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COMPARISON OF TRADITIONAL THERAPY VERSUS NEUROFEEDBACK FOR ADHD: A ONE YEAR RETROSPECTIVE STUDY OF 50 PATIENTS

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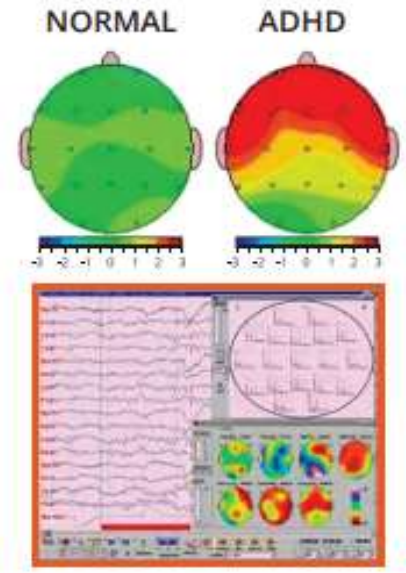
ABSTRACT
The treatment for children with attention deficit/hyperactivity disorder (ADHD) today is predominantly pharmacological. Behavior therapy (BT) and neurofeedback (NF) are promising alternative non-pharmacological treatments. In our study fifty patients were tested. These included twenty-five control patients and 25 patients with neurofeedback. We evaluated the quantitative electroencephalography (QEEG) of these patients after 10 sessions. Research shows that excess theta or a high theta/beta ratio is typical for ADHD. After treatment here was significant reduction of theta waves (P< 0.0001). Thus, supporting neurofeedback as an effective treatment modality for ADHD.

INTRODUCTION
Attention Deficit Disorder and Attention Hyperactivity Disorder are two of the most common neurological disorders diagnosed in children and teenagers. An estimated 8.4% of children have ADHD (Danielson, 2018). ADD/ADHD is genetically-based neurological disorders that affect the way in which the brain functions with resulting symptoms of inattention, impulsivity and hyperactivity. Medical science first documented children exhibiting inattentiveness, impulsivity and hyperactivity in 1902. Since that time, the disorder has been given numerous names, including minimal brain dysfunction, hyperkinetic reaction of childhood, and attention-deficit disorder with or without hyperactivity. With the Diagnostic and Statistical Manual, Fifth Edition (DSM-5) classification system, the disorder has been renamed attention-deficit/hyperactivity disorder or ADHD. The current name reflects the importance of the inattention aspect of the disorder as well as the other characteristics of the disorder such as hyperactivity and impulsivity.



Treatment
Traditional ADHD treatment usually incorporates a combination of behavioral therapy and the use of medication. Parent-Child Interaction Therapy (PCIT) is an evidence-based therapy modality to help young children with ADHD. This behavioral therapy is an initial method primarily recommended in In preschool-age and younger children. Another primary form of treatment for ADHD is medication. There are various choices for the pharmacological treatment of ADHD. Children and families may alternate between these

treatments based on efficacy of the treatment and the tolerability of the medication.

The FDA has approved psychostimulants (amphetamines and methylphenidate) as a first-line pharmacological treatment for the management of ADHD (Pliszka, 2007). Stimulants such as methylphenidate (MPH) and Amphetamine (AMP) are the two most used medications in children, adolescents, and adults with attention-deficit/hyperactivity disorder (ADHD) for the past 60 plus years (et al Childress). The basic pharmacological mechanism of AMP and MPH is to increase the levels of dopamine and norepinephrine in the synaptic cleft by blocking their monoamine transporters in the brain (et al Childress, et al Hodgkins). While the response rates to these drugs are up to 71% with AMP and 68% in MPH (et al Childress), the side effect profile raises concern on the long-term health of children and adolescents. Loss of appetite has been well established as a common side effect of stimulants. Metanalysis review studied the use of MPH in children and adolescents illustrated a significant decrease in the frequency of appetite of 30.3 %, 95% CI: 18.0-42.6 in patients on stimulant ADHD medication (et al schneider). Several studies put forward that the development or increase in severity of tics could be linked to the use of ADHD stimulant treatments (et al Kaplan) However, this notion has been counteracted with other studies that show no evidence in the development of tics with the use of stimulant dosage or duration to treat ADHD (et al Robatzek). Thus, further research needs to be conducted as this effect could be based on a case by case. Other adverse effects like, insomnia and psychiatric effects have been recorded with the use of stimulant drugs.

For those children that cannot tolerate the adverse effects of stimulants, atomoxetine is a nonstimulant alternative with similar efficacy in treating ADHD to stimulant medication (et al Banaschewski). Atomoxetine works by inhibiting the presynaptic norepinephrine transporter (NET) thus preventing the reuptake of norepinephrine in the brain (et al Fu). A randomized study with 228 children diagnosed with ADHD concluded that the reduction in ADHD symptoms are equivalent to children treated with MPH. Additionally, the patients treated with MPH reported more insomnia than those treated with atomoxetine (et al Dittmann). A double blinded study with a total of 291 children (ages 7-13) with ADHD randomized atomoxetine group (n=129), MPH group (n=38) and placebo group (n=124) discovered that both atomoxetine and MPH are effective in the treatment of ADHD (et al Banaschewski). Aside from having a similar efficacy atomoxetine also has similar adverse effects that are similar to stimulants such as decreased appetite and weight loss. Furthermore, dry mouth, insomnia, constipation, mood swings and fatigue have been reported with the use of atomoxetine.

Tricyclic antidepressants (TCAs) have also been used to treat children with ADHD. A double blinded study investigated the efficacy of desipramine (3.5 mg/kg per day) showed that the ADHD response rate in N=41 (7 girls and 34 boys) 71% with desipramine and 0% with placebo (et al Biederman). Controlled trials showed that 75mg/day dose of imipramine may reduce hyperactivity in 3 to 10 days (et al Banaschewski, et al Gualtieri). The side effects profile of TCAs includes dry mouth, blurred vision, constipation, dizziness, and weight gain. Patients treated with desipramine were found to have elevated heart rate, and intraventricular defects. (Oxford Textbook of Attention Deficit Hyperactivity Disorder).

Neurofeedback Therapy (EEG, QEEG, and HEG)

Research suggest that behavioral therapies enable patients to reinforce the psychosocial skills resulting in long term efficacy rather than short term as seen with pharmaceutical treatments alone (et al Monastra). For this reason, other treatment modalities have been encouraged for further investigation to find long term treatment for ADHD. One of the most prevalent in today's research is electroencephalogram (EEG) biofeedback therapy. EEG biofeedback is a series of brainwaves patterns that are classified based on their distinct frequency ranges. Quantitative electroencephalography (QEEG) is a modern type of electroencephalography (EEG) analysis that involves recording digital EEG signals which are processed, transformed, and analyzed using complex mathematical algorithms. QEEG has brought new techniques of EEG signals feature extraction: analysis of specific frequency band and signal complexity, analysis of connectivity, and network analysis. (Popa et. Al) They are brain mapping tools used to evaluate differences in brain function from a database of people of the same age and gender without difficulties. QEEG brain mapping and neurometric analysis enables the formulation of treatment options guided by the brain patterns associated with abnormal behaviors rather than relying solely on questionnaires or behavioral observations. QEEG is especially useful in revealing the underlying abnormal brainwave patterns associated with ADD/ADHD. There are six wavelength patterns in total. Delta: 0.5-4Hz, Theta: 4-8 Hz, Alpha 8-13Hz, Sensorimotor (SMR): 12-15Hz, Beta: 15-35 Hz, Gamma: 35-50Hz. Out of the six distinct types, delta and theta are considered the slow activity wavelengths, they are linked to daydreaming and drowsiness. Whereas alpha represents a relaxed states without focus and Beta is associated with high alertness, concentration, and focus. Children with ADHD have increased levels of theta activity and decreased levels of beta wavelength activity (et al Alhambra) EEG therapy initially studied by Lubar and Shouse in 1976 (et al Arns). Where they looked the different wavelengths activity of 16-20Hz (Beta) at the same time attempting to reduce cortical activity (theta 4-8 Hz) this led to a reduced impulsivity, hyperactivity, and enhanced attention span of the subjects under study (Et al Monastra, et al Arns). Additionally, a Meta analysis study published randomized clinical trials investigated five studies that included total of 263 patients with ADHD using EEG as

a treatment modality. Found that EEG substantially improved ADHD total score on a parent assessment scale (effect size of -0.49) also EEG improved inattention and hyperactivity/impulsivity with effect size of -0.46 and -0.34 respectively (et al Franchi). This neurofeedback therapy can be effective in helping treat ADHD.

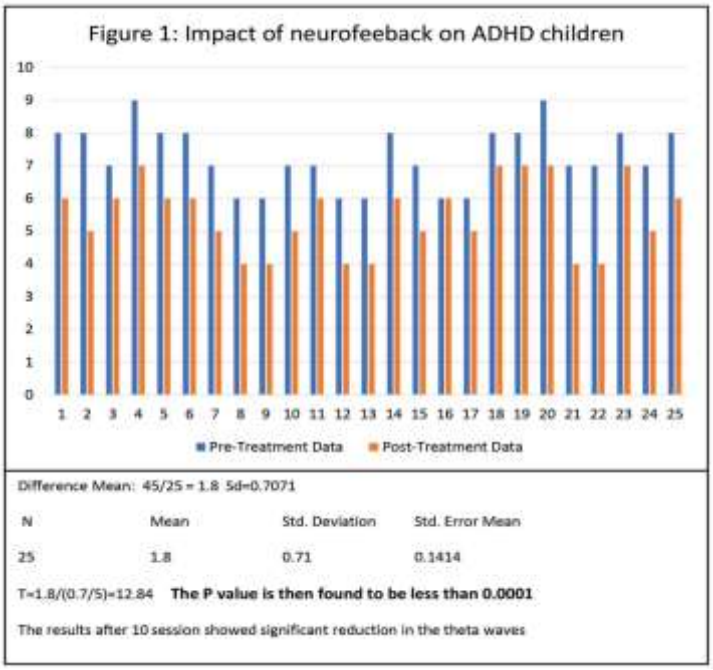
Hemoencephalography (HEG) is a neurofeedback technique that offers researchers with feedback regarding cerebral perfusion in the prefrontal cortex. There are two forms of HEG, one is near infrared spectroscopy (NIRS) and second is Passive infrared (pIR). Passive infrared consists of a sensor that detects light from the infrared spectrum that correlates to the levels of heat produced by the activity of brain region. The heat recorded is relative to the amount of sugar utilized in the respective to the metabolic activity within neurons. Near-infrared spectroscopy measures the neural activity in the brain by using detecting the absorption of the light according to the level of oxygenated and deoxygenated hemoglobin. In a pilot study NIRS neurofeedback was used as a treatment modality for children with ADHD. The study investigated children (N=27) ages 7-10 years with ADHD and exposed them to 12 sessions of near-infrared spectroscopy and 12 sessions in EEG group. In both groups attention task was conducted for the children at 4 weeks and 6 months after NIRS training. The study investigators found ADHD symptoms decreased significantly 4 weeks and 6 months after NIRS training and trend reduction in the EEG group (Marx et al) Although the small sample size is a limitation in this study, NIRS has shown to have promise in the treatment of ADHD.

Procedure

The use of neurofeedback therapy is simple. The QEEG Sensors are placed on the scalp to record brainwave patterns consciously. The brainwaves are converted into game-like displays or colorful images paired with sounds to give auditory feedback as well by a computer. The patient consciously controls what occurs on the computer screen by changing their brainwave patterns in the direction desired. They simultaneously learn to change their brain state solely by controlling their level of concentration via playing a computer game, an action that feels familiar to them. The brainwaves are recorded and measured by the number of waves per second (Hz).

RESULTS

Figure 1: Impact of neurofeeback on ADHD children



Difference Mean: 45/25 = 1.8 Sd=0.7071

N	Mean	Std. Deviation	Std. Error Mean
25	1.8	0.71	0.1414

T=1.8/(0.7/5)=12.84 **The P value is then found to be less than 0.0001**

The results after 10 session showed significant reduction in the theta waves

Following the sessions of QEEG various psychological examinations were performed in order to evaluate patients and the efficacy of neurofeedback therapy. The neurofeedback training aimed at enhancement of the "Focused Attention" and "40 Hz-centered gamma" indices in autism +ADHD was accompanied by improved in Hyperactivity and Irritability by the Aberrant Behavior Checklist (ABC) inventory. Using the Achenbach System of Empirically Based Assessment (ASEBA) patients showed improvements in Attention Problems/Deficits and Conduct Behavior Scores. After performing the Social Responsiveness Scale, Second Edition (SRS-2) patient showed improvements in T-score. The use of self-regulation of prefrontal EEG measures of "Focused Attention" ("Inhibit All" protocol) and "40 Hz-centered Gamma" indices using protocol with DVD-control as a visual feedback along with auditory feedback was effective in maintaining interest and motivational engagement of children with autism spectrum disorder with co-occurring ADHD. Employing ten 25 min. long sessions of neurofeedback were sufficient to achieve ability to control EEG parameters of interest as evidenced by increase of theta/beta ratio and gamma power targets during training sessions. During 20-25 min. of individual neurofeedback sessions we found linear increase of electrodermal activity (SCL), decrease of heart rate and several heart rate variability (HRV) measures improvements.

CONCLUSION

As shown by the statistical data in our study, neurofeedback is effective treatment modality that provided additional benefits when compared to Traditional treatment in ADHD patients. Standard ADHD protocols that inhibit theta (4–8 Hz) and reinforce beta (13–20 Hz) or sensorimotor rhythm (SMR) (13–15 Hz over the motor strip) have been used extensively and are based on experience and research showing that excess theta or a high theta/beta ratio is typical for ADHD. Three decades of research on the use of EEG neurotherapy in the treatment of ADD/ADHD has demonstrated efficacy and maintenance. Numerous research studies have shown that EEG neurotherapy is at least as effective in reducing ADD/ADHD symptoms as psychostimulant drugs and most studies have reported treatment success rates of between 70-80% for those children who show abnormal brainwaves in their EEG brain maps. Neurofeedback therapy has been effective in: helping sustain concentration or attention; reducing susceptibility or distractions; improving ability to listen when spoken to directly; improving organization skills; reducing forgetfulness; reducing overactivity; reducing excessive talking; reducing need to interrupt others; improving ability to wait turn; and reducing impulsivity. Neurofeedback therapy is an effective treatment method that provides additional benefits compared to traditional treatment in ADHD patients.

REFERENCES

1. Review A review of neurofeedback treatment for pediatric ADHD.[J Atten Disord. 2012]
2. Efficacy of neurofeedback treatment in ADHD: the effects on inattention, impulsivity and hyperactivity: a meta-analysis.[Clin EEG Neurosci. 2009]
3. American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, 5th edition. Arlington, VA., American Psychiatric Association, 2013.
4. Practice Parameter for the Assessment and Treatment of Children and Adolescents With Attention-Deficit/Hyperactivity Disorder. Pliszka - Journal of the American Academy of Child & Adolescent Psychiatry, 2007.
5. Childress, A. C., Komolova, M., & Sallee, F. R. An update on the pharmacokinetic considerations in the treatment of ADHD with long-acting methylphenidate and amphetamine formulations. Expert Opinion on Drug Metabolism & Toxicology, 2019; 15(11): 937–974. https://doi.org/10.1080/17425255.2019.1675636
6. Hodgkins, Paul, et al. "Amphetamine and Methylphenidate Medications for Attention-Deficit/Hyperactivity Disorder: Complementary Treatment Options." European Child & Adolescent Psychiatry, 5 July 2012; 21(9): 477–492, https://doi.org/10.1007/s00787-012-0286-5
7. Schneider, Benjamin N., and Michael Enenbach. "Managing the Risks of ADHD Treatments." Current Psychiatry Reports, 19 Aug. 2014; 16(10), https://doi.org/10.1007/s11920-014-0479-3.
8. Kaplan, Gabriel, and Jeffrey H. Newcorn. "Pharmacotherapy for Child and Adolescent Attention-Deficit Hyperactivity Disorder." Pediatric Clinics of North America, Feb. 2011; 58(1): 99–120, https://doi.org/10.1016/j.pcl.2010.10.009.
9. Roessner, Veit, et al. "First-Onset Tics in Patients with Attention-Deficit-Hyperactivity Disorder: Impact of Stimulants." Developmental Medicine & Child Neurology, 13 Feb. 2007; 48(7): 616–621, https://doi.org/10.1111/j.1469-8749.2006.tb01326.x
10. Banaschewski, T., et al. "Non-Stimulant Medications in the Treatment of ADHD." European Child & Adolescent Psychiatry, July, 2004; 13(S1). https://doi.org/10.1007/s00787-004-1010-x
11. Dittmann, R.W., et al. "Atomoxetine and Methylphenidate Treatment in Children with ADHD: A Prospective, Randomized, Open-Label Trial." European Neuropsychopharmacology, Jan. 2001; 11: S318–S319, https://doi.org/10.1016/s0924-977x(01)80448-x.
12. Spencer, Thomas, et al. "A Double-Blind Comparison of Desipramine and Placebo in Children and Adolescents with Chronic Tic Disorder and Comorbid Attention-Deficit/Hyperactivity Disorder." Archives of General Psychiatry, 1 July, 2002; 59(7): 649, https://doi.org/10.1001/archpsyc.59.7.649.

13. Gualtieri, C. Thomas, and Randall W. Evans. "Motor Performance in Hyperactive Children Treated with Imipramine." Perceptual and Motor Skills, June 1988; 66(3): 763–769, https://doi.org/10.2466/pms.1988.66.3.763.
14. Banaschewski, Tobias, et al. Oxford Textbook of Attention Deficit Hyperactivity Disorder. Oxford, Oxford University Press, 2018.
15. The Role of Quantitative EEG in the Diagnosis of Neuropsychiatric Disorders.
16. Livint Popa et al. - Journal of Medicine and Life – 2020.
17. Meyer, Jenny, et al. "Moderators of Long-Term Treatment Outcome When Comparing Two Group Interventions for Adolescents with ADHD: Who Benefits More from DBT-Based Skills Training?" BMC Psychiatry, 6 Dec. 2022; 22(1). https://doi.org/10.1186/s12888-022-04435-8
18. Soler-Gutiérrez, Ana-María, et al. "Evidence of Emotion Dysregulation as a Core Symptom of Adult ADHD: A Systematic Review." PLOS ONE, 6 Jan. 2023; 18(1): e0280131, https://doi.org/10.1371/journal.pone.0280131
19. Alvez-Contreras, Alma Y., et al. "Therapeutic Approaches for ADHD by Developmental Stage and Clinical Presentation." International Journal of Environmental Research and Public Health, 8 Oct. 2022; 19(19): 12880, https://doi.org/10.3390/ijerph191912880.
20. Monastra, Vincent, et al. "The Effects of Stimulant Therapy, EEG Biofeedback, and Parenting Style on the Primary Symptoms of Attention-Deficit/Hyperactivity Disorder." Applied Psychophysiology and Biofeedback, 27(4).
21. Bennett, Forrest, et al. "STIMULANT MEDICATION for DEFICIT / HYPERACTIVITY DISORDER." Pediatric Clinic of North America, Oct. 1990; 46(5).
22. Alhambra, Marabella A., et al. "EEG Biofeedback": Journal of Neurotherapy, Aug. 1995; 1(2): 39–43, https://doi.org/10.1300/j184v01n02_03.
23. Arns, Martijn, et al. "A Decade of EEG Theta/Beta Ratio Research in ADHD." Journal of Attention Disorders, 19 Oct. 2012; 17(5): 374–383, https://doi.org/10.1177/1087054712460087
24. Micoulaud-Franchi, Jean-Arthur, et al. "EEG Neurofeedback Treatments in Children with ADHD: An Updated Meta-Analysis of Randomized Controlled Trials." Frontiers in Human Neuroscience, 13 Nov. 2014; 8, www.ncbi.nlm.nih.gov/pmc/articles/PMC4230047/, https://doi.org/10.3389/fnhum.2014.00906.
25. Marx, Anna-Maria, et al. "Near-Infrared Spectroscopy (NIRS) Neurofeedback as a Treatment for Children with Attention Deficit Hyperactivity Disorder (ADHD) Pilot Study." Frontiers in Human Neuroscience, 7 Jan. 2015; 8, https://doi.org/10.3389/fnhum.2014.01038.