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Brainwaves and Nuerofeedback: Understanding and Treating Brain Dysregulation in ADHD

Brainwaves and Neurofeedback

Understanding and Treating Brain Dysregulation in ADHD

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Neurons communicate with each other through electrochemical signals which can be measured as wave-like patterns. The brain typically uses cues from the environment to regulate these brainwave patterns. Yet overly dominant or other dysfunctional patterns may produce brainwave dysregulation and accompanying behavioral problems. Brainwave dysregulation is detected through indications of abnormal brainwave ratios as measured by EEG equipment. Neurofeedback is a form of biofeedback that allows individuals to change deregulated brainwave rhythms (biofeedback is a type of alternative medicine that trains patients to regulate internal processes using operant conditioning). Neurofeedback has proven to be an effective treatment for those with ADHD. ADHD is one of the most commonly diagnosed disorders among younger populations. Individuals with ADHD are often in a state of

under-arousal and must use hyperactive movement to keep up with events in their surroundings (which may be in part due to brainwave dysregulation). In comparison to other treatments, neurofeedback can be remarkably beneficial to individuals with brainwave dysregulation while causing few or no side-effects.

Neurofeedback, a relatively new area of study, is a form of biofeedback that allows individuals to change deregulated brainwave rhythms (Myers & Young, 2012). Biofeedback is a type of alternative medicine that trains patients to regulate internal processes using operant conditioning (Frank, Khorshid, Kiffer, Moravec & McKee, 2010). Feedback from physiological processes is delivered to the patient in the form of visual or auditory cues (or both). Patients can learn to visualize the relationship between mental control and physiological processes. Doing so may aid in their recovery from disorders caused by brainwave deregulation.

Typically, sophisticated computerized electroencephalography (EEG) workstations are used to compare theta-wave and beta-wave ratios (Hill & Castro, 2009). If abnormal ratios are indicated, or if particular brainwaves are improperly dominant, neurofeedback may be prescribed as treatment.

Neurofeedback can be remarkably beneficial to individuals with brainwave dysregulation while causing few or no side-effects (Hill & Castro, 2009). Other treatments, such as medication or various types of psychotherapy, can be costly or even risky. In contrast, neurofeedback may provide safer, cheaper, and more efficient treatment. In particular, I will examine the benefits of using neurofeedback in treating brainwave dysregulation in individuals with Attention deficit hyperactivity disorder (ADHD).

Brainwaves

Neurons communicate with each other through electrochemical signals (Heraz & Frasson, 2011). When many neurons fire, the accumulation of these signals can be measured as wave-like activity using an EEG device (Heraz & Frasson, 2011). The wave patterns emerge from the constant hyperpolarization and depolarization of the neuronal membranes (Kropotov, 2009). The more energetic the membranes - that is, the faster the underlying neurons are stimulated - the higher the frequency (and possibly the amplitude) of the wave. Frequencies are divided into five main types: delta (1-4 Hz), theta (4-8 Hz), alpha (8-12 Hz), beta (12-25 Hz), or gamma (25-100 Hz; see Heraz & Frasson, 2011). The state of the brain is associated with these different types of brainwave frequencies.

Delta and theta waves are associated with lower physical activity. Delta waves are usually recorded during sleep, are associated with improving the immune system, and are related to slow metabolic processes (Heraz & Frasson, 2011; Kropotov, 2009). Theta waves may be recorded while dreaming during sleep, during moments of deep relaxation, or during moments of increased creativity (Heraz & Frasson, 2011). Alpha waves are present during relaxed consciousness (usually when the eyes are closed) and have been associated with feelings of well-being (Kropotov, 2009; Saxby & Peniston, 1995). Furthermore, beta waves have the highest frequency wave. Beta waves are divided into two bands: low beta (13-20 Hz) and high beta (21-30 Hz; see Heraz & Frasson, 2011). Beta waves have been found to be associated with an alert mind and high concentration (Heraz & Frasson). Not only are brainwaves associated with states of mind and body, they are associated with emotion. For instance, gamma waves appear during meditation and have been linked to “feelings of satisfaction, gratitude, compassion, and love” (Rubik, 2011, p. 110).

Multiple types of waves may be present at one time within the brain. Yet brainwave patterns may become dominant. Should it persist (that is, should the brain be "parked" in one type of brainwave) behavioral dysfunction may occur (Hill & Castro, 2009). Therefore, excessively dominant brainwave patterns may cause dysfunction.

Dysregulation can also occur when brainwaves fail to adapt to the context (Hill & Castro, 2009). When the task at hand requires strict focus, high-frequency wave patterns typically appear. On the contrary, when the brain emits a low-frequency pattern, the individual may feel sleepy or have a hard time focusing. Problems may arise when the brain is emitting low-frequency patterns when in a context where high focus is required. This dysregulation can produce agitated behavior, over- or under-arousal, and has even been linked to problems such as bed wetting and nightmares (Hill & Castro, 2009). Hence, brainwave dysregulation can influence behavior and health.

Neurofeedback

As already noted, clinicians have developed neurofeedback in order to regulate brainwaves. Robbins (2008) invited readers to: "Imagine a simple procedure versatile enough to treat epilepsy, autism, and attention deficit disorder, addictions, and depression without drugs, surgery, or side effects. These are only some of the capabilities of neurofeedback" (as cited in Myers & Young, 2012, p. 20).

To determine whether or not neurofeedback treatment should be prescribed, clinicians first place EEG electrodes on the scalp in order to measure brainwave patterns (Hill & Castro, 2009). Next, the obtained EEG data are analyzed as ratios (for example, the ratio of theta to beta activity is compared). A normal theta to beta ratio in adults is 1-1.15 to 1.0 (children normally have higher ratios). Adults with brainwave dysregulation may have ratios as high as 2 to 1 or 4 to 1 (Hill & Castro, 2009). Thus, brainwave dysregulation is detected in abnormally high or low ratios of brainwaves.

ADHD and Neurofeedback

ADHD is the disorder most commonly diagnosed among younger populations (Gevensleben et al., 2009). Usually, ADHD includes "inappropriate levels of inattention, impulsiveness and hyperactivity" (p. 780). ADHD can interfere with academic development and social relationships (Gevensleben et al., 2009). People with ADHD are often in a state of under-arousal and must use hyperactive movement to keep up with events in their surroundings (Hill & Castro, 2009).

Medication is a common and effective treatment for ADHD, but it can cause side effects including loss of appetite, sleep problems, and stunted growth (Lansbergen, Dongen-Boomsma, Buitelaar, & Slaats-Willemse, 2011). Thus, neurofeedback can be safer (Myers & Young, 2012). Specifically in cases of ADHD, it may be used to train individuals to increase their brainwave frequencies to a level appropriate to the current situation (Hill & Castro, 2009).

Brainwave activity (recorded by EEG equipment) can generate visual and auditory feedback from a monitor. Initially, patients are asked to relax and to focus on the monitor in order to play a video game without using a controller. The game provides feedback according to the patient's brainwave pattern. Individuals are rewarded for closer and closer approximations to the desired pattern (Druic, Assmus, Gundersen, & Elgen, 2012).

Hill and Castro (2009) described a video game in which the patients guide a large dot that eats smaller dots. When the patient's EEG data show an approximation to the proper brainwave pattern (for example, one that is indicative of staying focused) points are awarded. To complete the task at hand (get a high score on the game) the patient learns to manipulate his or her brainwaves (Hill & Castro, 2009). Over multiple sessions (usually 20-40 sessions), patients gradually change their brainwaves and maintain the desired pattern (Hill & Castro, 2009).

To test whether or not proper brain areas are being correctly targeted, self-reports are filled out by patients (or their parents) which identify behavioral changes (Hill & Castro, 2009). Different areas of the brain can be targeted and trained by changing the position of the electrodes on a patient's head (Hill & Castro, 2009). Because of the specificity of the areas of the brain to be targeted, neurofeedback must be tailored for individual patients (Hill & Castro, 2009).

Neurofeedback has demonstrated a 60% to 80% success rate (Myers & Young, 2012). It is relatively inexpensive, reduces the need for medication, and may enhance self-confidence (Hill & Castro, 2009). Hill and Castro (2009) shared the following example: Otis, an 11-year-old with ADHD, was producing eight times as many sleep waves (theta) as faster waves (beta). He had major behavioral problems, including difficulties in school and with relationships. After session 22 of neurofeedback, his brainwave ratio decreased from 4.6 to 1.0, and his behavior had greatly improved. After 40 training sessions, Otis's ADHD symptoms were significantly reduced. He was able to discontinue treatment, and he was still doing well a year later.

Future Research

Future research may lead to new techniques for more specifically targeting brain regions. Such research may address a related question: Does neurofeedback change other aspects of brain functioning aside from brainwaves?

Also, extending the use of neurofeedback to individuals without brainwave dysfunction may prove valuable. Neurofeedback could increase performance, including higher cognitive functioning, such as more intense or more sustained focus, thereby improving efficiency and brain health for all individuals.

Conclusion

Brainwave dysregulation can negatively influence an individual's well-being and health by affecting behaviors, feelings, and attitudes (Hill & Castro, 2009). The brain uses cues from the environment to regulate brainwave patterns. Overly dominant or other dysfunctional patterns may produce brainwave dysregulation and accompanying behavioral problems.

Neurofeedback has been shown to be effective in treating individuals with ADHD. Feedback is provided in the form of video games connected to devices that monitor EEG data (Druic et al., 2012), whereby this technique positively reinforces the proper brainwave display.

Not only is neurofeedback safer when compared to the side effects of medication, but it can also empower its users by providing greater control over their bodies and their environments. Therefore, through targeting brainwave dysregulation, neurofeedback can safely and effectively improve individuals' lives.

References

Frank, D. L., Khorshid, L., Kiffer, J. F., Moravec, C. S., & McKee, M. G. (2010). Biofeedback in medicine: Who, when, why and how? *Mental Health Family Medicine*, *7*(2): 85–91. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2939454/

Gevensleben, H., Holl, B., Albrecht, B., Vogel, C., Schlamp, D., Kratz, O., & . . . Heinrich, H. (2009). Is neurofeedback an efficacious treatment for ADHD? A randomized controlled clinical trial. *Journal of Child Psychology and Psychiatry*, *50*(7), 780-789. doi:10.1111/j.1469-7610.2008.02033.x

Heraz, A., & Frasson, C. (2011). Towards a brain-sensitive intelligent tutoring system: Detecting emotions from brainwaves. *Advances in Artificial Intelligence*, 1-13. doi:10.1155/2011/384169

Hill, R. W., & Castro, E. (2009*). Healing young brains: Drug-free treatment for childhood disorders - including autism, ADHD, depression, and anxiety*. Charlottesville, VA: Hampton Roads Pub. Co.

Kropotov, J. D. (2009). *Quantitative EEG, event-related potentials and neurotherapy*. Oxford, UK: Elsevier Inc.

Lansbergen., M. M, Dongen-Boomsma, M. V., Buitelaar., J. K., & Slaats-Willemse, D. (2011). ADHD and EEG-neurofeedback: A double-blind randomized placebo-controlled feasibility study. *Journal of Neural Transmitters*, *118*(2): 275–284. doi: 10.1007/s00702-010-0524-2

Myers, J. E., & Young, J. (2012). Brain wave biofeedback: Benefits of integrating neurofeedback in counseling. *Journal of Counseling & Development*, *90*(1), 20-28. doi: 10.1111/j.1556-6676.2012.00003.x

Rubik, B. (2011). Neurofeedback-enhanced gamma brainwaves from the prefrontal cortical region of meditators and non-meditators and associated subjective experiences. *Journal of Alternative & Complementary Medicine*, *17*(2), 109-115. doi: 10.1089/acm.2009.0191

Saxby, E., & Peniston, E. G. (1995). Alpha-theta brainwave neurofeedback training: An effective treatment for male and female alcoholics with depressive symptoms. *Journal of Clinical Psychology*, *51*(5), 685-693. doi:10.1002/1097-4679(199509)51:5<685::AID-JCLP2270510514>3.0.CO;2-K