CAN NEUROFEEDBACK HELP AUTISTIC CHILDREN AND THEIR FAMILIES?

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Neurofeedback is a type of brain-training technology that involves monitoring brain waves using electroencephalography (EEG) sensors. The equipment then provides auditory or visual cues to encourage the automatic functioning of the brain to make more favorable decisions. Since many emotions and behaviors are unconscious reactions, it is worth investigating this approach as a safe intervention that addresses the automatic functioning of the brain as it relates to the symptoms of autism.

Neurofeedback is an extension of the field of biofeedback and tracks only one variable, the brain's electrical activity or brain waves. It provides feedback to the individual's automatic, unconscious brain. The goal is improved brain performance in such areas as cognitive functioning and emotional regulation. In the last decade, an increasing number of families with autistic children are exploring it as a non-pharmaceutical support for brain health.

Neurofeedback is sophisticated brain-training technology that is safe to be used with children. Its use on children with attention-deficit/hyperactivity disorder (ADHD) has been studied for over 30 years. More recent studies show benefits for autistic children in the areas of focus, sensory regulation, impulse control, and emotional regulation.[1,2]

History of Neurofeedback

Neurofeedback machines have been in use since the 1960s. The more sophisticated devices used today have benefited from advancements in computer power and speed. Such advancements led to the development of a fully automated neurofeedback system in 2010.

The brain has approximately 100 billion neurons that fire about 100 times per second and that can send a signal in 0.5 milliseconds. The brain communicates through electricity and through chemicals called neurotransmitters. Whenever the brain makes a decision, that information manifests as electricity that is sent along the pathways of the brain known as neurons. Neurotransmitters are used to send signals between neurons.

Neurofeedback Measures Electrical Activity

The good and bad choices of humans appear in the brain's millisecond-by-millisecond electrical activity, commonly known as brain waves. For example, theta brain waves are dominant when we are sleeping. When we are excited or overstimulated, beta waves are dominant. There are five basic types of brain waves: delta, theta, alpha, beta and gamma. The waves are associated with a particular mental state. The table below summarizes the five types of waves.

Name	Frequency	Normal occurence	Significance
Delta	0.5-3.5 Hz	Deep sleep and infants	Sign of significant brain dysfunction, lethargy/ drowsiness or cognitive impairment
Theta	4-7.5 Hz	Young children, drowsiness, some aspects of learning	Slowing often related to attention/cognitive impairments, internal focus
Alpha	8-13 Hz	Eyes closed, relaxation, self-awareness	Excessive alpha during demand states can be a sign of difficulties with learning, emotional stability, relating to the environment or others
Beta	13-30 Hz	Fast activity associated with alertness and activity	Excessive beta is often associated with anxiety, irritability and poor integration
Gamma	Greater than 30 Hz	May be associated with problem-solving and memory consolidation	Unknown

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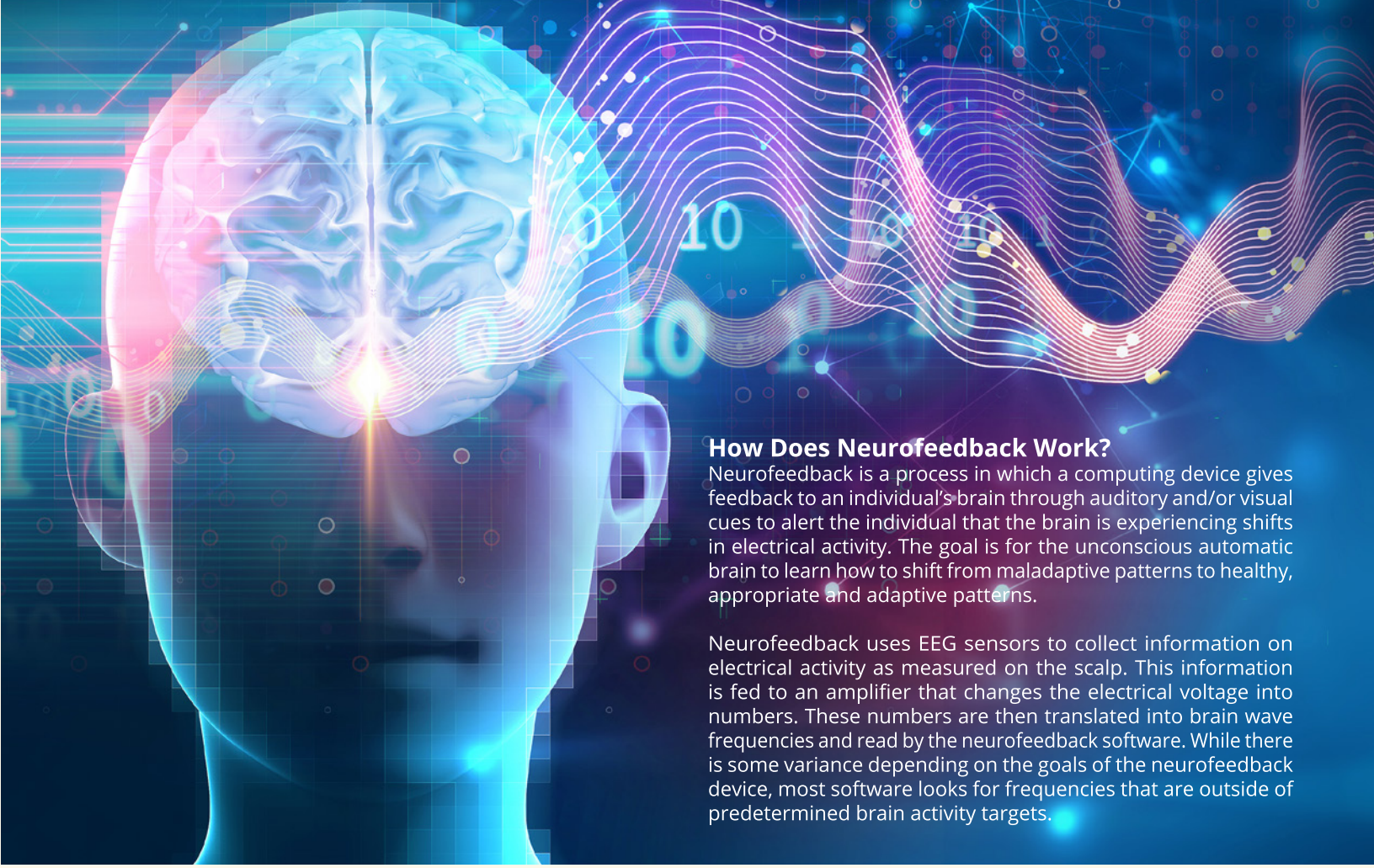
When neurofeedback was still in its infancy, neurologists and neuropsychologists started to understand that measuring brain activity was a meaningful way to track the brain's choices. They also found that giving feedback to the brain about those choices could help individuals optimize their brain function.



How Does Neurofeedback Work?

Neurofeedback is a process in which a computing device gives feedback to an individual's brain through auditory and/or visual cues to alert the individual that the brain is experiencing shifts in electrical activity. The goal is for the unconscious automatic brain to learn how to shift from maladaptive patterns to healthy, appropriate and adaptive patterns.

Neurofeedback uses EEG sensors to collect information on electrical activity as measured on the scalp. This information is fed to an amplifier that changes the electrical voltage into numbers. These numbers are then translated into brain wave frequencies and read by the neurofeedback software. While there is some variance depending on the goals of the neurofeedback device, most software looks for frequencies that are outside of predetermined brain activity targets.

Types of Neurofeedback

The two main types of neurofeedback are linear or protocol neurofeedback, and non-linear or dynamical neurofeedback.

Linear Neurofeedback

Linear neurofeedback works by first taking a brain map known as a quantitative electroencephalography (QEEG). It then measures the brain wave frequencies of the trainee's brain and looks for brain activity abnormalities. For example, it may show that the brain is not emitting enough beta activity. Using this information, a set of protocols is created by an expert trainer that helps the brain shift away from maladaptive patterns and rewards brain patterns that are within the range of "optimal" brain activity. The trainer uses data and self-reported information from the client to adjust the protocols over a series of sessions.

Under this approach, feedback is provided via cues in visual stimuli, like video games. For example, a spaceship will only move forward if the brain exhibits the beta wave frequency. The movement of the spaceship provides positive feedback that the brain is on the right track. As the brain is rewarded, it learns to increase the production of that frequency. By way of example, the brain map of a child who struggles with impulsivity would likely show overactivity in impulsive brainwaves. In response, the trainer would set the protocol so that the spaceship moves if the child's brain downregulates those brain waves.

Non-linear Neurofeedback

Non-linear neurofeedback allows the trainee's brain to decide what to do about the maladaptive brain wave patterns. The expertise shifts from an external trainer to the individual's own brain to reorganize and optimize itself. It is designed using dynamical non-linear mathematics that mirrors how the brain naturally uses feedback to improve itself. The key ingredient in the brain's ability to improve itself is access to real-time information about its own decisions as reflected through brain wave patterns.

Also called dynamical neurofeedback, non-linear neurofeedback teaches the automatic functioning brain to learn to function optimally by using precise, current data rather than habitual data. Consider the example of a child who immediately has a meltdown upon getting in the car after school. The automatic brain reacts with hyperarousal, screaming and kicking, which uses a lot of energy and is not in keeping with a safe environment. It is also not an ideal way to communicate a need to a caregiver. The brain is stuck in a high-energy pattern that is not effective.

Neurofeedback encourages the brain to alter its patterns because it is naturally programmed to use energy effectively and efficiently when problem-solving. Symptoms may arise when the brain fails to recognize maladaptive habits that are not useful in addressing current needs. In addition, a positive feedback loop occurs during non-linear sessions that reinforces learning. For instance, if the brain transitions from hyperarousal to relaxation in a session, it expends less energy and makes a decision that aligns better with current needs. In a secure environment, calm is an appropriate emotion. Consistently practicing this outcome during sessions can motivate the brain to collect present data and make effective decisions even when it is disconnected from the system.

During a non-linear neurofeedback session, the brain is being alerted to pay attention to its moment-to-moment choices. The software checks if the brain is shifting patterns by sampling 256 datapoints per second. When shifts happen, the software stops the music that is playing during the session. Most non-linear systems use auditory cues because hearing is the primary sense used by the brain to notice changes in the environment. Note, for example, that we can hear even when we are sleeping. When the brain is alerted by the interruptions, it notices its habitual patterns. Patterns that are noticed can be assessed, and corrections can be made. Once the trainee's brain learns to use the present moment as its source of information, qualitative shifts happen. Returning to the example of the child who has meltdowns after school, his or her automatic-functioning brain will register the present and be less motivated to expend energy in a meltdown after training with neurofeedback. The parent may notice that the meltdowns are less frequent and intense, and that they don't last as long.

The only non-linear system currently on the market is called NeurOptimal®. It is fully automated and can be used in both an office or a home setting, thus making it more convenient for autistic families.

Benefits

While both linear and non-linear neurofeedback are safe for children, some temporary side effects have been reported in linear neurofeedback. The most common are feelings of agitation or lethargy. Experience shows that a more skilled trainer will achieve better outcomes with fewer transitory side effects. There are no traditional side effects with non-linear neurofeedback equipment because it only provides feedback for the brain without forcing a state change in brain waves.

Both types of neurofeedback can lead to improvements for autistic children in areas such as behavior, attention span, mood regulation and sensory motor skills.[1,2]

With linear neurofeedback, the targeted changes are worked on separately. Any changes would be reflective of the area of functioning that is being addressed, such as impulsivity. A brain map would be taken every three months to reassess the areas in need of training.

With non-linear neurofeedback, however, all areas that are maladaptive could shift concurrently. Therefore, changes could be seen during the same timeframe of training in multiple areas, such as reduced anger, better focus, and increased tolerance for sensory experiences.

Ways to Enhance Outcomes

Neurofeedback outcomes can be influenced by other brain health factors, including proper nutrition, regular exercise and sufficient sleep. These factors enhance blood and oxygen flow to the brain, which, in turn, promotes healthy brain function. It is also worth noting that there are reports of improved outcomes for children when a caregiver participates in the neurofeedback sessions. This is likely due to the fact that stressed parents can return to a state of regulation more quickly and remain there for longer periods. In addition, the interconnectedness of nervous systems means that a calm parent can cue a child's system.

Conclusion

Neurofeedback — a non-invasive brain-health intervention — is being investigated by many in the autism community. Although more research is needed to establish its clinical relevance, there is promising evidence of its potential. Parents and caregivers who are interested in learning more about neurofeedback should look for an experienced trainer who is certified in using the technology.

References

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