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Undergraduate

The Neuropsychological Effects of Exercise: A New  
Prescription for Healing

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PSY 181

## THE NEUROPSYCHOLOGICAL EFFECTS OF EXERCISE

**Abstract**

The rates of physical inactivity in America have skyrocketed in the past several decades, and still appear to be increasing. This has led to a slew of illnesses, both physiological and psychological, and it is critical that it be reversed. More and more in recent times, health professionals are turning to pharmaceuticals to treat the ailments of their patients, when instead they should first look at how their patients can help themselves with exercise. In this paper, I have outlined a small selection of the vast positive effects that can come from regular physical activity. These effects include improvements in mood, the reduction of mental illness such as depression, and benefits to cognition. The collection of findings in this paper can be used to demonstrate to health professionals and policy makers alike that physical activity is a critical key to solving America's health crisis.

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### Introduction

The climbing rates of mental illness in America paired with the declining rates of physical activity are staggering and call for immediate concern. Approximately 1 in 5 adults in the U.S. experiences a mental illness in a given year, while 1 in 5 children aged 13-18 experiences some severe mental illness at some point throughout their lives (National Alliance on Mental Illness, n.d.). Common treatments for these illnesses include therapy and medications, but mental health professionals are ignoring a proven successful treatment option and that is exercise. Physical inactivity contributes to as many as 250,000 premature deaths per year, and that is likely a conservative estimate (Bryan, 2007). The range of health problems that can be alleviated with voluntary exercise include cardio-respiratory diseases, an array of cancers, age-related cognitive decline, and the onset of Alzheimer's and Parkinson's diseases (Hansen, 2001; Bryan, 2007; Walsh, 2011). Exercise increases brain volume, vascularization, blood flow, and functional abilities in the brain (Walsh, 2011). It also promotes neurogenesis, synaptogenesis, neuronal preservation, interneural connections, and an essential protein called brain-derived neurotrophic factor (Walsh, 2011). In children, physical fitness has been associated with better academic achievement, while obesity has been associated with poorer achievement (Jerstad, 2010). Even with these correlates shown study after study, schools across the nation cut out time for physical activity in the name of saving money and furthering education. Jerstad (2010) notes, however, that adding time in the school day for vigorous physical activity has shown to improve the performance of children, even when it takes away from class time. It is also pointed out that rates of depression statistically tend to increase during adolescence, while physical activity tends to decline (Jerstad, 2010). Exercise has vast benefits for the adult population as well, with studies showing that 6 months of steady aerobic exercise can increase activity in the prefrontal cortex,

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leading to improvements in executive functioning and cognitive performance (Davis, 2011). In light of extensive research showing the neuropsychological benefits of regular exercise, it is clear that psychologists and physicians should prescribe physical activity to their patients as a primary treatment option in order to benefit their physical and mental health as a whole.

### **Psychological Benefits of Exercise**

#### **Mood Improvement**

One of the most well-documented benefits of exercise is its ability to induce positive affect in individuals. In particular, researchers have noted its ability to increase positive mood and decrease negative mood (Bryan, 2007). In one experiment, researchers studied different psychological variables to see how much exercise was required to reap positive rewards (Hansen, 2001). What Hansen et. al (2001) found was that increased levels of exercise intensity were associated with reduced levels of confusion, fatigue, and negative mood. These psychological effects began within 10 minutes of exercising, but the variable of confusion improved more slowly, over the span of 20 minutes (Hansen, 2001). These findings are in line with the general guidelines for adults and children to exercise for at least a cumulative 30 minutes per day. Hansen et. al (2001) noted that in particular, exercise helps individuals to manage anxiety, depression, anger, tension, reaction to stress, self-efficacy, and self-esteem (Hansen, 2001). Another group of researchers were able to obtain similar results when they ran a within-subjects design experiment including a sedentary trial and a trial including bouts of acute exercise (Bryan, 2007). The research team confirmed a relationship between increases in positive affective states and acute exercise behavior (Bryan, 2007). These correlations between exercise and improved positive affect have been confirmed across a broad number of studies, creating a foundation of validity for its argument.

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### **Executive Functioning**

Studying a different aspect of positive neuropsychological effects of exercise, Davis et. al (2011) set out to study the benefits physical activity produced concerning executive functioning. Executive functioning is a term used to describe the activity mediated by the prefrontal cortex that grants the ability for supervisory cognitive functions that are used to achieve a goal (Davis, 2011). Some of these functions include planning and carrying out actions, allocating attention and memory, response selection and inhibition, goal setting, self-monitoring, and so on (Davis, 2011). Davis et. al's (2011) study revealed dose-responsive benefits of exercise on executive function and math achievement, involving increased bilateral prefrontal cortex activity and reduced bilateral posterior parietal cortex activity. This study was looking at overweight children in particular, but the results were consistent with adults in regards to the behavioral and brain activity changes that have been observed as a response to exercise (Davis, 2011). Physical activity may prove to be an important method of enhancing aspects of children's mental functioning that are central to cognitive development (Davis, 2011). This study provides a critical link for demonstrating the value of physical activity in young children—not only for their health, but also for their academic performance. Beyond children, voluntary exercise has also proven to be associated with long-term improvements in mental function for adults and is said to be the single best thing a person can do to slow the cognitive decline that accompanies normal aging (Linden, 2011). With these obvious benefits of exercise, it only makes sense to urge people—young and old—to carry out the recommended amount of daily physical activity, both as a treatment and a preventative measure.

### **Depression**

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Major depression is a common psychiatric disorder that arises during adolescence and increases risk for suicide, academic failure, interpersonal problems, delinquency, and more (Jerstad, 2010). Researchers have stated that exercise has a natural antidepressant effect, blunting the brain's response to physical and emotional stress (Linden, 2011). Physical activity has been shown to decrease the risk for depression in many ways, from increasing monoamines like serotonin and dopamine in the brain, serving as a distraction to negative affect, and improving self-esteem (Jerstad, 2010). The form of physical activity is not important either, as it has been proven that both aerobic exercise and weight training are effective for combatting mild to moderate depression (Walsh, 2011). The only particular choice that has been documented as better for improving mental health is in choosing high intensity exercise over a low intensity option (Walsh, 2011). Jerstad et. al (2010) conducted a study with 476 adolescent girls to see how physical activity affected their risk for depression, and found a bidirectional relationship between physical activity and depression. In particular, it was documented that physical activity significantly reduced future increases in depression, while depression significantly reduced the chance of future physical activity (Jerstad, 2010). It was noted that the reduction in physical activity may be explained by fatigue and psychomotor retardation caused by major depression, along with low self-esteem preventing young girls from playing sports (Jerstad, 2010). This enhances the necessity for physical activity, as it is thought that physical activity may provide social connectedness, efficacy, and enjoyment contributing to lower risk of depression (Jerstad, 2010). It is clear to see that a major benefit of exercise is that it is a valuable preventative measure to a vast array of psychological illnesses.

### **Neurological Benefits of Exercise**

#### **Brain-Derived Neurotrophic Factor (BDNF)**

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Brain-derived neurotrophic factor (BDNF) is a peptide growth factor that influences the central and sensory nervous systems, the development of vasculature, and neuronal growth and regeneration in the hippocampus and other regions including the spinal cord and skeletal muscle (Bryan, 2007). Recent research in human and nonhuman animals has linked BDNF to depression and other central nervous system disorders (Bryan, 2007). In a study by Bryan et. al (2007), it was discovered that voluntary exercise increased levels of BDNF and improved cognitive performance. Specifically, animal studies have shown that aerobic exercise increases growth factors like BDNF, leading to increased capillary blood supply to the cortex and the growth of new neurons and synapses (Davis, 2011). This rise in neurogenesis and synaptogenesis resulted in better learning and performance (Davis, 2011). From the study conducted by Bryan et. al (2007), it was shown that the BDNF gene moderated the effects of exercise on mood, heart rate, and perceived exertion where positive affect was the result of acute exercise. The researchers stated that this was made possible by the physiological factors, namely the BDNF gene, having a relationship with mood response, where mood response was a significant correlate of future motivation to exercise (Bryan, 2007). It is important to note that while BDNF may play an important role in a person's experience of exercise, it is not a single gene responsible for the motivation to exercise in the future. There are several factors involved in the response to exercise—psychologically and physiologically—and the interplay of those factors is still a subject of study.

### **Serotonin**

Serotonin is a hormone found in the digestive tract, central nervous system, blood platelets, and in the pineal gland (Hibben, 2013). The hormone helps to regulate appetite, sleep, learning, and memory, and is best known for its contributions to our feelings of well being



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(Hibben, 2013). One way to naturally raise levels of serotonin in the brain is by exercising (Young, 2007). It has been proven in animal studies that exercise increases tryptophan and 5-HIAA, a serotonin subtype, in rat ventricles (Young, 2007). It has also been confirmed in recent studies that exercise increases extracellular levels of serotonin and 5-HIAA in various brain areas, including the hippocampus and greater cortex (Young, 2007). Young (2007) describes two different mechanisms that may be at work in the process of serotonin levels increasing from exercise: (a) motor activity increases the firing rates of serotonin neurons, resulting in increased release and synthesis of the neurotransmitter, and (b) there is an increase in the levels of tryptophan, the serotonin precursor, in the brain that persists after a bout of exercise. By adding 15-20 minutes per day of physical activity, serotonin and other feel-good hormones will be boosted throughout the brain and body (Hibben, 2013). This can alleviate the negative symptoms caused by various mood disorders, including mild to moderate depression.

### **Conclusion**

Based on the evidence presented in this paper and the vast ocean of evidence that is present in the current literature, it is clear that regular physical activity should be enforced for people of all ages in order to keep neuropsychological functioning in line. The array of diseases that could be prevented by implementing regular exercise into the lifestyles of all people, young and old, is vast. It has been noted by researchers that the decline in overall vigorous physical exercise is likely to be a contributing factor to the high levels of depression in society today (Young, 2007). It is now common for schools to cut out physical education programs in the name of more class time, even though this has proven to be detrimental to the learning and overall health of the students. In order to reverse the enormous rate of disease that is plaguing America and other countries as a whole, exercise is the most promising first step. The CDC and American

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College of Sports Medicine recommends 30 minutes or more of daily moderate physical activity carried out in short bouts throughout the day (Hansen, 2001). In the United Kingdom, the National Institute for Health and Clinical Excellence has published a guide on using exercise as treatment for depression, recommending treating mild clinical depression with exercise rather than antidepressants (Young, 2007). If physicians, teachers, mental health professionals, and the media in America begin to promote a healthier lifestyle full of physical activity, the overall quality of life and rates of productivity are likely to improve drastically. The key is to get people to take the first step. Further research could aid in discovering methods to reach out to those who are physically inactive and require outside motivation to change. It is evident that so many people lack the motivation they need to engage in regular exercise, so discovering what it will take to demonstrate to this population the importance of exercise will be critical. It might require more adamant recommendations by their physicians or it also might take the blatant demonstration of where an inactive life will lead them. Solving this crisis of physical inactivity in America will be a crucial first step to creating a healthier nation in terms of both physical and psychological health.

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