The effects of exercise on improved learning for the young.

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ABSTRACT

Background: It is widely accepted that exercise can have significant health benefits improving physical health, however it is not commonly recognised that exercise has a positive effect on cognitive health. An increasing amount of research shows a relatively new concept, that exercise can improve cognitive health and alertness. In section 1, past studies will be addressed and in section 2 we will discuss possible future developments that have come from studies into the effects of exercise on improved learning for the young.

Methods: We would implement our study by using a large sample of participants randomly selected from a primary school. We would allocate an even number of children from each year group into two independent groups; one our active group and the other a control.

Results: We anticipate that we would find a significant increase in the academic achievement of those that participate in regular exercise, prior to lessons.

Conclusions: An increase in exercise, leads to enhanced BDNF production and consequently more neurogenesis. This in turn results in an increase in academic potential in primary school children.

Keywords: Brain Derived Neurotrophic factor (BDNF), Neurogenesis, Gamma Aminobutyric Acid (GABA), Glutamate, Improved Learning, Cognitive, exercise, Hippocampus

INTRODUCTION

Exercise is defined as activity requiring physical effort carried out to sustain or improve health and fitness (Oxford English Dictionary 2013). Research into the possibility of exercise conditioning, not only the muscles of the body, but also improving cognitive health is continuously increasing. By improving cognitive health in children, their academic performance can be improved.

It is a well-known fact that regular exercise for children is important to keep the body active and healthy. In the United Kingdom (UK) the national strategy for physical activity of children and young people states that “To maintain a basic level of health, children and young people aged 5-18 need to do at least 60 minutes of physical activity every day, which should be a mix of moderate-intensity aerobic activity, such as fast walking, and vigorous-intensity aerobic activity, such as running. On three days a week, these activities should involve muscle-strengthening activities, such as push-ups, and bone-strengthening activities, such as running. Many vigorous-intensity aerobic activities can help you meet your weekly muscle and bone strengthening requirements, such as running, skipping, gymnastics, martial arts and football.” (www.nhs.uk)

In developed countries, children are less likely to carry out exercise throughout the course of their day, as transport is readily available. For example, cars are very popular, as the Department of Transport states that in the UK in 2010, 66% of females and 80% of males held a full car driving licence. While the proportion of males holding a licence remained fairly stable since the early 1990’s, the proportion of females with a licence continued to increase. This suggests that cars are used widely by many families to take children places, and they may be replacing other ways of getting around that involve exercise such as walking or cycling. As well as cars, public transport is used frequently and has a big impact on children's lives for example school busses are used daily by thousands of students, and take them directly to their schools, meaning they don’t have to walk far to get to school resulting in reduced daily physical exercise. The ease of being entertained by things such as television and computer games also means children are less likely to find entertainment by going outside and playing active games that involve exercise. Social features of videogames and social networks mean that children can easily talk to their friends and socialise without having to go and meet up with them. This lack
of exercise means less Brain Derived Neurotrophic Factor (BDNF) being produced, this consequently means a decrease in the stimulation of neurogenesis.

The brain is made up of millions of neurons. Neurons are nerve cells specialised to transmit information around the body via electrical signals and they interface at a junction called the synapse. Electrical Information enters neurons through the many dendrites which input signals. These electrical signals are carried by an axon on a neuron and trigger the release of chemicals such as Glutamate and Gamma Aminobutyric Acid (GABA).

The link between exercise and improved learning has been extensively researched and has been proven by a number of studies. Most of these studies use animal models to provide evidence for this relationship. For example an experiment done on lab rats by Cotman (2002) demonstrated how exercise, especially aerobic exercise, stimulates the production of BDNF. BDNF mediates the creation of neurons and receptors in the brain. An increase in receptor sites increases the chances of two neurons binding together, hence leading to an increase in memory and learning ability. This has been shown to be vital in the pursuit to improve learning in the young.

Dewar (2008) claimed that exercise for children stimulates brain growth and therefore improves cognitive performance. Van Pragg (1999) carried out an experiment using mice, where sedentary mice were compared to mice that were running in their wheel for three miles a day. The results of this experiment showed that the mice that were performing regular exercise showed dramatic brain growth, especially in the hippocampus. This is the part of the brain associated with learning and memory.

These studies suggest that exercise can stimulate the production of neurones in the brain, improving cognitive health (Cotman 2002). Cotman suggests that increasing the amount of exercise you do increases the production of BDNF, consequently resulting in an improvement in cognitive function. This theory is supported by a number of research studies and there are many organisations worldwide that work to promote exercise as a way of enhancing brain health.

One of these studies was an experiment done by two children Jada and Maurna (2007) to test the immediate effects of exercise on their short term memory. They designed a very simple experiment that involved eight of their friends doing a simple memory test in which they were shown 25 household items and were asked to recall as many of these items as they could. The eight children were then split randomly into two equal groups, one group was made to “chill out” and play board games whilst, the remaining four were made to complete an obstacle course. After ten minutes of this, the children were made to repeat the memory test. The scores of both groups were compared and after graphing the data, they found that there was a slight improvement in the scores of the exercise group.

Davis et al. (2007) conducted a randomized, controlled experiment on overweight children and found that doing forty minutes of aerobic exercise per day enhanced the children’s’ ability to pay attention and resist distraction, helping them to concentrate on schoolwork.
This shows that even small amounts of exercise can immediately improve short term memory, but what about in the long term? Could regular exercise have a big impact on the improvement of children’s long term performance in school? There is very minimal evidence available for the long term effect of exercise on improved learning in children. We therefore performed a Gedanken experiment to investigate the effects of exercise in the long term for the cognitive health and academic performance of children.

**DISCUSSION**

Children spend a large percentage of their time in school so by including exercise regularly in the weekly timetable, it will make exercise more accessible and also allow a higher percentage of children to participate in at least an hour or two of aerobic exercise per week.

One way to increase exercise associated learning is by introducing short bursts of exercise prior to each lesson into the national curriculum for primary schools. For example, including just five minutes of simple aerobic exercise that doesn’t involve excessive running about, and so, can therefore be easily accomplished in a current classroom set up, without the necessity of modifications and therefore unnecessary extra costs. Moreover the simplicity of the exercises will make it accessible to students of all abilities. Furthermore, carrying out these exercises in group situations will encourage and motivate all students to join in, as it will make it fun and engaging for all pupils. The study carried out by Jada and Maurna (2007), suggests that this type of method could prove to be effective, particularly with the short term learning capacity of students. However, with our study we aim to investigate the effect of exercise on learning in the long term.

To carry out our study we would randomly select students from a primary school. We would allocate an equal number of students from each year group, into each category (i.e. pupils from reception to year six) we would also aim to select children with varied abilities to participate, in order to gain a sample that is representative of the whole population of the students from the chosen school; random selection is likely to give this type of data, because every student has an equal chance of being allocated to either group. Half of the selected students from each year group would partake in aerobic exercise for five minutes prior to each lesson. The remaining participants would then be asked to continue with their normal routines. Results of grades and academic achievements would be monitored and compared before and after the experiment as well as during the longitudinal study, taking place over a long period of time such as the academic school year, in which the experiment is to take place. We expect to find a positive correlation between exercise and learning with participants that take part in the aerobic exercises and no significant change in the learning ability of participants that do not partake in the aerobic exercise. If this positive correlation is found in the original study, it could then also be repeated in further studies using different students from a variety of schools, in order to gain a sample size that is representative of the whole population. If trends of similar positive correlations are found, then this would increase the reliability of our findings to the extent where this method could be put into practice.

This method for increasing learning ability could be implemented by getting all primary school children to participate in 5 minutes of aerobic exercise within the classroom prior to each lesson. The exercises carried out would be varied and would include simple activities such as star jumps or jogging on the spot. These are all activities that can be carried out in a small space using no specialised equipment and that would not exert too much energy, and as a result would not wear down children. The results we expect to get from this based on the research behind our study are that children will be in a better mood, more focused and will
consequently learn more efficiently. Additionally, the structure of our development suggests that there will be further benefits in other aspects of health, for instance a reduction in childhood obesity. As it is widely accepted that short bouts of regular exercise, leads to a decrease in the risk of obesity. Other aspects of the benefits of exercise such as the release of endorphins have been shown in studies to improve mood.

Short bouts of physical exercise can also have psychological benefits to children aged nine to ten (Williamson et al. 2001). Certain types of physical exercise can lead to enhanced mood (Steinberg, Sykes, & LeBoutillier, 1996). The results of the study carried out by Steinberg et al. showed that after exercise there is a significant increase in self-proclaimed positive mood, whereas after watching videos a significant decrease in mood was observed. It is common for children to watch television or play video games in the morning before school. Although this is personal choice, by introducing the new exercise scheme into the curriculum we can help to counter this drop in positive mood. Whether this is linked to the increase of neurogenesis is not known, however they are both proven to have a positive effect on learning of the young; as a more positive mood can lead to children being more focused and engaged with the subject. So the introduction of exercise into the national curriculum will improve both mood and increase neurogenesis which will consequently have a definite positive effect on learning.

As research has previously shown, neurogenesis is the key for increased learning capacity. For example the study done by Wei Deng, James B. Aimone & Fred H. Gage (2010) suggests an important role for adult hippocampi neurogenesis in learning and memory. One possible development to increase neurogenesis is by providing BDNF that has been artificially synthesized. This can help to increase BDNF and consequently result in more neurogenesis. This has been shown by extensive research into depression being reduced by BDNF. These developments provide a base for the development of the link between increase BDNF and learning. However, should we be promoting the regular use of drugs in a child’s everyday life? Is it responsible to encourage children to rely on drugs to improve their learning, would this ultimately reduce their motivation?

Our Gedanken experiment is based on our extensive research of the findings of previous studies; however one major limitation of research into the effects of exercise on learning of the young is that it is mostly based on rodents. This greatly reduces its reliability, because animal studies can not be generalized to humans. This is because, although they may respond in the same way to some things, they don't necessarily to everything (e.g. Thalidomide had no detrimental effect on animals, but caused birth defects in humans); ultimately each race has its own specific characteristics. However, ethical limitations prevent experiments such as the van Pragg experiment being carried out on children. It is deemed unethical to carry out some experiments on human beings, because we cannot risk depriving or causing harm both physically and psychologically to others. If the van Pragg experiment was to be carried out on children, it could cause significant disruption during a pivotal stage of development and learning. One further issue is that children are not able to give fully informed consent.

CONCLUSION
Our developmental study provides one method for improving learning of the young. It is based on the idea that exercise increases BDNF production and BDNF consequently increases learning capacity by increasing neurogenesis. Although this is a widely researched aspect of science, is not easily defined. This is due to the complexity of the brain, and our lack of understanding for it. Our study would be very time consuming, and does raise some ethical
issues such as disrupting childrens’ learning. However the expected results would show a significant improvement for future development of the education system.

In this study, we have not only considered the effect of BDNF on learning, but also the effect, that exercise has on improving mood and therefore attitude and attention. This is thought to be down to endorphins, however once again their effect is not explicitly defined. Nevertheless, our research suggests that exercise can definitely have a substantial positive effect on learning. Introducing an increased amount of exercise into the curriculum could be a very effective way of introducing more exercise into the increasingly sedentary lives of children. However, making such a dramatic change to the education system would be very difficult to implement. It would be a lengthy process to introduce the new system due to constricting and complex regulations. Even finding a school willing to participate in our original study would be challenging. However, this would surely be one of the most easily implemented and cost effective methods of introducing regular exercise to children in order to improve both physical health and academic achievement.

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