EEG Neurofeedback: An effective treatment for ADHD

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Abstract
In lieu of an abstract, below is the first paragraph of the paper.

Attention deficit hyperactivity disorder (ADHD) is most commonly treated with psychostimulant medications due to the ease of administration. However, a new treatment called EEG biofeedback is proving efficacious in the treatment for ADHD without the side effects of psychostimulants. Neurofeedback is a process in which people learn to self-regulate their brain waves (Masterpasqua & Healey, 2003). The ability to alter brain activity ultimately has the ability to change behaviors that are causing people distress. This alteration occurs by operant conditioning, that is, reinforcement and punishment.
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The Beginnings of the EEG and Neurofeedback

Attention deficit hyperactivity disorder (ADHD) is most commonly treated with psychostimulant medications due to the ease of administration. However, a new treatment called EEG biofeedback is proving efficacious in the treatment for ADHD without the side effects of psychostimulants. Neurofeedback is a process in which people learn to self-regulate their brain waves (Masterpasqua & Healey, 2003). The ability to alter brain activity ultimately has the ability to change behaviors that are causing people distress. This alteration occurs by operant conditioning, that is, reinforcement and punishment.

The human brain is made of 100 billion neurons with 80% in the cortex; each sending signals and all interconnected by intra-cortical loops and neurotransmitters. The interconnectedness, or extent to which neurons are working together, is also known as coupling and is shown through what is known as coherence on an EEG (Lubar, 1997). It has been found that 97% of brain activity recorded through the EEG occurs in the cortex. Everyday some of these neurons die without regeneration, but new connections and neural circuits are also being formed simply through experience, learning, and emotions. In addition, we can also learn to control the way our brain operates and form new connections (Lubar, 1997).

History of Neurofeedback and the Development of the Pathological Brain

Neurofeedback began in the 1960’s with the infamous alpha/theta (peak performance) and the experiments with cats (Hill & Castro, 2002). At that time it was viewed as a hoax and another way to alter one’s mental state during the “flower power” era. However, increased technology, more research, and a better understanding of how the brain works led researchers and psychologists to envision the potential benefits of such a treatment. Before treatment could be considered, the EEG patterns of pathology needed to be characterized. New technology (i.e. functional MRI’s, PET scans, and quantitative EEG’s [QEEG]) have helped improve the diagnosis of certain disorders including ADHD, which is typically viewed as a strictly neurological problem. In studies of children who have been diagnosed using the DSM-IV-TR criteria for ADHD, a QEEG is given to see the actual way their brain functions. With strong reproducibility, children with ADHD have a greater amount of slow wave (4-7 hertz) brain waves as well as a decrease in the (8-11 hertz) frequencies in their prefrontal cortex, which is responsible for executive functioning (Masterpasqua & Healey, 2003). The lower frequency bands (4-7 Hz) are known as theta waves and are associated with a drowsy or dreamy state. Whereas the higher frequency bands (12-15 Hz and 15 to 18 Hz) are known as sensory motor rhythm (SMR) and beta waves respectively. These two states are associated with both calm and active alert states that are functioning while we are engaged in learning and concentration on a task. The reason children with ADHD have trouble paying attention is their brains are sleeping and they are trying to find activities that are exciting and will wake up their brain. This is also why stimulant medications decrease the symptoms of ADHD. Some children with ADHD may also exhibit excess of high beta activity (19+ Hz) which are associated with a hyper-alert state (Hill & Castro, 2002).

ADHD and Neurofeedback...how it works

Since the 1970’s researchers have studied the effects of neurofeedback on ADHD (Rossiter & La Vaque, 1995). Researchers now know what is happening in the brain of a child (or adult) with ADHD, and what has to be done to change it. In a typical neurofeedback session for someone with ADHD, three electrodes are used, a ground, a reference, and the third on the scalp is the location being trained. More electrodes and training sites can be used if the child requires more areas of specialized training. A good clinician will have a Q-EEG recording taken before the first session and will have the results interpreted in order to specialize treatment for each client. The electrodes allow for the amplification of the brain waves which are shown

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on the computer screen. The client typically does not pay attention to the computer readout because they focus on the game used for training. Unlike most computer games clients use their brain rather than a joystick control this game. The therapist selects the desired brain activity bands both to be punished and rewarded. In the case of a child with ADHD the reward bands are typically SMR and beta waves which will help a child with focused attention. Inhibited (punished) bands, include the slow wave activity theta waves and the fast wave activity of high beta waves. These high beta waves are responsible for a hyper-alert state often associated with fear and anxiety. Reinforcement is received through both visual and auditory cues, and through this reinforcement, children learn how to maintain the state in which they have received rewards, thereby changing their brain waves (Hill & Castro, 2002).

What the Research Shows

Researchers have examined different aspects of neurofeedback including efficacy as well as comparison studies of neurofeedback and drug treatments. These studies have yielded many interesting results that must be further examined longitudinally but are promising for those who may not benefit from drug or behavior therapies.

The most commonly used treatment for ADHD today is drug therapy due to the ease of use, simplicity of administration, and fast results. However, drug therapies, specifically stimulants, are also quite controversial. One aspect of the controversy is due to the disturbing side effects including depression, anxiety, and possible tic disorders that may arise in children. Another downfall of medication is that the effects are not long-term and are only apparent when the child is on medication (Mash & Wolfe, 2005). Studies that have examined the effects of biofeedback versus pharmaceutical treatments have been very helpful in deciphering the major differences between the treatments. One study by Fuchs, Bribaumer, Lutzenberger, Gruzelier, and Kaiser (2003) examined the differences between Methylphenidate (a stimulant) and EEG biofeedback. Their 33 participants had a primary diagnosis of ADHD and neither the biofeedback nor the medication group received any treatment prior to the study. To assess their progress pre and post measures were given. These measures included a continuous performance test (TOVA) as well as parent and teacher report measures. Their results indicate that both treatments groups had significantly better ratings on the parent and teacher rating scales as well at the TOVA performance test. However, due to the similar treatment effects, this begs the question, why choose neurofeedback over medicinal treatments which may be less expensive, less time consuming, and have more rapid effects? The answer to this question lies in the long-term effects of neurofeedback. Rossiter and LaVaque (1995) reported similar findings, and determined that while EEG biofeedback may be more expensive in the short-term (especially since many insurance companies do not cover it); long-term costs are less because continual treatment is not necessarily needed and only “booster” sessions may be required. However, medication requires a life long commitment because over half of the children with ADHD will not outgrow the disorder.

Other research has examined the differences between neurofeedback and placebos. DeBeus, Ball, deBeus, and Herrington (2004) have preliminary findings from their study of 26 children who have completed 40 sessions of neurofeedback as compared to those in a placebo group. They found, by means of parent and teacher ratings, performance on a continuous performance test, and QEEG’s that neurofeedback has successfully changed the electrophysiology of the children who received the neurofeedback as opposed to those in the placebo treatment. The children who received the placebo feedback also showed a reduced learning curve whereas those children who received actual feedback were more successful at learning how to control the EEG. However, these are preliminary findings and, by the end of their study, 52 children will complete neurofeedback and subsequent comparisons will be made.

Studies have been conducted that are able to show the exact changes in EEG activity in the cortex due to neurofeedback as opposed to medicinal treatments. Lubars (1997) demonstrated that few structural and functional changes in the cortex actually occurred when children were on medications. However, EEG biofeedback led to such changes in the cortex as assessed by QEEG’s pre and post neurofeedback. By increasing the higher frequency activity, specifically SMR and low beta activity and decreasing the slow wave theta activity, there are long-term improvements in attention and subsequently academic performance. Many
parents also report improvements in other aspects of behavior besides attention, which have been confirmed by QEEG findings that show more than one area of the brain is changed; other areas and waves are affected due to the looping of different areas (Lubar, 1997). Cox, Kovatchev, Morris, Phillips, Hill, and Merkel (1998) also determined differences in QEEG differences between children on and off medication. All children were given QEEG’s and then assigned to a neurofeedback or medicine condition. There were no significant behavioral differences between the groups while on task during treatment. However, a three-month follow-up, revealed significant QEEG differences between the groups. The neurofeedback group was able to change their electrophysiology whereas the medicinal group was not.

While there is still a lack of research, studies are underway that are more controlled and will further the current information concerning neurofeedback and how it works. Ever advancing technology will also help us further discriminate the causes and effects of ADHD on the brain. The more that is understood about what is going on in the brain of a child with ADHD the more advanced treatments become and the more efficacious they are. While many advocate pharmaceutical treatments, some children do not benefit from medication and others experience disturbing side effects. There must be treatments for these children that are successful in treating ADHD, neurofeedback is such a treatment. By conducting continual research to strengthen our knowledge and understanding of neurofeedback, this will be a possibility. In addition, research will help these families financially because they will be able to receive insurance reimbursement which for most is a major deterrent from such a treatment. More clinicians must be willing to invest in educating themselves on this treatment as well as conducting their own clinical research. Finally, preliminary findings from studies assessing the effectiveness of neurofeedback for the treatment of ADHD have shown that this is an effective treatment for many children, is long lasting, and there are no adverse side effects. If medication is not the route to be taken for a child with ADHD, neurofeedback should be considered along with other forms of therapy for families.

References