Neurofeedback in Adolescents and Adults With Attention Deficit Hyperactivity Disorder

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Steven M. Butnik
ADDVANTAGE, PLLC

Neurofeedback is being utilized more commonly today in treating individuals who have attention deficit hyperactivity disorder (ADHD). Neurofeedback, which is based on theories that recognize the organic basis of ADHD, utilizes biofeedback to guide individuals to regulate their brain activity. Neurofeedback relies on research that has demonstrated that most individuals who have ADHD, as compared to matched peers, have excess slow wave activity and reduced fast wave activity. It provides immediate feedback to the individual about his or her brain wave activity in the form of a video game, whose action is influenced by the individual's meeting predetermined thresholds of brain activity. Over several sessions of using the video and auditory feedback, individuals reduce their slow wave activity and/or increase their fast wave activity. Individuals who complete a course of training sessions often show reduced primary ADHD symptoms. Research has shown that neurofeedback outcomes compare favorably to those of stimulant medication. © 2005 Wiley Periodicals, Inc. J Clin Psychol/In Session 61: 621–625, 2005.

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Introduction

Neurofeedback, also known as *electroencephalogram (EEG) biofeedback*, has been utilized as a treatment strategy for attention deficit hyperactivity disorder (ADHD) since the 1970s (Lubar, Swartwood, Swartwood, & O'Donnell, 1995). Initially dismissed as poorly researched and overly hyped, neurofeedback over time has gained more empirical support, has become more widely practiced, and has received more acceptance among practitioners who work with clients who have ADHD. Evidence of neurofeedback's growing impact can be seen in its inclusion in popular books about ADHD (e.g., Sears & Thompson, 1998), edited volumes about ADHD (Incorvaia et al., 1999), and several books for

Correspondence concerning this article should be addressed to: Steven M. Butnik, Ph.D., ADDVANTAGE, PLLC, 6722 Patterson Avenue, Richmond, VA 23226; e-mail: sbutnik@gmail.com.

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parents and professionals (Hill & Castro, 2003). There are presently more than 1,500 practitioners using neurofeedback.

In this article I review the underlying theory and empirical research on use of neurofeedback with adolescents and adults who have ADHD and then present a clinical illustration and some of the research findings.

Neurofeedback first was used to train children who have ADHD in the 1970s after researchers noted improvements in the school performance of children who had seizure disorders who were being treated with neurofeedback. Early single case studies showed behavioral and academic gains among children who had ADHD (Lubar, 1976).

Neurofeedback's growing acceptance can be understood in the context of increased interest in and understanding of the organic basis of ADHD. Also, neurofeedback's underlying assumptions are consistent with theories of brain plasticity and models that describe ADHD as a disorder of neural regulation and underarousal.

Theories that describe ADHD as a condition associated with brain underarousal often note the insufficient production of or utilization of neurotransmitters, which causes inefficient communication among neurons. Neurofeedback's effectiveness is based on operant conditioning of bioelectrical neuroregulation. In essence, clients receive reinforcement when neurons communicate, or fire more rapidly. By facilitating connections among neurons, neurofeedback resembles pharmacologic approaches in which stimulants facilitate the utilization of neurotransmitters.

Neurofeedback utilizes the relationship between mental states and brain wave frequencies. Activation and arousal of the central nervous system are related to the rhythmic activity of neuronal firing patterns. Alert, aroused mental states are reflected in higher frequencies; this fast wave activity, known as *beta waves*, occurs at 13 to 21 cycles per second (hertz [Hz]). Inalert mental states are reflected in lower frequencies; this slow wave activity, known as *theta waves*, occurs at 4 to 8 cycles per second.

Quantitative electroencephalography (QEEG) has demonstrated that individuals who have ADHD produce more slow wave activity and less fast wave activity than other individuals. These findings suggest cortical slowing (Monastra et al., 1999). QEEG uses well-developed databases of specific brain wave patterns to help identify "signatures" of psychiatric conditions. This research on ADHD yielded sensitivity and specificity results of 86% and 98%, respectively (Monastra et al., 1999). That is, 86% of the individuals identified as having ADHD by using traditional diagnostic procedures were also classified as having ADHD by using the QEEG procedure alone; in addition, QEEG correctly identified 98% of those individuals who did not have ADHD.

The goal of neurofeedback is to train the individual to normalize abnormal EEG frequencies and to increase awareness of how a normalized EEG pattern "feels." Clients learn how to produce patterns of brain waves that occur when one is motorically still, externally focused, and alert. In effect, neurofeedback helps people to be more attentive to being attentive.

Neurofeedback uses basic principles of biofeedback to provide clients with immediate feedback of brain electrical activity, which leads to their learning to regulate mental states.

By using electrodes attached to the scalp, electrical activity of the brain is sent to and processed by an electroencephalograph and computer. Data are displayed to the client in a format resembling that of a video game. The game action is controlled by clients who meet preset training parameters. Each time the brain waves find their way to the preset state, the client is quickly rewarded with positive feedback. Most often, clients are trained to reduce slow wave activity and increase fast wave activity. As clients learn to regulate their mental activity in this manner, symptoms of ADHD diminish.

Clinicians utilize a variety of training protocols. Typical training sessions occur twice weekly; sessions last about 1 hour and include several distinct conditions. Each session starts with a 2-minute gathering of baseline data. Four 5- to 10-minute conditions follow and alternate the playing of "video games" with reading and listening tasks. A variety of game screens can be used. Typically, games are simple and may resemble a Pacman maze.

Clinicians may provide coaching to help clients maintain their focus and effort; metacognitive strategies may accompany the reading and listening conditions. For example, clients may be encouraged to read or listen to a paragraph with a particular purpose (e.g., looking for the answer to a particular question).

Clinical results of neurofeedback training have been generally positive. Early published research (Lubar et al., 1995) used single-subject A-B-A-B designs as well as small groups of clinical subjects. There have been no large-scale, double-blind, or controlled studies that have investigated the long-term effects of neurofeedback. However, two recent clinical studies have yielded findings supportive of its effectiveness.

In one investigation (Monastra, 2002), two groups of children and teens who had ADHD were studied (100 children between 6 and 19 years of age). One group was provided a variety of treatments, including medication, school consultation, and parent counseling; the other group received the same regimen, combined with neurofeedback. The two groups of children did not differ on any of the traditional pretreatment measures. Measures were taken twice: 1 year after treatment began while they were still using medication, and again 1week after they stopped using it. Measures included behavior checklists, a Test of Variables of Attention (TOVA) (a continuous performance test), and a QEEG attention index. At the first outcome assessment (while they were still on medication), TOVA scores for both groups were within normal limits. Behavior ratings of children who did not receive neurofeedback as reported by parents and teachers were in the clinical range; children who received neurofeedback were rated in the normal range. After 1 week without medication, the TOVA scores of children who did not receive neurofeedback fell in the clinical range in three of four scales; the TOVA scores of children who received neurofeedback remained in the normal range. Behavior ratings of the neurofeedback group also remained in the normal range. The QEEG showed cortical slowing in the group of children who did not receive neurofeedback; the group of children who did receive it no longer showed evidence of cortical slowing.

In another investigation (Fuchs, Birbaumer, Lutzenberger, Gruzelier, & Kaiser, 2003), children who had ADHD were given either medication or neurofeedback. After about 40 neurofeedback sessions the two groups were compared on a variety of traditional ADHD measures. Findings indicated that the groups performed at a comparable level. This study provided evidence that neurofeedback compares favorably to traditional medication, at least in the short run. Other preliminary studies (Thompson & Thompson, 1998) indicate gains in IQ scores, neuropsychological measures, handwriting, and social behaviors. Research findings bolster the enthusiasm reported by clinicians (including this author) who see significant gains in clients.

Clinicians typically receive training in neurofeedback procedures as part of their graduate school or internship experiences. Practicing clinicians who seek training can attend workshops; there are organizations that certify practitioners (e.g., Biofeedback Certification Institute of America).

Neurofeedback can be expensive; some insurance plans consider neurofeedback to be experimental and do not provide coverage. Single sessions range in cost from $50 to $125. The number of sessions required to complete training varies with the individual; for bright, inattentive individuals training may require 30 to 40 sessions. When hyperactivity accompanies inattention and/or when individuals have comorbid learning problems, training may require more sessions.

Case Illustration

Client Description

Alan, a 16-year-old high school junior, was referred for a psychological assessment by his parents because of poor grades, diminished motivation for school, and behavior problems. There had been no previous psychological evaluations. Developmental and family history indicated that Alan was the older of two children. Alan's parents both completed college and both reported some struggles with procrastination and underachievement. Alan's younger sister excels academically. Family history did not reveal any close relatives who had significant educational, substance abuse, or psychological problems.

Alan was a healthy youngster who had no major illnesses, injuries, or hospitalizations and no reported hearing or vision problems. His development in all areas had been within normal limits. Appetite was reported to be good. Alan's sleep was reported to be poor, with trouble falling asleep and trouble getting up for school.

Psychological testing with the Wechsler Intelligence Scale for Children (Third Edition) (WISC-III) revealed intelligence in the lower part of the average range, with a relative weakness in tasks requiring working memory. Academic testing showed achievements to be within the range suggested by intellectual measures. There were no serious emotional or personality problems noted.

The Child Behavior Checklist, Teacher Report Form, and Brown ADD Scales consistently supported a diagnosis of ADHD, combined type. In addition, Alan committed a significantly high number of omission and commission errors on the Connors' Continuous Performance Test. A QEEG scan showed an attention index more than two standard deviations above the average of same-aged peers who did not have ADHD.

Case Formulation/Course of Treatment

Presented with a number of options, Alan and his parents elected to try neurofeedback, in part because of their concerns about the long-term effects of medication. Alan was seen in one session to establish initial training parameters. An inhibit threshold for theta–alpha activity was set at a power level so that Alan's initial slow wave activity fell in the target range about 50% to 55% of the time. A reinforcement threshold was set so that Alan's faster, beta activity fell above the target level about 45% to 50% of the time.

Subsequent hour-long sessions were scheduled twice weekly. Each session included a baseline condition and conditions featuring auditory and visual feedback alternating with silent reading and listening. Coaching was provided during each condition to encourage Alan to become more aware of his focused attention.

Outcome and Prognosis

At the ninth session, Alan proudly announced that he had figured out what he needed to do to "make the game work." A session-to-session graph of his progress to date provided evidence that Alan had indeed reduced the amplitude of his slow wave activity. Though this rapid progress stabilized, gradual and continued improved attention and productivity at school were reported. Neurofeedback stopped after 30 sessions. Alan had gained a sense of control over his attention, and he began to feel more academically confident; his stated motivation and grades improved. Parents and teachers noted increased self-control and increased responsibility. In a follow-up telephone call 1 year after the termination of neurofeedback sessions, Alan's mother reported that he had had a successful first semester in college. Alan and his parents understood these positive results may be retained; however, additional follow-up sessions may be useful to maintain gains.

Clinical Issues and Summary

Given the current state of evidence supporting neurofeedback, the following conclusions can be offered: Neurofeedback provides an additional helpful intervention for individuals who are trying to manage their ADHD. For individuals who have strong negative feelings about medication, it provides an alternative. It can also be useful for individuals who cannot take traditional medications because of health complications or those who have had negative reactions to medication. Neurofeedback has proved to be safe; there are generally no side effects. Most neurofeedback research has focused on children and adolescents; as in research on the effectiveness of psychosocial interventions with teens and adults who have ADHD, research on this treatment with these populations is in its infancy and should continue. And, as they do for psychosocial interventions with teens and adults and who have ADHD, preliminary outcome studies and significant anecdotal evidence support this treatment.

Select References/Recommended Readings

Fuchs, T., Birbaumer, N., Lutzenberger, W., Gruzelier, J.H., & Kaiser, J. (2003). Neurofeedback treatment for attention-deficit/hyperactivity disorder in children: A comparison with methylphenidate. Applied Psychophysiology and Biofeedback, 12, 1–12.

Hill, R., & Castro, E. (2002). Getting rid of Ritalin: How neurofeedback can successfully treat attention deficit disorder without drugs. Charlottesville, VA: Hampton Roads.

Incorvaia, J., Mark-Goldstein, B., & Tessemer, D. (Eds.). (1999). Understanding, diagnosing, and treating AD/HD in children and adolescents. Northvale, NJ: Jason Aronson.

Lubar, J.F., & Bahler, W.W. (1976). Behavioral management of epileptic seizures following EEG biofeedback training of the sensorimotor rhythm. Biofeedback & Self-Regulation, 1, 77–104.

Lubar, J.F., Swartwood, M.O., Swartwood, J.N., & O'Donnell, P.H. (1995). Evaluation of the effectiveness of EEG neurofeedback training for ADHD in a clinical setting as measured by changes in T.O.V.A., scores, behavioral ratings, and WISC-R performance. Biofeedback & Self-Regulation, 20, 83–99.

Monastra, V.J. (2002). The effects of stimulant therapy, EEG biofeedback and parenting style on the primary symptoms of ADHD. Applied Psychophysiology and Biofeedback, 4, 231–49.

Monastra, V.J., Lubar, J.F., Linden, M., VanDeusen, P., Green, G., Wing, W., et al. (1999). Assessing attention deficit hyperactivity disorder via quantitative electroencephalography: An initial validation study. Neuropsychology, 13, 424–433.

Robbins, J. (2000). A symphony in the brain: The evolution of the new brainwave biofeedback. New York: Atlantic Monthly.

Sears, W., & Thompson, L. (1998). The ADD book: New understandings, new approaches to parenting your child. Boston: Little, Brown.

Thompson, L., & Thompson, M. (1998). Neurofeedback combined with training in metacognitive strategies: Effectiveness in students with ADD. Applied Psychophysiology & Biofeedback, 23, 243–263.