

A Parent's Guide to Neurofeedback

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### Abstract

For parents with children with Attention Deficit / Hyperactivity Disorder (ADD/ADHD), neurofeedback represents an exciting new alternative to treatment with medication. Powerful psycho-stimulant drugs such as Ritalin have side-effects and do not work on changing the underlying causes of the condition. Neurofeedback therapy focuses on changing the underlying symptoms by re-training the brain. Neurofeedback technology has been scientifically proven to be an effective treatment for the underlying core symptoms of ADD/ADHD. This research paper explores the emerging field of neurofeedback and attempts to present evidence of the effectiveness of neurofeedback in simple terms that parents can understand. Neurofeedback provides immediate information to an individual on the state of their brain function. More simply, with certain limitations, the brain can be trained to produce a desired effect. Unhealthy brain wave patterns, such as those associated with ADD/ADHD, can be changed. And those changes are likely to be long term and possibly permanent. Neurofeedback should not be seen as a cure-all remedy. However, if applied properly, neurofeedback presents a safe and effective alternative treatment for ADD/ADHD.

*Keywords:* neurofeedback, attention deficit / hyperactivity disorder (ADD/ADHD), brain training, brain waves, learning disorders

### A Parent's Guide to Understanding the Fundamentals Neurofeedback

Neurofeedback has emerged as one possible treatment alternative for Attention Deficit / Hyperactivity Disorder (ADD/ADHD). This research paper explores the emerging field of neurofeedback and attempts to present evidence of the effectiveness of neurofeedback in simple terms that parents can understand. ADD/ADHD is the most commonly found behavioral disorder affecting children. Estimates range from 3% up to 10% of children are affected by this condition (Beauregard & Lévesque, 2006; Cantwell, 1996; Gevensleben et al., 2009; Steiner, Frenette, Rene, Brennan, & Perrin, 2014; Steiner, Sheldrick, Gotthelf, & Perrin, 2011). The core ADD/ADHD symptoms are “a persistent pattern of inattention and/or hyperactivity-impulsivity that is a predominant characteristic of an individual's behavior” (Fox, Tharp, & Fox, 2005, p. 365). The result is poor behavior and poor academic performance at school. Children with ADD/ADHD typically also have difficulty maintaining social relationships with peers. At home, this disorder not only negatively affects the child, but also affects the entire family.

Although there has been considerable research of ADD/ADHD, the exact cause is not understood at this time. Many children are treated for ADD/ADHD with powerful psychostimulant drugs such as Ritalin. Parents are searching for alternatives to drug therapy due to the side-effects and long-term risks. While the drug has been shown to address some of the symptoms, the evidence suggests that it does not work on changing the underlying causes of the condition. According to Fox et al, “to date no medication has been found that creates long-term improvement in children with ADHD” (2005, p. 368).

#### **Attention Deficit / Hyperactivity Disorder (ADHD)**

The core behavior associated with ADD/ADHD is characterized by inattentiveness, impulsivity, hyperactivity and response inhibition (Beauregard & Lévesque, 2006, p. 4;

Monastra, Monastra, & George, 2002, p. 231; Steiner et al., 2014, 2011, p. 615). In addition to problems at home, children with ADD/ADHD have trouble in school, resulting in poor academic performance and difficulty managing social relationships. Unless this behavior is addressed early on, the problems may continue into adolescents and in some cases, into adulthood. The classic ADD/ADHD behaviors/symptoms are categorized into three subtypes:

- Predominantly Inattentive Type
- Predominantly Hyperactive-Impulsive Type
- Combined Type - inattention and hyperactivity-impulsivity (Fox et al., 2005, p. 365).

In addition to the core symptoms, there are additional overlapping symptoms such as learning disorders, anxiety, depression, emotional problems and other conduct disorders (Pop-Jordanova, Markovska-Simoska, Zorcec, & others, 2005). In chronic cases, 50% to 60% of children continue to exhibit symptoms beyond childhood into adolescence and adulthood (Hillard, El-Baz, Sears, Tasman, & Sokhadze, 2013; Steiner et al., 2011). The causes of ADD/ADHD are not clearly understood and there is no single test to determine if a child has the disorder.

However, research indicates psychosocial and biological factors play a role in ADHD (Cantwell, 1996). Other possible causes of ADHD being explored include chemical variations in the brain, genetic irregularities, poor diet, exposure to toxins, and complications during pregnancy (Fox et al., 2005). Millichap and Yee explore the link between diet and ADHD. Their research article focuses on a controversial study from Australia which suggests a link between ADHD in adolescents with a “western style” diet high in fat and refined sugars (Millichap & Yee, 2012). On the other hand, a healthy diet of fish, vegetables, tomatoes, fruits and whole grains is “not associated with ADHD diagnosis” (Millichap & Yee, 2012, p. 335). Whatever the cause, diagnosing ADHD is a complex process involving the evaluation of many factors. Cantwell

(1996) stresses that a diagnosis of ADHD should be based on a clinical picture that covers early life, persists over time, cuts across multiple settings and causes dysfunction at home and school. While it is understandable that a parent would want to find an explanation for their child's behavior, labeling children so early in their development could be detrimental to the child and may in fact worsen the stigma associated with learning disorders. In addition, a proper diagnosis of ADD/ADHD or any other behavioral disorder should only be made by a licensed behavioral or medical professional.

### **Treating ADD/ADHD**

Once ADD/ADHD is diagnosed, there are three general approaches to treatment. They are drug therapy, behavioral therapy, and a combination of the two. The most commonly known approach is psychostimulant drug therapy, i.e. Ritalin (Doggett, 2004, p. 70). The use of drugs on children with ADHD is controversial. Many doctors and parents are concerned with the long-term risks of using drugs such as Ritalin, even though temporary effectiveness has been reported in a majority of children taking the medication. "Reduced aggression," and "improved social functioning" are reported in children taking psychostimulant drug therapy (Doggett, 2004, p. 74). Drugs such as Ritalin and other psycho-stimulants have only short-term effects and do not address the underlying problem. In addition, psychostimulant drug therapy in children is not without side-effects and possible long term risks. Some side-effects from Ritalin include: insomnia, headaches, dizziness, irritability, and stomach ache, among others (Cantwell, 1996; Doggett, 2004; Hammond, 2011). The long-term risks of drug therapy are not clearly understood. Alternative forms of treatment are needed in cases where drug therapy is not possible or effective.

### **Training the Brain**

Studies have shown that brain wave patterns can be re-trained using the principles of operant conditioning (Lubar, 1991). Operant conditioning is a type of learning that involves “attempting to modify behavior through the use of positive and negative reinforcement” (McLeod, 2007, p. Operant Conditioning) In addition, researchers have been able to associate a high proportion of theta to beta brain waves with the presence of ADD/ADHD (Leins, et al., 2007).

Neurofeedback is a system which combines EEG technology and computers to capture and display instantaneous information (feedback) about brain waves. The goal of brain training is to change dysfunctional brain waves patterns to more desirable “healthy” patterns. The encouraging news for parents and their children is that recent scientific studies and scholarly articles indicate that neurofeedback training has been demonstrated to be an effective treatment for ADD/ADHD and other learning disorders in children (Gevensleben et al., 2009, 2014; Hammond, 2011; Hillard et al., 2013; Lubar, 1991; Monastra et al., 2002; Pop-Jordanova et al., 2005; Sherlin, Arns, Lubar, & Sokhadze, 2010; Steiner et al., 2014, 2011).

### **Types of Brain Waves**

Before we can gain an understanding of the neurofeedback process, we need to introduce some fundamental concepts about brain waves. Brain waves can be detected using an electroencephalogram (EEG) which measures brain activity. Sensors are applied to the scalp in specific locations and the information is captured to a computer which “provides real-time, instantaneous audio and visual feedback about brain activity” (Hammond, 2007, p. 26). Brain waves are measured in Hertz (Hz). There are four types of brain waves which are focus of neurofeedback training. They are shown in Figure 1.0.

- Delta waves (.5 – 4 Hz): deltas are the slow brain waves typically associated sleep (Hammond, 2007, p. 26);
- Theta waves (4 – 8 Hz): thetas are typically associate with daydreaming and mental inefficiency (Hammond, 2007, p. 26). Excessive theta wave activity is commonly linked to “confusion, slow reaction times, slow judgment and difficulties with impulse control” (Sanford, 2014, p. 30);
- Alpha waves (8-12 Hz): Slower and larger brain waves often associated with relaxation (Hammond, 2007, p. 26). Abnormally high alphas brain waves are associated with attention deficit disorder / hyperactivity disorder, depression, and other disorders (Sanford, 2014, p. 31). More importantly, high proportions of theta waves to beta waves has been identified as a marker for attention deficit hyperactivity disorder in many children” (Sanford, 2014, p. 31). Inattention, distract-ability, depression and anxiety have also been associated with excessive amounts of theta waves (Sanford, 2014).
- Beta waves (above 13 Hz): Small, but fast brain waves associated with mental activity and outwardly focused attention (Hammond, 2007). Excessive beta waves are commonly associated with attention deficit disorder, obsessive compulsive disorder, sleep disorders, learning disorders, anxiety and depression, among others (Sanford, 2014).

It is important for parents to understand that the *ratio of theta to beta brain waves* is useful in assessing the presence of ADD/ADHD (Monastra et al., 1999, p. 430). Persons with ADD/ADHD and other learning disorders “tend to have excessive slow waves” or a high ratio of theta to beta brain waves (Hammond, 2011, p. 306). In addition, a more recent study by Ogrim, Kroptov, & Hestead concludes that “elevated theta as a marker of inattention and executive problems in ADHD” (2012, p. 486). Overall, numerous research studies have repeatedly

demonstrated that the ratio of brain waves can be changed by engaging the patient in computer based activities that are targeted to lower excessive theta waves and increase insufficient beta waves.

### **Neurofeedback Training**

An exciting new approach being explored in the treatment of ADD/ADHD involves EEG (Electroencephalography) biofeedback also known as neurofeedback. Neurofeedback is defined as “a neuro-behavioral treatment aimed at acquiring self-control over certain brain activity patterns and implementing these skills in daily-life situations” (Gevensleben et al., 2009). In other words, neurofeedback is brain training. Neurofeedback training is based on the principles of operant conditioning which state that “behavior which is reinforced tends to be repeated (i.e. strengthened); behavior which is not reinforced tends to die out or be extinguished (i.e. weakened)” (McLeod, 2007, p. operant-conditioning.html). Neurofeedback provides immediate information to an individual on the state of his or her brain function. More simply, with certain limitations, the brain can be trained to produce a desired effect.

Research has shown children with ADD/ADHD tend to have a higher ratio of theta/beta brain waves (Monastra et al., 1999, p. 425). Consequently, the neurofeedback training protocol for children with ADHD focuses on lowering the amount of theta brain waves and increasing the amount of beta brain waves, thus decreasing the ratio of theta/beta brain waves. The amount of training needed is not the same for every child. Parents should be aware that results do vary. Each child's brain wave patterns are unique.

Neurofeedback training plans should be customized to the child's needs. The process starts with an intake interview and computer-based assessment. The parents and child are interviewed separately. The interviews are needed to identify different types of behavioral



problems the child is experiencing in the home and at school. The intake interview should be conducted by a licensed psychologist or psychiatrist. Next, the child is given a computer-based assessment. The assessment is conducted with an evaluation tool such as IVA+Plus: Integrated Visual and Auditory Continuous Performance Test (CPT) which is used to establish baseline measures and identify visual and auditory functional performance. Figure 2.0 shows sample results of a “before and after” IVA+Plus assessment summary report for a child with ADHD. IVA+Plus evaluates the auditory and visual response abilities through a series of exercises which test and measure response times. The results are compared to a normative database to determine if the results are within normal ranges or are consistent with markers associated such as ADD/ADHD. The intake interview and assessment will help the evaluator determine if the child is a good candidate for neurofeedback training.

Neurofeedback training is typically done in 30 - 45 minute sessions. Sensors are placed on the scalp of the child in specific locations. The sensors capture and relay the brain wave signals to the computer. During each session, the child will engage in computer-based activities similar to video games. A certified clinician should be present throughout the duration of each session to provide coaching and support. The training plan is “designed to assist the person to gradually change and retrain their brain wave patterns” (Hammond, 2011, p. 308). The number of training sessions can vary between 20 – 40 sessions depending on the severity of the condition. Research has shown that the changes are expected to be long-term (Hammond, 2011).

There are several different neurofeedback systems on the market. One such system is SMART Mind Pro by BrainTrain (patent pending). BrainTrain claims to be the “world’s #1 developer of professional software for testing and training cognitive abilities” (“BrainTrain”,

2014, p. Who We Are). This system is currently utilized at the Institute for Research, Assessment & Professional Development on the campus of California State University, San Bernardino. The BrainTrain website lists three basic modules in their SMART Mind Pro neurofeedback system:

- Neurosport Games - Using only brain power, clients of all ages learn to excel at activities such as shooting baskets, kicking field goals, playing soccer, fishing, and others;
- MindPower Games – An interactive entertainment style video game where the client maintains his or her SmartMind Pro EEG “zone” while playing the game. This activity is targeted toward improving hand-eye coordination, visual processing speed, and focus;
- Captain’s Log Brain Games – Training with the games in this module develops the ability to optimize learning and improve executive functioning (“IVA+Plus: Integrated Visual and Auditory Continuous Performance Test (CPT) | :: BrainTrain – Changing the Way People Think ::,” 2014) .

The clinician plays an important role in the neurofeedback training. The SMART Mind Pro software allows the clinician to create individualized training plans with the goal of down-training or up-training specific brain waves. Parents need to make sure that the person providing the treatment is trained and certified in the use of the particular type of neurofeedback system being used. Neurofeedback is most effective when applied under the guidance of a licensed behavioral professional with a M.D. or Ph.D. degree. Parents are cautioned against systems which advertise a “do-it-by-yourself” approach. Mild side effects have been associated with neurofeedback training. They include: fatigue, anxiety, headaches and/or irritability. Despite the

possible side effects, neurofeedback appears to be an effective long term treatment for ADD/ADHD. Sherlin et al. (2010) recommend that neurofeedback is a safe and efficacious, Level 5, intervention for ADHD. This rating is the highest attainable according to the guidelines set forth by the American Psychological Association. For parents, this means the treatment has been scientifically proven and validated. In other words, parents can trust neurofeedback, if applied properly, to be a valid treatment option for ADHD.

While this research paper has focused solely on neurofeedback for ADD/ADHD, it is important to note that neurofeedback is also being studied as a treatment for a variety of other disorders affecting the brain. These include: dyslexia, Down Syndrome, cognitive and memory enhancement, uncontrolled epilepsy, traumatic brain injuries, strokes, alcoholism and substance abuse, anti-social personality, criminal behaviors, post-traumatic stress disorder, autism and Asperger's Syndrome, anxiety and depression, insomnia, headaches and migraines (Hammond, 2011). Early studies suggest more research is needed to determine the effectiveness of neurofeedback in treating these disorders.

### **Conclusion**

For parents with children with ADD/ADHD, neurofeedback represents an exciting new alternative to treatment with medication. Neurofeedback technology has been scientifically proven to be an effective treatment for the underlying core symptoms of ADHD including: decreased impulsiveness and hyperactivity; increased mood stability; improved sleep patterns; increased attention span and concentration; improved academic performance; increased retention and memory (Hammond, 2011). In addition, research shows promising results supporting neurofeedback as a treatment for a wide-range of other disorders affecting the brain. However, neurofeedback should not be seen as a cure-all remedy. Additional research is needed, but early

results are encouraging. Research has consistently shown that unhealthy brain wave patterns, such as those associated with ADHD, can be changed. And those changes are likely to be long term and possibly permanent.

Parents should exercise caution when evaluating a neurofeedback treatment center. Neurofeedback services should be rendered under the strict supervision of a licensed therapist or medical doctor. Clinicians should have a strong background in counseling, preferably a Master's degree. The clinician is normally present during the entire session to provide coaching and counseling as needed. In addition, clinicians should be trained and certified in the neurofeedback system. Typically, neurofeedback training takes 30 – 45 minutes per session. The specific number of sessions needed is difficult to determine. However, 20 – 40 sessions is the normal amount necessary to bring about changes related to ADD/ADHD.

Every child is unique. Neurofeedback training plans must be customized to the needs of the child. However, the training protocol commonly used to address ADD/ADHD targets the ratio of theta to beta brain waves. Lowering the theta brain waves and raising the beta brain waves has been shown to reduce and even eliminate the classic behaviors associated with ADD/ADHD. Additional good news for parents is that their child will likely enjoy neurofeedback training. Figure 3.0 shows an example of the system with video game-like activities and the research grade EEG headset. For parents struggling with the decision to medicate their child, neurofeedback presents a safe and effective alternative treatment for ADD/ADHD.

Appendix

Figure 1.0

Four Brain Wave Types: Beta, Alpha, Theta and Delta (“Nu-Brain International: Improve Your Brain... Improve Your Life,” 2014)

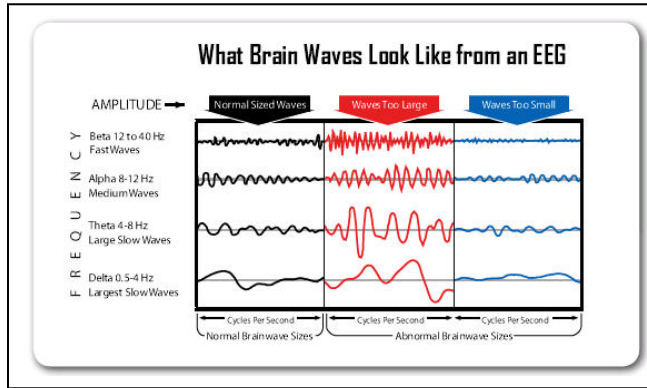


Figure 2.0

A sample before and after IVA+Plus assessment for child with ADHD (Demos, 2014)

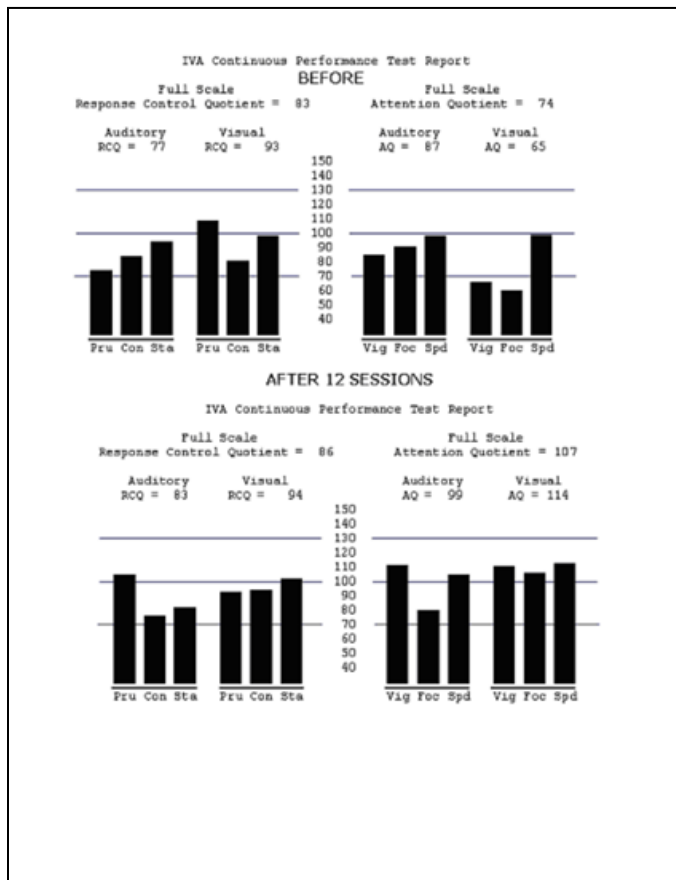


Figure 3.0

Sample of video game-like activity. Shown with research grade EEG headset - MindWave (Whitehead, 2014).



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