

# Cognitive Enhancement: Physical Exercise and Drug

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## Abstract

As more work with high intellectual requirement appears, cognitive enhancement has become a topic at the center of the general public's attention. The most typical cognitive enhancement methods include cognitive manipulation, physical exercise, neurotechnology, cognitive training, and cognitive-enhancing drugs; each has its advantages and limitations. This article analyzes the method that has the greatest potential to be fully applied to society and the method that is more controversial and needs to be regulated strictly to ensure social stability if it is popularized.

## Keywords

Cognitive enhancement; Physical exercise; Drug.

## 1. Introduction

Cognitive enhancement, defined as the amplification or extension of core capacities of the mind through improvement or augmentation of internal or external information processing systems [1], has been a heated topic over the past years. In the early years, research into cognitive enhancement mainly focused on verifying the effect of cognitive enhancement methods. Then researchers started to be interested in the transfer effect of those methods, which means the impact of the cognitive enhancement in one area on another area. More recent researches include investigations into the target population and the mechanisms of cognitive enhancement methods, in other words, for whom and how the cognitive enhancement methods work. Many researchers have given comments on varied cognitive-enhancing methods. In this essay, it is considered and explained that physical exercise is one of the safest and the most pragmatic cognitive-enhancing methods, and cognitive-enhancing drugs the method which requires the most vigilance to be popularized.

## 2. Physical Exercise

As a way of cognitive enhancement, physical exercise has been put into many experiments and daily life. It is also be considered the most beneficial and effective method, specifically for three reasons.

The first reason is that physical exercise is a very effective way to improve people's cognitive ability. First of all, various studies have shown that aerobic exercise can significantly improve the cognitive abilities of people of all ages. In the past, Erickson et al. conducted a study in which they imaged the hippocampus of the elderly and explored the difference in hippocampus volume and the relationship between its related cognitive abilities and aerobic exercise. They sampled 165 cognitively healthy elderly people between the ages of 59 and 81 and assessed their cardiorespiratory function through exercise tests. They ask the elderly to perform spatial memory tasks. At the same time, they use functional magnetic resonance imaging (fMRI) to measure the volume of the elderly's hippocampus. The results of the study show that the cardiopulmonary function is positively correlated with the volume of the bilateral hippocampus, and the volume of the bilateral hippocampus is positively correlated with the

spatial memory ability. [2] This study shows that aerobic physical exercise could enhance the cognitive abilities such as memory performance of older people. In addition, although there are not many experiments about children cognitive enhancement, luckily, we still found some experiments could prove that and cognitive abilities of younger people are still proportional to their physical activities. For example, Sibley and Etnier conducted a meta-analysis and found that the physical activity of children aged 4 to 18 is positively correlated with their cognitive function. The results of the survey show that physical activity is positively correlated with the performance of the eight measured quantities (i.e., perceptual skills, intelligent quotient, memory, developmental level/academic readiness, and other). It can be concluded that physical exercise is beneficial to all cognitive functions, not just memory. [2] Moreover, through these researches, we can find that the positive correlation between physical activity and cognitive ability does not only affect the population of a specific age, but the entire population from children to the elderly. In addition, physical activity has a very obvious effect on improving cognitive ability, and its influence on various aspects of the brain, such as the hippocampus, is also supported by biology. So in general, this method is an effective method that is applicable to a wide range of people and has a significant improvement effect.

Besides the effectiveness, physical exercise also has many other benefits. Firstly, exercise can burn fat and help people lose weight. Secondly, exercise stimulates the body's bone cells, thereby preventing osteoporosis and bone thinning. Moreover, exercise can improve cardiopulmonary function, so that you can stay away from chronic diseases such as cardiovascular disease, endocrine system disease, and respiratory system disease. At the same time, exercise could also help to improve sleep. Regular participation in physical exercise can make people fall asleep faster and sleep better, but playing sports before going to bed can make people too excited to fall asleep. And the last point, which is also a unique benefit that other cognitive enhancement methods, such as cognitive manipulation and eating drugs, do not have, physical makes people happy. Not only because it can stimulate the brain to release chemicals that make people feel happy and relaxed, but also spending time with family and friends during exercise is a happy thing in itself.

Additionally, physical exercise is very easy to do. Sports do not require people to be rich or knowledgeable, or have good relationships with someone, or even young and strong. As long as a person finds a way, he can do aerobic exercises like running. And only spending a small amount of time a day on exercise is enough to achieve the effect to enhance cognitive ability, it does not require much time and energy.

However, physical exercise also has its shortcomings. The improvement of cognitive ability or any other improvement through exercise requires long-term exercise, and insisting on daily exercise is not so easy. It requires extreme self-discipline, not just the occasional reminder of exercise. So from this perspective, it is not so easy to achieve cognitive improvement through exercise.

Overall, although physical exercise requires lots of time of work, it still a great method to enhance cognitive ability.

### 3. Cognitive-enhancing Drugs

Cognitive enhancing drugs have gained wide popularity nowadays. Cognitive-enhancing drugs improve executive functions, including working memory, cognitive flexibility, and inhibitory control. Some of the cognitive-enhancing drugs are used for medical purposes, such as stimulants Ritalin and Adderall, to treat ADHD (attention deficit hyperactivity disorder). Despite the medical usage of cognitive enhancers, these drugs are also used among college students to improve grades and learning capacity. The popularity of cognitive enhancers is continuously increasing. A study [3] of usage of cognitive enhancers among French college

students indicates that 67.4% of the 206 college students investigated have used cognitive enhancers in 2013, and 12 of them used illegal cognitive enhancers. The usage of cognitive enhancers is worth affirming. However, general public's comprehension of cognitive enhancers is still vague, and the regulation for cognitive-enhancing drugs is still weak that there exist many hidden problems behind the usage of cognitive enhancers by the general public, just as in the case of college students above.

One major problem generated by the general public's incomplete understanding of cognitive-enhancing drugs is that cognitive enhancers vary in target users. For example, for people with a low span of working memory, such as those with ADHD, the effect of methylphenidate is noticeable [4]. However, for those healthy individuals, the effectiveness of methylphenidate is much smaller [4]. In a 2020 study on the effect of methylphenidate, modafinil, and caffeine on healthy adults [5], 48 healthy males were received one of the three stimulants or placebo and were tested for a number of cognitive abilities, including working memory, speed of information processing and sustained attention. The study was randomized and double-blind. The result of this study indicates that the three stimulants tested either have a few positive effects on a specific domain or have no effect [5].

For ordinary people who would like to purchase cognitive enhancers to improve certain abilities, the result may not be the same as expected and even be exceeded by the side effects of cognitive enhancers. Popular cognitive-enhancing drugs, including Piracetam, Adderall, and Ritalin, have similar side effects, including headaches, anxiety, tremors, and nausea. Moreover, if the drugs are purchased without guidance from the professions, the result might be the mixed-use of drugs, which causes even more severe symptoms, including anorexia.

Another problem that is needed to be considered is drug abuse. Many of the cognitive enhancers are addictive—for example, modafinil. A study by Volkow Nora [6], director of the National Institute on Drug Abuse in Bethesda, Maryland, and her team shows that the working mechanism of modafinil, which has been approved for the treatment of fatigue, is related to the rewarding system of the human brain, which means that there is a high possibility of addiction when using the drug [6]. However, this is only a part of the story since a more severe consequence of using cognitive enhancers is an actual psychological dependence on these drugs. Once people benefit from the improved performance caused by cognitive enhancers, they would struggle to maintain their grades, therefore using more drugs. The result would be an endless cycle since once these people deem from their heart that their performances result from drugs instead of their actual capacity, they would probably lose their self-affirmation and the capacity to behave well without the drugs.

Other problems of cognitive-enhancing drugs include social-economic inequality. Since access to cognitive enhancers is not equally distributed in society, people with higher social status are more likely to benefit from these drugs, which results in an increased social gap. The resulting social gap also leads us to reflect on meritocracy, which means people's achievements are entirely determined by their talent and effort instead of wealth or social status. Also, there might be coercion, especially when parents force their children to take cognitive-enhancing drugs just for competition. In this case, the children lose their autonomy, which is against the four basic principles in biomedical ethics. Some people argue that the trade of cognitive enhancers can be limited to medical use. However, many college students purchase drugs from the underground market, which is potentially harmful to their health and the economy.

In all, it is undeniable that cognitive-enhancing drugs are essential for the treatment of diseases regarding cognitive ability, and researchers' effort to improve the condition for patients should be appreciated. However, once cognitive-enhancing drugs are used for competitive purposes, it might kick the start of a trend in which people consistently pursue better and better results based on more and more intake of cognitive-enhancing drugs, during which neither their mental nor physical health is protected. Therefore, we should probably think twice and

construct a more complete supervisory system before popularizing cognitive-enhancing drugs to the whole society.

#### 4. Conclusion

In conclusion, physical exercise is considered the most beneficial and effective method to enhance cognitive abilities currently because of its effectiveness based on experiments, its side benefits, and its easy-to-do. As for cognitive-enhancing drugs might seem easier to improve cognitive abilities by taking some pills, but their side effects, addictiveness, and ethical issues shall not be ignored. Therefore, a mature regulatory system consisting of moral laws and regulatory authorities is needed as a prerequisite for popularizing cognitive-enhancing drugs. This work mainly analyzes the two methods that are currently considered the best and the worst. However, in the future, there will be a faster and more effective way than physical exercise, and cognitive-enhancing drugs will also reduce their problems in continuous research and reforms. Cognitive enhancement is still doubted by many people from different fields, especially the ethical issues it has been extensively concerned with. However, scientists never stop further researching on it, so it is still unknown that whether cognitive enhancement could be used in common life.

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