercise increase the secretion of nerve growth factor, which helps neurons grow and stay healthy.

Role of Neurotrophins:

Brain fitness is purported to be positively influenced through mental and physical exercises that increase levels neurotrophins. Neurotrophins are a small class of proteins that are vital in neuronal development and function. In development, neurotrophins act to protect and warrant the survival of an adequate number of neurons. The survival of ample neurons is vital to ensure that they are match for target innervations. Neurotrophins also assist cell fate decisions, innervations patterns, the development of axons, dendrite pruning, etc. Neurotrophins are also important for regulating neural function and neuronal survival.[11] Neurons are affected most predominantly by neurotrophins; however, they are important for many parts of the body in addition to the nervous system. Neurotrophins are crucial for the

survival of neurons in the peripheral nervous system (PNS) as well as neurons in the central nervous system (CNS). The four most common neurotrophins are Nerve Growth Factor (NGF), Brain Derived Neurotrophic Factor (BDNF), Neurotrophic Factor-3 (NT-3), and Neurotrophic Factor-4/5 (NT-4/5). In order to understand how neurotrophins affects brain fitness, it is important to understand how they work.

Nerve growth factor (NGF) was the first neurotrophic to be discovered and is the most famous. The effects of NGF are present in a multitude of tissues through human development as well as adulthood. NGF is associated with immunity, stress reaction, nerve maintenance and neurodegenerative diseases. NGF is known have a predominant effect on the sympathetic ganglion cells and dorsal root ganglion cells with free nerve endings and the cholinergic neurons of the basal nucleus. Sympathetic ganglion cells are masses of neuronal cell bodies in the sympathetic branch of the visceral (autonomic) nervous system. Dorsal root ganglionated masses of neuronal cell bodies in the posterior portion of the spinal cord where sensory information is processed. Cholinergic neurons are profuse in parts of the brainstem, the base of the forebrain, and the basal ganglia. They are thought to play a role in regulating the general level of activity of CNS neurons, especially during the different phases of wakefulness and sleep and also during learning.[12] Therefore, it can be purported that increased secretion of NGF can stimulate the sympathetic nervous system, the sensory portion of the spinal cord, parts of the brainstem, the base of the forebrain, and the basal ganglia. Perhaps the roles of these individual structures can be facilitated or preserved with increased NGF.

Secretion of brain derived neurotrophic factor (BDNF) is stimulated by cortical neurons, and is essential for permanence of striatal neurons in the brain. Both patients with Alzheimer's and with Huntington disease exhibit reduced levels of BDNF. Striatal neurons are the nerve cells that make up the stratium. The stratium is an inclusive term for several structures of the midbrain. The stratium is the major point of entry for receiving input from most or all cortical areas and analyzing inhibitory outputs to the various parts of the midbrain. Therefore, it may be deduced that secretion of BDNF can have an influence on many parts of the cerebral cortex and coincidentally the functions of the areas influenced.

Spiral ganglion neurons are particularly sensitive to neurotrophic factor-3 (NT-3). The spiral ganglion neurons contain the cell bodies of the auditory primary afferent fibres. The central process of these cells collects at the base of the cochlea to form the cochlear division of the eight nerves. These afferent fibres carry auditory impulses toward the central nervous system. Therefore, it may be reasoned that healthy levels of NT-3 can preserve the function of these cells that are crucial for processing auditory information in the brain.

An article entitled "Neurotrophic 4/5 is a trophic factor for mammalian facial motor neurons" summarizes a study that was conducted on the researchers' findings in 1993. The research suggests that NT-4/5 prevents injuries that cause death of facial motor neurons in neonatal rats. Additionally, there is functional receptor for NT-4/5 in facial motor neurons that can be serviceable thought embryonic development and even postnatal life. Thus, both NT-4/5and brain-derived neurotrophic factor (BDNF) may be physiological survival factors for facial motor neurons and may serve as restorative means for motor neuron disease.

Activities presumed to promote brain fitness

Further information: Neurobiological effects of physical exercise

Not all brain activity exercises the brain in the same way.

- Activities that require you to use all your senses, break your routines and engage in novel experiences which can create BDNFs(Neurotrophins) as explained in the book Keep Your Brain Alive, Workman Publishing.
- Activities that involve planning ahead, like chess, stimulate the frontal lobe area of the brain.
- Activities like ballroom dance and basketball, train short range spatial skills, used when one walks through a short limited space, like the interior of a house.
- Activities like learning a new language or painting require the coordinating of multiple regions of the brain.
- Physical exercise promotes BDNF.
- Reading books, and writing
- Cognitive training games

Practical Effects:

A significant issue in brain fitness work has been establishing that brain training exercises have impacts on brain function that exist outside the context of the training task.

Other studies, however, have looked at changes in tests of everyday function that occur after brain-based training. In a review of these studies, the following significant effects were noted. Improvements on speed of processing training tests were related to improvements in the Timed Instrumental Activities of Daily Living test (TIADL). Evidence of ceiling effects were also noted, indicating that subjects who were further below normal at the beginning of training had the largest expected gains. Further, the effect sizes may be related to customizing the training difficulty to the performance level of the trainee. Subjects trained with one training strategy, the Useful Field of View test (UFOV), showed significant improvements in an on-the-road driving test designed to evaluate driver response during potential dangerous situations. Specifically, subjects trained with UFOV made fewer dangerous manoeuvres after training. In another study, the researchers have found that action video game experience is shown to improve trainees' probabilistic inference. These results were established both in visual and auditory tasks, indicating generalization across modalities. In a study performed with Air force flight cadets it has been shown that training addressing attention control processes yielded significant transfer of skills from the training environment to actual flight.

Lately, brain training games have been actively marketed as a "magic bullet" for Alzheimer's and Dementia. While there are few studies showing effectiveness of brain training for older adults, it has to be noted that many brain training games are purely commercial and have no scientific footing. To address growing public concerns with regard to aggressive online marketing of brain games to older population, a group of neuroscientists published a letter warning general public that there is a lack of research showing effectiveness of brain games in elderly. Authors of this letter suggest that many popular computerized training programs are not very effective and some other interventions, such intense physical exercise, may have greater benefits. With regard to research studies supporting benefits of brain training games for older adults, there is the strong evidence that participants only gain in the trained task and that there is limited transfer of skills to the real life activities.

Another recent market for *Brain Training* services is children who are not meeting academic expectations in school. Student's performance on standardized norm-reference tests of cognitive abilities (e.g., Woodcock-Johnson Test of Cognitive Ability - IV) serve as a guide to determine which cognitive processes are relative strengths and weaknesses. For a description of these processes see Cattell–Horn–Carroll theory. A pre-training test provides both data on proposed weaknesses in need of training and a baseline measurement to compare performance on post-training administrations of the test. The assumption is that identifying and training a weaker cognitive process will result in generalizable improvements to academic performance. Cognitive training takes an analogue form of the skill performed on the test, and predictably does improve performance on that discrete skill in post-test measures. There is currently no evidence that this improvement in these discrete, trained skills, generalizes to better performance on higher order, more complex intellectual or academic skills.

Examples:

Several commercial and academic programs have arisen to provide brain training services.

Neurobics

Neurobics are exercises that claim to enhance the brain's performance. These exercises are described by Lawrence Katz and Manning Rubin in their book *Keep Your Brain Alive*; however they are not scientifically proven. The term neurobics was popularized by Lawrence Katz in 1999. It is presumed that unusual sensory stimulation and activities like non-routine actions and thoughts, produce more of such chemicals of the neurobiology system of body that encourage growth of new dendrites and neurons in the brain. Routine actions become so automatic to the individual that most of actions are done largely unconsciously. Such automated or unconscious actions require less activity in the brain, and exercise it less. With the help of neurobics exercises, it is claimed that one can stimulate the brain. We also Neuroplasticity, Neurocognitive, Serious game, Environmental enrichment, Mental exercises.

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