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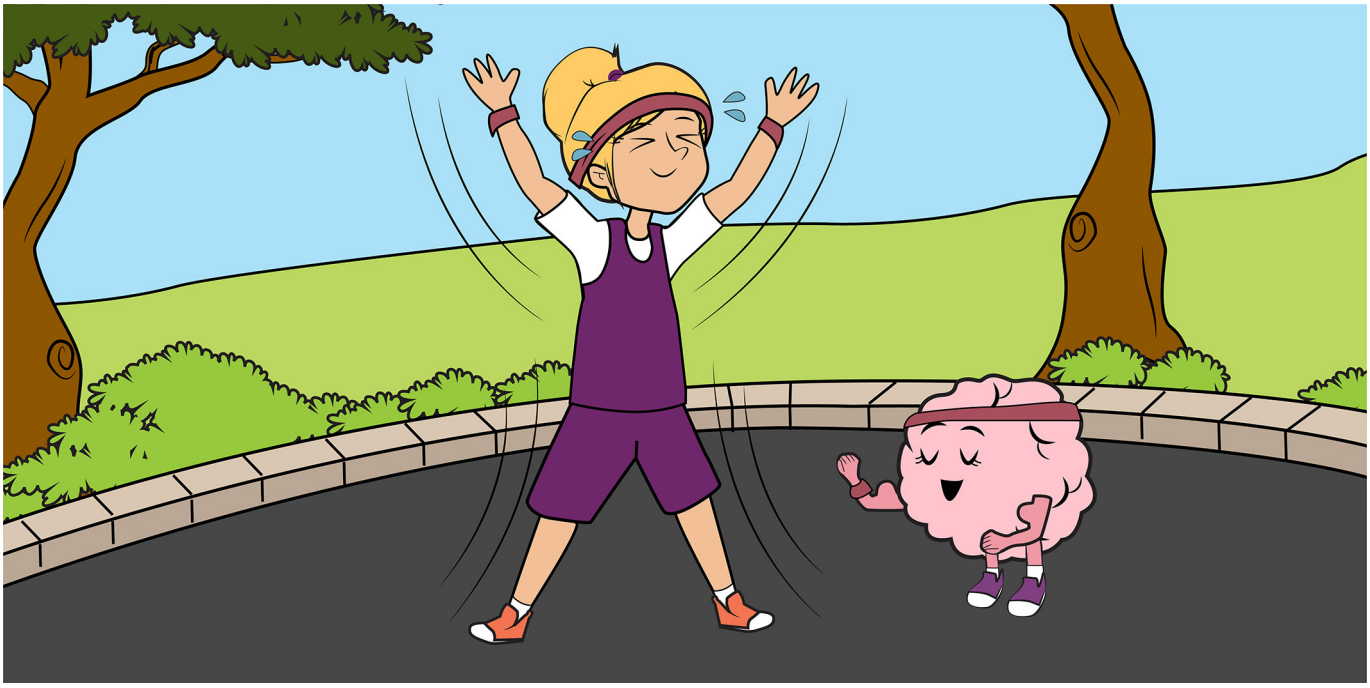

THE BRAIN AND EXERCISE: IN SICKNESS AND IN HEALTH

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The brain, like any other organ in the body, is made up of various types of cells. Nerve cells called neurons are the major cells in the brain. Their main function is to transfer messages and orders to and from the organs of the body. Neurons communicate with each other and with other cells through connections that resemble electrical wires. Throughout a person's life, neurons remodel and rewire their connections to become weaker or stronger. This remodeling is known as brain neuroplasticity, which means "the ability to adapt or change." Neuroplasticity is affected by several factors. For example, physical activity such as exercise can reshape the brain for the better, by enhancing memory and attention. These changes can improve academic performance and protect people from certain brain diseases. These are just a few reasons why we should all exercise more often.

THE BRAIN: THE BODY'S COMMAND CENTER

If you think about it, it is fascinating how a gooey blob, known as the brain, happens to be the most complex organ in the body. The brain controls the activity of almost every other organ. However, the brain was not always considered the center of thought and intelligence. For example, Ancient Egyptians preferred to preserve the hearts of mummies, rather than the brains. They believed that the heart was the organ of intelligence and the motor of the body. Today, scientists know better, and they work around the clock to explore the many wonders of the brain. Despite their continuous efforts, there is still so much that we do not know about the brain! What *do* we know about the brain? We know that the brain is soft and fragile, and therefore is protected by three membranes and a strong, bony skull. The brain is divided into three main parts: the cerebrum, the cerebellum, and the brainstem (Figure 1).

The **cerebrum** is the largest and most noticeable part of the brain. It is divided into two halves, called left and right hemispheres. Each hemisphere consists of five lobes. Each lobe contains distinct areas responsible for specific functions. For example, one lobe contains the brain areas responsible for intentional movement, while another contains the areas responsible for the sense of touch. It is important to understand that these various lobes communicate with one another to organize and coordinate our behaviors. The **cerebellum** is sometimes called the "little brain." In humans, it is smaller than the cerebrum and is found at the base of the brain. The cerebellum handles many brain functions, such as the planning of movements and adjustment of posture. You can easily distinguish the cerebellum by its folds, which look like elongated bands. Finally, the **brainstem** connects the brain with the rest of the **nervous system**. The brainstem plays a major role in controlling the heart and respiration.

When looking at these larger structures, the brains of different people seem to be alike, but we can notice many differences once we "zoom in" on people's brains. This is because the cells of the brain, called **neurons**, are constantly reshaping their connections with each other. Neurons have elongated extensions called axons and dendrites that allow them to communicate (Figure 1). Neurons are connected differently in different brains. Think of it this way: if two or more neurons have no reason to talk to each other, they will not be motivated to stay in touch. On the other hand, some neurons can become close friends and establish strong connections with each other when motivated by certain signals, for example, when you are learning a new sport. The constant change in the relationships between neurons is important because it allows the brain to learn, adapt, and store memories. The change in the connections between neurons over time is a process that scientists call **neuroplasticity** [1].

CEREBRUM

The largest part of the brain; it consists of the right and left hemispheres.

CEREBELLUM

Also known as the little brain, it is usually smaller than the cerebrum. It is attached at the bottom of the brain.

BRAINSTEM

The part of the brain that resembles a stalk or a trunk. It connects the cerebrum with the spinal cord.

NERVOUS SYSTEM

The system that organizes the body's actions and senses by sending signals from the body to the brain and vice versa.

NEURONS

Nerve cells, which are the main cells of the nervous system. Neurons have long extensions called dendrites and axons that help them to communicate with each other.

NEUROPLASTICITY

A process that allows the brain to be reshaped and remodeled over time. It involves changes in the connections between various neurons.

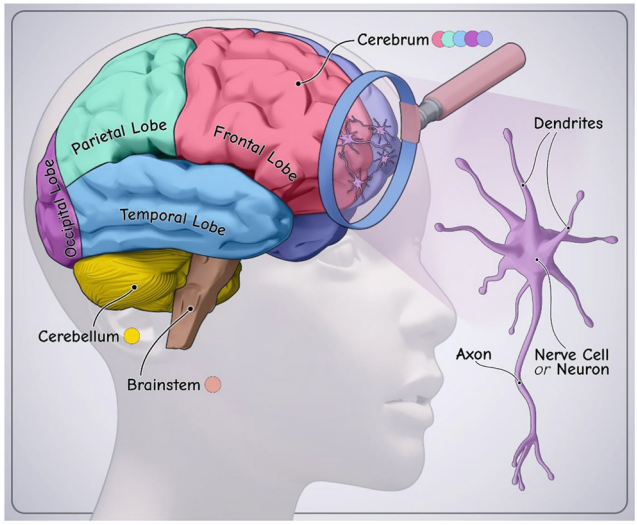

Figure 1

The brain has 3 main parts. The cerebrum, the cerebellum, and brain stem. The cerebellum is divided into two hemispheres. Each hemisphere consists of five lobes. Four of the five lobes are shown in the figure, while the fifth lobe lies deep beneath the surface and is not shown in this figure. The cerebellum is attached to the base of the cerebrum, and the brainstem which resembles a stalk connects the cerebrum to the spinal cord. The brain is made up of cells called nerve cells or neurons, which have extensions called axons and dendrites that help them to communicate with each other and with the body's organs.

"NEURO" + "PLASTIC" = NEUROPLASTICITY

When we say that neurons are plastic, we do not mean the plastic that is polluting our planet! Plastic can also be used as an adjective, to mean something that can be easily shaped and molded. Neuroplasticity indicates that the brain cells are always being reshaped and remodeled. Some neurons tend to strengthen their connections, while others weaken certain connections with other cells. When we learn new information or practice new hobbies, the neurons that are involved release chemicals that strengthen and elongate their connections. Thus, these chemicals promote neuroplasticity and help brain cells to connect, so that we learn more effectively (Figure 2).

The signals that neurons receive from outside the brain dictate which other neurons they should communicate with. To illustrate, let us look at an example. Suppose that you are learning tennis for the first time. Each time you practice, a team of neurons, assembled from the different lobes of the brain, is responsible for your activity. These neurons try to communicate with each other in the most efficient way, so that you get better at tennis. Communication between this team of neurons is made more efficient by either extending new connections toward each other or boosting the existing connections. If you decide to stop practicing tennis, the communication between the team members becomes weaker, and you start losing the skills you acquired [1].

The brain needs to be stimulated all the time! Stimulation encourages neurons to make new connections and join new teams. This reshaping of the brain allows a person to learn new things. Stimulation of the brain can occur through mental activities and through physical activities. A combination of both is even better for reshaping the brain!

Figure 2

Exercise benefits the brain in several important ways. A healthy brain with many strong connections between neurons can help you in school and in your future career.

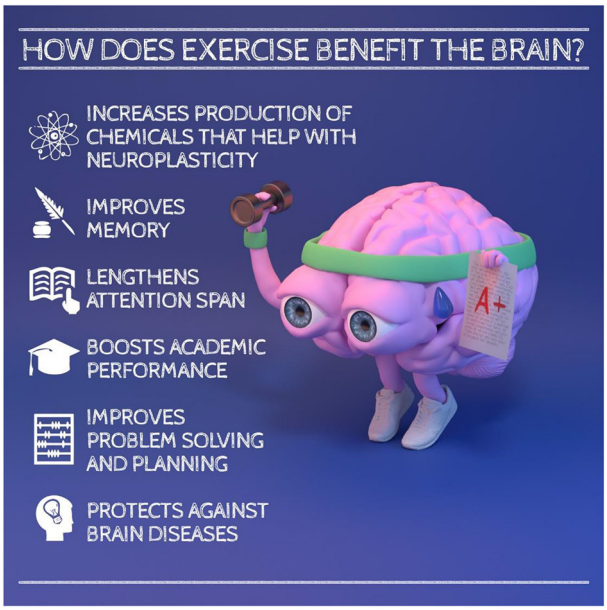

Figure 2

An idle, non-exercising brain becomes slow and lazy. So, you should try to stimulate your brain as often as possible (Figure 3)!

EXERCISE AND BE WISE: THE BRAIN AND SPORTS ARE CLOSE ALLIES!

Scientists have been studying the positive effects of exercise on the body and the brain for a long time. Sadly, most people between the ages of 11 and 17 do not perform the recommended amount of physical activity. So, if you have been skipping your physical exercise sessions, here is one more reason why you should not.

During adolescence, the brain goes through a significant maturation process. Lifestyle factors, such as physical activity, have a great influence on the brain's maturation process. As we mentioned earlier, neurons form strong connections when they are encouraged to do so...and physical activity is an excellent encouragement! When many neurons are encouraged to form new connections or modify their existing connections, entire areas of the brain may become altered. For example, the brain area responsible for memory is often larger and more developed in young adolescents who exercise regularly. Also, individuals who exercise regularly have a greater number of active neurons in the memory area when they perform tasks that involve memory, such as memorizing a list of random words. Young adolescents who are less fit may need to use much more brain energy to perform the same task.

Figure 3

(A) If the brain is left unstimulated, it becomes lazy and sluggish. **(B)** Regular aerobic exercise can give the brain a boost.

Figure 3

What is more, scientists have found a positive relationship between physical activity and academic performance. They discovered that students who exercised more had higher grades than those who did not. Scientists have also noticed that physical exercise boosts certain mental abilities such as attention, planning, and problem-solving. These important mental abilities can help you perform better at school *and* will help you in any future career. This is yet another reason why you should seize the opportunity to strengthen your brain by exercising whenever you get the chance [2]! A lifestyle with low levels of physical activity can in fact cause a decline in mental abilities and academic achievement, in both children and adolescents [3].

So, which physical exercises can boost brain activity? The answer is **aerobic exercise**. Aerobic exercise includes any activity that stimulates the heart and increases the amount of oxygen in the blood, such as running, swimming, jogging, cycling, dancing, hiking, skipping rope, kickboxing, or anything else you can think of that gets your heart pumping!

AEROBIC EXERCISE

A type of exercise in which the heart is stimulated and the body uses more oxygen than normal.

EXERCISE CAN BE NEURO-PROTECTIVE

In addition to the previously mentioned benefits, exercise can also protect us from diseases of the brain that cause neurons to die. These are known as **neurodegenerative diseases**. Alzheimer's disease is a well-known neurodegenerative disease that makes it hard for people to remember even the basic things, such as how to get dressed. Aerobic exercise may actually delay this decline in brain performance of people with Alzheimer's disease [4]. Exercise can also help the brain to recover after a stroke. A stroke can occur when the blood supply to the brain is interrupted. Exercise can help stroke-damaged brains to become well again. Studies have also shown that exercise is beneficial after traumatic brain injuries. Traumatic brain injury is the term for damage that occurs in the brain due to an external force, like a hard hit to the head. Studies have shown that exercise improves learning following brain injuries. However, engaging in physical activity following a brain injury should be done gradually, according to a

NEURODEGENERATIVE DISEASES

A disease that affects the nervous system and usually causes the death of nerve cells. Examples include Alzheimer's disease and Parkinson's disease.

doctor's guidelines, to avoid further injury. The more severe the brain injury, the more time a person will need before hitting the playground again [5].

THE BOTTOM LINE

Now you know that exercise can benefit not only your body but also your brain. Phsyical activity promotes a healthy brain by enhancing the process of neuroplasticity. In fact, phsyical activity can strengthen the existing connections between neurons and at the same time helps to add new connections between them. As such, exercise can improve memory and academic performance; with the added bonus of slowing down neurodegenerative diseases and helping the brain to heal better after injury. So, the next time you do not feel like going to a gym class or decide to skip exercising, try to remember that good things come to those who sweat!

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YOUNG REVIEWERS

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We are a group of students in Paris who are eager to learn more from the exciting scientists and articles we are exposed to in this project!

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