National Resource Center on AD|HD
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WHAT WE KNOW

Complementary and Alternative Treatments: Neurofeedback (EEG Biofeedback) and AD/HD

WHAT IS NEUROFEEDBACK?

The human brain emits electrical activity in waves that can be measured by a device called an electroencephalograph (EEG). When the results of an EEG measurement are analyzed, scientists are able to identify certain brain wave patterns recorded by the machine. There are several frequencies of brain waves when we are awake; these are called alpha (medium), beta (fast), and theta (slow) waves. Alpha waves are seen when a person is in a relaxed state, and not actively thinking or interacting with one's environment.

Beta waves are present when a person is interacting with the surrounding environment, and is concentrating, thinking, or solving problems. Theta waves are often seen during times of drowsiness, daydreaming or during light sleep, but can also occur during thoughtless, restless overactivity. (A fourth type of brain wave, called delta, is seen during deep sleep).

Neurofeedback, formerly called electroencephalographic (EEG) biofeedback, and occasionally referred to as neurotherapy, is an intervention for AD/HD based on findings that many individuals with AD/HD show low levels of arousal in frontal brain areas, with excess of theta waves and deficit of beta waves. Supporters of this treatment suggest that the brain can be trained to increase the levels of arousal (increase beta waves and reduce theta waves) and thereby reduce AD/HD symptoms. Neurofeedback treatment involves placing electrodes on a person's head to monitor brain activity. Feedback is given to the patient with cues that can be as simple as an audio beep or as complex as a video game. When the brainwaves are of the desired frequency, the beep may inform the patient, or the character in the game will move in the proper direction. When the patient has learned how to increase these arousal levels, proponents believe improvements in attention will result and that there will be reductions in hyperactive/impulsive behavior.

The concept of neurofeedback as an intervention for AD/HD is based on data showing that many individuals with AD/HD have more slow-wave (especially theta) power in their EEG than those without AD/HD, and conversely, less beta power (Monastra, 2002, 2005).[1, 2]

literature to date, Monastra noted that over the past 25 years, numerous studies have reported benefits from neurofeedback in AD/HD. Based on the five-level grading of evidence used by the American Psychological Association (APA; see Table 1), Monastra concludes that neurofeedback is "probably efficacious" for AD/HD.[3] Others, including CHADD's Professional Advisory Board (PAB), suggest that "possibly efficacious" better reflects the state of published science.

Using the four-level scale of the American Academy of Child and Adolescent Psychiatry (AACAP), Hirshberg et al (2005)[3], editors of the special EEG issue of Child and Adolescent Psychiatric Clinics of North America, in which Monastra's review appeared, were even more enthusiastic than he was. They stated "EBF [EEG biofeedback] meets the AACAP criteria for 'Clinical Guidelines' for treatment of ADHD…"[4] AACAP's scale is:

- **Minimal Standard (MS)** applies to recommendations backed up by rigorous empirical evidence, and/or an overwhelming clinical consensus;
- **Clinical Guidelines (CG)** applies to recommendations based on strong empirical evidence and/or strong clinical consensus; (N.B. The CHADD PAB is not aware of any strong clinical consensus supporting neurofeedback at this time, and the strength of the empirical evidence is a matter of debate among experts.)
- **Option (OP)** applies to recommendations that are acceptable based on emerging empirical evidence or

TABLE 1: LEVELS OF EFFICACY (AMERICAN PSYCHOLOGICAL ASSOCIATION)

Level 1	**Not Empirically Supported**	supported only through anecdotal evidence or non-peer reviewed case-studies;
Level 2	**Possibly Efficacious**	shown to have a significant impact in *at least one* study, but the study lacked a randomized assignment between controls;
Level 3	**Probably Efficacious**	shown to produce positive effects in *more than one* clinical, observational wait list or within-subject or between-subject study;
Level 4	**Efficacious**	shown to be more effective than a no-treatment or placebo control group; the study must contain valid and clearly specified outcome measures, and it must be replicable by at least two independent researchers demonstrating the same degree of efficacy;
Level 5	**Efficacious and Specific**	shown to be statistically superior to credible placebo therapies or to actual treatments, and it must be shown as such in two or more independent studies.

NEUROFEEDBACK AS INTERVENTION FOR AD/HD?

There are six partially controlled studies published that examine the effectiveness of neurofeedback as an AD/HD intervention. In a review of the published

clinical opinion, but lack strong empirical evidence and/or clinical consensus;
- **Not Endorsed (NE)** applies to practices that are known to be ineffective.

In contrast to Hirschberg, the CHADD PAB feels that "Option" would be a more accurate characterization of neurofeedback at the current state of knowledge. Others are also less optimistic. Loo & Barkley note that many of the neurofeedback studies "suffered from significant methodological weaknesses." These weaknesses "make interpretation of the results and conclusions about the actual effect of EEG biofeedback impossible."[5] The following are some of the deficiencies Loo and Barkley found among the studies:

- Lack of control groups;
- Confounding variables: Treatments other than the one being studied may not be accounted for and could distort the results (an example would be a person with AD/HD who is taking medication to treat the condition and the investigators not accounting for the effects of the medication treatment);
- Small sample sizes;
- Uncertainty as to whether all the children in the studies were accurately diagnosed with AD/HD;
- Lack of placebo control procedures: The control group or another group was not subjected to a placebo treatment to determine if the actual outcome was a result of the treatment provided;
- Absence of "blinding" on the part of clinicians ("blinding" or "masking" keeps a clinician from knowing whether a particular individual is receiving the treatment being studied or placebo), which could cause the researchers to skew the results unintentionally;
- Lack of randomization in some studies (study subjects were not randomly assigned to control and experimental groups). Subjects or parents chose whether they wanted neurofeedback (usually at additional cost to them), and the financial, motivational, and other family resources that would allow such a choice may well select for those who would fare better anyhow regardless of treatment. This is a particular problem for the large study (Monastra) that otherwise would have been most convincing despite its lack of blinding;
- Lack of rigorous peer review.

Loo and Barkley additionally note that previous research has not examined the mechanism of change, and wonder whether the positive results to date have been obtained because of attentional training coupled with intense practice and salient rewards and/or altered breathing patterns minimizing theta activity rather than direct training from EEG. Monastra shared many of the same concerns with Loo and Barkley in his 2006 review of the literature.

In summary, there are significant concerns about the studies cited here due to the lack of proper controls or random assignment of test subjects.

Of public health importance, one study suggests it may be feasible to administer treatments in schools. [6] In fact, Foks reported that over the last decade several schools in the USA have begun to utilize neurofeedback for the special education of children with AD/HD and learning disorders, with corresponding increases in regular class inclusion and significant financial savings.[7]

"Supporters of this treatment suggest that the brain can be trained to increase the levels of arousal …and thereby reduce AD/HD symptoms."

Much further research is needed to explore this interesting and promising but fairly demanding and expensive treatment. In 2006, CHADD wrote the National Institute of Mental Health (NIMH) requesting an NIMH large-scale research endeavor to address the issues raised here.

Finally, Loo & Barkley note that "even with such demonstrations [of efficacy], it must also be shown that treatment is cost-effective relative to the prevailing empirically supported approaches."[8] This is an important point, especially for a treatment that has required expensive and sophisticated equipment involving use of an expert operator. Parents are advised to proceed cautiously as it can be expensive—a typical course

of neurofeedback treatment may require 40 or more sessions—and because other AD/HD treatments (i.e., multi-modal treatment) currently enjoy substantially greater research support. (See *What We Know* #3 and #9.) Typical neurofeedback sessions are administered by psychologists with doctoral degrees at their customary professional rate. Recently, home kits have been developed and are available in the market. While these have the advantage of allowing children to participate at

"There are significant concerns about the studies cited here …"

home, the lack of professional administration has raised questions and none of the research studies mentioned here evaluated these at-home, non-supervised approaches. Parents should not presume that results obtained in a research or clinically supervised setting will automatically be duplicated at home.

Further Research Needed

Neurofeedback continues to be an intervention that generates much interest and attention from both researchers and consumers alike. While there is enough evidence to warrant its continued study as a possible intervention to reduce AD/HD symptoms, current research does not support conclusive claims about its efficacy. Based on the available evidence and the cost involved, parents and others should continue to exercise caution if considering neurofeedback as an intervention for themselves or their child.

REFERENCES

1. Monastra, VJ., Monastra, DM., George, S., (2002). 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):231-49.

2. Monastra, VJ., Lynn, S., Linden, M., Lubar, JF., Gruzelier, J., LaVaque, TJ., (2005). Electroencephalographic biofeedback in the treatment of attention-deficit/hyperactivity disorder. *Applied Psychophysiology and Biofeedback*, 30(2):95-114

3. Monastra, VJ., Lynn, S., Linden, M., Lubar, JF., Gruzelier, J., LaVaque, TJ., (2005). Electroencephalographic biofeedback in the treatment of attention-deficit/hyperactivity disorder. *Applied Psychophysiology and Biofeedback*, 30(2):95-114

4. Hirshberg, LM., Chiu, S., Frazier, JA., (2005). Emerging brain-based interventions for children and adolescents: overview and clinical perspective. *Child and Adolescent Psychiatric Clinics of North America*, 14(1):1-19.

5. Loo, SK., Barkley, RA., (2005). Clinical utility of EEG in attention deficit hyperactivity disorder. *Applied Neuropsychology*, 12(2):64-76.

6. Carmody, D., Radvanski, DC., Wadhwani, S., Sabo, JJ., Vergara, L., (2001). EEG biofeedback training and attention deficit/hyperactivity disorder in an elementary school setting. *Journal of Neurotherapy*, 4(3):5-27.

7. Foks, M. (2005). Neurofeedback training as an educational intervention in a school setting: How the regulation of arousal states can lead to improved attention and behavior in children with special needs. *Educational and Child Psychology*, 22(3):67-77.

8. Loo, SK., Barkley, RA., (2005). Clinical utility of EEG in attention deficit hyperactivity disorder. *Applied Neuropsychology*, 12(2):64-76.

The information provided in this sheet was supported by Grant/Cooperative Agreement Number 1UD38DD000335-01 from the Centers for Disease Control and Prevention (CDC). The contents are solely the responsibility of the authors and do not necessarily represent the official views of CDC. This fact sheet was approved by CHADD's Professional Advisory Board in December, 2007.

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