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What Is Neuroplasticity?

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Neuroplasticity is the brain's ability to change and adapt due to experience. It is an umbrella term referring to the brain's ability to change, reorganize, or grow neural networks. This can involve functional changes due to brain damage or structural changes due to learning.

Plasticity refers to the brain's malleability or ability to change; it does not imply that the brain is plastic. *Neuro* refers to neurons, the nerve cells that are the building blocks of the brain and nervous system. Thus, neuroplasticity allows nerve cells to change or adjust.

Types of Neuroplasticity

The human brain is composed of approximately 100 billion neurons. Early researchers believed that neurogenesis, or the creation of new neurons, stopped shortly after birth.

Today, it's understood that the brain's neuroplasticity allows it to reorganize pathways, create new connections, and, in some cases, even create new neurons.

There are two main types of neuroplasticity:

- **Functional plasticity** is the brain's ability to move functions from a damaged area of the brain to other undamaged areas.
- **Structural plasticity** is the brain's ability to actually change its physical structure as a result of learning.

How Neuroplasticity Works

The first few years of a child's life are a time of rapid brain growth. At birth, every neuron in the cerebral cortex has an estimated 2,500 synapses, or small gaps between neurons where nerve impulses are relayed. By the age of three, this number has grown to a

where nerve impulses are relayed. By the age of three, this number has grown to a whopping 15,000 synapses per neuron.

The average adult, however, only has about half that number of synapses. Why? Because as we gain new experiences, some connections are strengthened while others are eliminated. This process is known as *synaptic pruning*.

Neurons that are used frequently develop stronger connections. Those that are rarely or never used eventually die. By developing new connections and pruning away weak ones, the brain can adapt to the changing environment.

Benefits of Neuroplasticity

There are many benefits of brain neuroplasticity. Allowing your brain to adapt and change helps promote:

- The ability to learn new things
- The ability to enhance existing cognitive capabilities
- Recovery from strokes and traumatic brain injuries
- Strengthening areas where function is lost or has declined
- Improvements that can boost brain fitness

Characteristics of Neuroplasticity

There are a few defining characteristics of neuroplasticity.

Age and Environment Play a Role

While plasticity occurs throughout the lifetime, certain types of changes are more predominant at specific ages. The brain tends to change a great deal during the early years of life, for example, as the immature brain grows and organizes itself.

Generally, young brains tend to be more sensitive and responsive to experiences than much older brains. But this does not mean that adult brains are not capable of adaptation.

Genetics can have an influence as well. The interaction between the environment and genetics also plays a role in shaping the brain's plasticity.

Neuroplasticity Is an Ongoing Process

Plasticity is ongoing throughout life and involves brain cells other than neurons, including glial and vascular cells. It can occur as a result of learning, experience, and memory formation, or as a result of damage to the brain.

> While people used to believe that the brain became fixed after a certain age, newer research has revealed that the brain never stops changing in response to learning.

In instances of damage to the brain, such as during a stroke, the areas of the brain associated with certain functions may be injured. Eventually, healthy parts of the brain may take over those functions and the abilities can be restored.

Brain Plasticity Has Limitations

It is important to note, however, that the brain is not infinitely malleable. Certain areas of the brain are largely responsible for certain actions. For example, there are areas of the brain that play critical roles in movement, language, speech, and cognition.

Damage to key areas of the brain can result in deficits in those areas because, while some recovery may be possible, other areas of the brain simply cannot fully take over those functions that were affected by the damage.

How to Improve Neuroplasticity

There are steps you can take to help encourage your brain to adapt and change, at any age.

Enrich Your Environment

Learning environments that offer plenty of opportunities for focused attention, novelty, and challenge have been shown to stimulate positive changes in the brain. This is particularly important during childhood and adolescence, but enriching your environment can continue to provide brain rewards well into adulthood.

Stimulating your brain might mean:

- Learning a new language
- Learning how to play an instrument

- Learning how to play an instrument
- Traveling and exploring new places
- Creating art and other creative pursuits
- Reading

Get Plenty of Rest

Research has shown that sleep plays an important role in dendritic growth in the brain. Dendrites are the growths at the end of neurons that help transmit information from one neuron to the next. By strengthening these connections, you may be able to encourage greater brain plasticity.

Sleep has been shown to have important effects on both physical and mental health. Some researchers suggest that this is partly due to genetics and partly due to the makeup of the grey matter in the brain.

You can improve your sleep by practicing good sleep hygiene. This includes developing a consistent sleep schedule and creating an environment that contributes to good sleep.

Exercise Regularly

Regular physical activity has a number of brain benefits. Some research indicates that exercise might help prevent neuron loss in key areas of the hippocampus, a part of the brain involved in memory and other functions. Other studies suggest that exercise plays a role in new neuron formation in this same region.

A 2021 study adds that physical exercise also appears to boost brain plasticity through its impact on brain-derived neurotrophic factor (BDNF, a protein that impacts nerve growth), functional connectivity, and the basal ganglia—the part of the brain responsible for motor control and learning.

The U.S. Department of Health and Human Services recommends getting at least 150 minutes of moderate-intensity cardio exercises (such as walking, dancing, swimming, or cycling) per week and a minimum of two days of strength training exercises (lifting weights or doing bodyweight exercises).

Practice Mindfulness

Mindfulness entails completely immersing your mind in the present moment, without ruminating over the past or contemplating the future. Awareness of the sights, sounds, and sensations around you is key. Many studies have shown that cultivating and practicing mindfulness can foster the brain's neuroplasticity.

Play

Games aren't just for kids: Studies show that playing board, card, video, and other games can improve your brain's neuroplasticity.

Problems With Brain Plasticity

Brain changes are often seen as improvements, but this is not always the case. In some instances, the brain's structure and function can be negatively influenced or changed.

For example, brain plasticity can be problematic when it allows detrimental changes caused by substance use, disease, or trauma (including brain injury or traumatic experiences that result in post-traumatic stress disorder or PTSD). Even lead poisoning can negatively impact brain plasticity.

There are also some medical conditions that can limit or hinder brain plasticity. Among them are a variety of pediatric neurological disorders such as epilepsy, cerebral palsy, tuberous sclerosis, and Fragile X syndrome.

How Neuroplasticity Was Discovered

Beliefs and theories about how the brain works have evolved substantially through the years. Early researchers believed that the brain was "fixed," while modern advances have shown that the brain is more flexible.

Early Theories

Up until the 1960s, researchers believed that changes in the brain could only take place during infancy and childhood. By early adulthood, it was believed that the brain's physical structure was mostly permanent.

In his 2007 book, "The Brain that Changes Itself: Stories of Personal Triumph From the Frontiers of Brain Science," which took a historical look at early theories, psychiatrist and psychoanalyst Norman Doidge suggested that this belief that the brain was incapable of change primarily stemmed from three major sources:

- An ancient belief that the brain was much like an extraordinary machine, capable of astonishing things yet incapable of growth and change
- The inability to actually observe the microscopic activities of the brain

- The observation that people who had suffered serious brain damage were often unable to recover

Early on, psychologist William James suggested that the brain was perhaps not as unchanging as previously believed. Way back in 1890, in his book "The Principles of

Psychology," he wrote, "Organic matter, especially nervous tissue, seems endowed with a very extraordinary degree of plasticity." However, this idea went largely ignored for many years.

Modern Theories

In the 1920s, researcher Karl Lashley found evidence of changes in neural pathways of rhesus monkeys. By the 1960s, researchers began to explore cases in which older adults who had suffered massive strokes were able to regain functioning, demonstrating that the brain was more malleable than previously believed. Modern researchers have also found evidence that the brain is able to rewire itself following damage.

> Modern research has demonstrated that the brain continues to create new neural pathways and alter existing ones in order to adapt to new experiences, learn new information, and create new memories.

Thanks to advances in technology, researchers are able to get a never-before-possible look at the brain's inner workings. As the study of modern neuroscience flourishes, research has demonstrated that people are not limited to the mental abilities they are born with and that damaged brains are often quite capable of remarkable change.

A Word From Verywell

The brain has an amazing ability to change throughout the course of our life, allowing us to learn new things or recover after sustaining a brain-based injury. Still, there are limits to how much the brain can adapt.

Constantly challenging ourselves, making sleep a priority, and getting regular exercise can also help improve brain plasticity. Avoiding certain substances is beneficial as well.

FREQUENTLY ASKED QUESTIONS

Why is neuroplasticity important?

Without neuroplasticity, it would be difficult to learn or otherwise improve brain function. Neuroplasticity also aids in recovery from brain-based injuries and illnesses.

What is an example of neuroplasticity?

Research has found that children with blindness have increased connectivity and reorganized neurocircuits when compared with children without this condition. This suggests that the brain adapts to the inability to see by changing its structure and function, providing children with blindness a greater ability to use the information received from the other senses (such as hearing and touch).

25 Sources

Verywell Mind uses only high-quality sources, including peer-reviewed studies, to support the facts within our articles. Read our editorial process to learn more about how we fact-check and keep our content accurate, reliable, and trustworthy.

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