

Biofeedback for ADHD

Neurofeedback is the primary biofeedback modality for treating attention deficit hyperactivity disorder (ADHD). A large amount of studies can be found in review articles by Arns, Heinrich, and Strehl (2014) and by Micouland-Franchi et. al (2014). The early term of EEG biofeedback has been updated to be called neurofeedback in most publications. A variety of protocols have been used over the last three decades, so it is hard to summarize them in a brief review. The overall trend is to train the patient to lower the slow waves (especially theta) and increase the fast waves (beta) in the frontal regions of the brain (i.e., the frontal lobes).

Joel Lubar and his colleagues did the earliest studies (Lubar & Shouse, 1976, 1977) and showed that in training down the slow activity and training up the beta or faster brain activity, behaviors improved in children with ADHD. Lubar followed 52 patients over 10 years, and the gains were maintained over time. In another study, Linden, Habib, and Radojevic (1996), found that children with attention deficit disorder who received neurofeedback showed better control over their attentiveness and a Full Scale IQ gain of 10 points, while the control groups showed no gains. In a large study by Kaiser and Othmer (2000), significant improvements were found on the TOVA continuous performance test, as well as gains of 10 points in Verbal and Performance IQs.

A randomized, placebo, control group study done by Levesque, Beauregard and Mensour (2006) showed that with neurofeedback training, the experimental group of children with ADHD improved on neuropsychological measures as well as pre- post- fMRI measures of the anterior cingulate cortex, indicating that functional neuroanatomical changes occur with neurofeedback training.

Neurofeedback as a treatment model has expanded into Asian countries. In a study by Zhang, Zhang and Jin (2006), children with ADHD were randomly assigned to either a medication group (methylphenidate) or EEG biofeedback. They were rated pre- and post treatment, and at one, three and six month intervals. The EEG group showed substantially improved scores on the Conners Parent Rating Scale and at 6 month follow-up. In a study by Zhong-Gui, Hai-Qing, Shu-Hua, (2006), those children who did EEG biofeedback training showed significant improvements on the TOVA continuous performance test after 40 sessions.

Many more studies of improved functioning in ADHD can be found in other references (Bluschke et. al, 2016; Moss et. al, 2014; Lubar, 2003), and it has been shown that the positive results remain long after treatment has been completed (Thompson & Thompson, 2004; Monastra, 2003; Yucha & Montgomery, 2008; Lubar, 2003). In Yucha and Montgomery (2008), they conclude that the use of neurofeedback is strongly supported in the treatment of ADHD. This is despite the fact that treatment protocols vary widely. In addition, several studies have shown that the treatment effects last over time.

Professional Literature of Neurofeedback with ADD/ADHD & Learning Disabilities

The list of references below was taken from the professional neurofeedback organization at www.isnr.org. If you know of additions or corrections to this list, please e mail Dr. Larry Thomas, nurosvcs@aol.com.

Albert, AO, Andrasik, F, Moore, J & Dunn, BR (1998). Theta/beta training for attention, concentration and memory improvement in the geriatric population. *Applied Psychophysiology & Biofeedback*, 23 (2), 109. Abstract.

Alhambra, M, Fowler, T & Alhambra, A (1995). EEG biofeedback: A new treatment option for ADD/ADHD. *Journal of Neurotherapy*, 1 (2), 39-43.

Arns, M, Kleinnijenhuis, M, Fallahpour, K & Bretler, R (2007). Golf performance enhancement and real-life neurofeedback training using personalized event-locked EEG profiles. *Journal of Neurotherapy*, 11(4), 11-18.

Barabasz, A & Barabasz, M (1996). Neurotherapy and alert hypnosis in the treatment of attention deficit disorder. Chapter in S Lynn, I Kirsch & J Rhue (Eds.), *Casebook of Clinical Hypnosis*. Washington, DC: American Psychological Association Press, pp. 271-292.

Barabasz, A & Barabasz, M (2000). Treating AD/HD with hypnosis and neurotherapy.

Bazanov, O, Aftanas, L (2010). Individual EEG alpha activity analysis for enhancement neurofeedback efficiency: Two case studies. *Journal of Neurotherapy* 14(3), 244 ? 253.

Beauregard, M & Levesque, J. (2006). Functional magnetic resonance imaging investigation of the effects of neurofeedback training on the neural bases of selective attention and response inhibition in children with attention-deficit/hyperactivity disorder. *Applied Psychophysiology & Biofeedback*, 31 (1), 3-20.

- Becerra, J, Fernandez, T, Harmony T, Caballero M, Garcia F, Fernandez-Bouzas A, Santiago-Rodriguez E, Prado-Alcala R (2006). Follow-up study of Learning Disabled children treated with Neurofeedback or placebo. *Clinical EEG & Neuroscience*, 37(3), 198-203.
- Boyd, WD & Campbell, SE (1998). EEG biofeedback in the schools: The use of EEG biofeedback to treat ADHD in a school setting. *Journal of Neurotherapy*, 2 (4), 65-71.
- Breteler, M, Arns, M, Peters, S, Giepman, I & Verhoeven, L (2010). Improvements in spelling after QEEG-based neurofeedback in dyslexia: A randomized controlled treatment study. *Applied Psychophysiology & Biofeedback*, 35(1), 5-11.
- Budzynski, T (1996). Brain brightening: Can neurofeedback improve cognitive process? *Biofeedback*, 24(2), 14-17.
- Carmody, D, Radvanski, D, Wadhvani, S, Sabo, J & Vergara, L (2001). EEG biofeedback training and attention-deficit/hyperactivity disorder in an elementary school setting. *Journal of Neurotherapy*, 4 (3), 5-27.
- Carter, J & Russell, H (1991). Changes in verbal performance IQ discrepancy scores after left hemisphere frequency control training: A pilot report. *American Journal of Clinical Biofeedback*, 4(1), 66-67.
- Cunningham, M & Murphy, P (1981). The effects of bilateral EEG biofeedback on verbal, visuospatial and creative skills in LD male adolescents. *Journal of Learning Disabilities*, 14(4), 204-208.
- Drechsler R, Straub M, Doehnert, M, Heinrich H, Steinhausen H & Brandeis D. (2007). Controlled evaluation of a neurofeedback training of slow cortical potentials in children with ADHD. *Behavioral & Brain Functions*, 3, 35.
- Egner, T & Gruzelier, J (2001). Learned self-regulation of EEG frequency components affects attention and event-related brain potentials in humans. *NeuroReport*, 12, 4155-4159.
- Egner, T & Gruzelier, J (2004). EEG biofeedback of low beta band components: Frequency-specific effects on variables of attention and event-related brain potentials. *Clinical Neurophysiology*, 115 (1), 131-139.
- Fehmi, LG (2007). Multichannel EEG phase synchrony training and verbally guided attention training for disorders of attention. Chapter in J. R. Evans (Ed.), *Handbook of Neurofeedback*. Binghamton, NY: Haworth, pp. 301-319.
- Fehmi, LG (1978). EEG biofeedback, multichannel synchrony training, and attention. Chapter in AA Sugarman & RE Tarter (Eds.), *Expanding Dimensions of Consciousness*. NY: Springer.
- Fehmi, LG & Selzer, FA (1980). Biofeedback and attention training. Chapter in S. Boorstein (Ed.), *Transpersonal Psychotherapy*. Palo Alto: Science and Behavior Books.
- Fernandez, T, Herrera, W, Harmony, T, Diaz-Comas, L, Santiago, E, Sanchez, L, et al. (2003). EEG and behavioral changes following neurofeedback treatment in learning disabled children. *Clinical Electroencephalography*, 34(3), 145-150.
- Fleischman, M & Othmer, S (2005). Case study: Improvements in IQ score and maintenance of gains following EEG biofeedback with mildly developmentally delayed twins. *Journal of Neurotherapy*, 9(4), 35-46.
- 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 & Child Psychology*, 22 (3), 67-77.
- Fox, DJ, Tharp, D & Fox, LC (2005). Neurofeedback: An alternative and efficacious treatment for attention deficit hyperactivity disorder. *Applied Psychophysiology & Biofeedback*, 30 (4), 365-274.
- Fritson, K, Wadkins, T, Gerdes, P & Hof, D (2007). The impact of neurotherapy on college students' cognitive abilities and emotions. *Journal of Neurotherapy*, 11(4), 1-9.
- Fuchs, T, Birbaumer, N, Lutzenberger, W, Gruzelier, J & Kaiser, J (2003). Neurofeedback treatment for attention deficit/hyperactivity disorder in children: A comparison with methylphenidate. *Applied Psychophysiology and Biofeedback*, 28, 1-12.
- Gani C, Birbaumer N & Strehl U (2008). Long term effects after feedback of slow cortical potentials and of theta-beta amplitudes in children with attention-deficit/hyperactivity disorder(ADHD). *International Journal of Bioelectromagnetism*, 10 (4), 209-232.
- Hansen, LM, Trudeau, D & Grace, L (1996). Neurotherapy and drug therapy in combination for adult ADHD, personality disorder, and seizure. *Journal of Neurotherapy*, 2 (1), 6-14.
- Hirshberg, LM (2007). Place of electroencephalographic biofeedback for attention-deficit/hyperactivity disorder. *Expert Review of Neurotherapeutics*, 7 (4), 315-319.
- Jackson, GM & Eberly, DA (1982). Facilitation of performance on an arithmetic task as a result of the application of a biofeedback procedure to suppress alpha wave activity. *Biofeedback & Self-Regulation*, 7(2), 211-221.
- Jacobs, EH (2005). Neurofeedback treatment of two children with learning, attention, mood, social, and developmental deficits. *Journal of Neurotherapy*, 9 (4), 55-70.
- Kaiser, DA & Othmer, S. (2000). Effect of Neurofeedback on variables of attention in a large multi-center trial. *Journal of*

Neurotherapy, 4 (1), 5-15.

Kirk, L. (2007). Neurofeedback protocols for subtypes of attention deficit/hyperactivity disorder. Chapter in JR Evans (Ed.), *Handbook of Neurofeedback*. Binghamton, NY: Haworth Medical Press, pp. 267-299.

Kotwal, DB, Burns, WJ & Montgomery, D. D. (1996). Computer-assisted cognitive training for ADHD: A case study. *Behavior Modification*, 20(1), 85-96.

Kropotov, J, Grin-Yatsenko, V, Ponomarev, V, Chutko, L, Yakovenko, E & Nikishena, I (2007). Changes in EEG spectograms, event-related potentials and event-related desynchronization induced by relative beta training in ADHD children. *Journal of Neurotherapy*, 11 (2), 3-11.

Kropotov, J, Grin-Yatsenko, V, Ponomarev, V, Chutko, L, Yakovenko & E, Nildshena, I (2005). ERPs correlates of EEG relative beta training in ADHD children. *International Journal of Psychophysiology*, 55 (1), 23-34.

Kwon, H, Cho, J, Lee, E (2009). EEG asymmetry analysis of the left and right brain activities during simple versus complex arithmetic learning. *Journal of Neurotherapy* 13(2), 109 ? 116.

Leins, U, Goth, G, Hinterberger, T, Klingner, C, Rumpf, N & Strehl, U (2007). Neurofeedback for children with ADHD: A comparison of SCP and theta/beta protocols. *Applied Psychophysiology & Biofeedback*, 32 (2), 73-88.

Levesque, J, Beauregard, M & Mensour, B (2006). Effect of neurofeedback training on the neural substrates of selective attention in children with attention-deficit/hyperactivity disorder: a functional magnetic resonance imaging study. *Neuroscience Letters*, 394 (3), 216-221.

Linden, M, Habib, T & Radojevic, V. (1996). A controlled study of the effects of EEG biofeedback on cognition and behavior of children with attention deficit disorder and learning disabilities. *Biofeedback & Self-Regulation*, 2 1(1), 35-49.

Loo, S & Barkley, R (2005). Clinical utility of EEG in attention deficit hyperactivity disorder. *Applied Neuropsychology*, 12 (2), 64-76.

Lubar, J (1995). Neurofeedback for the management of attention-deficit/hyperactivity disorders. Chapter in M Schwartz (Ed.), *Biofeedback: A Practitioner's Guide*. NY, Guilford, 493-522.

Lubar, J (2003). Neurofeedback for the management of attention-deficit/hyperactivity disorders. Chapter in M. S. Schwartz & F. Andrasik (Eds.), *Biofeedback: A Practitioner's Guide (Third Edition)* NY, Guilford, 409-437.

Lubar, J & Lubar, J (1984). Electroencephalographic biofeedback of SMR and beta for treatment of attention deficit disorders in a clinical setting. *Biofeedback & Self-Regulation*, 9, 1-23.

Lubar, J.& Shouse, M (1976). EEG and behavioral changes in a hyperactive child concurrent with training of the sensorimotor rhythm (SMR): A preliminary report. *Biofeedback & Self-Regulation*, 1 (3), 293-306.

Lubar, J & Shouse, M (1977). Use of biofeedback in the treatment of seizure disorders and hyperactivity. *Advances in Clinical Child Psychology*, 1, 204-251.

Lubar, J, Swartwood, M, Swartwood, J & O'Donnell, P (1995). Evaluation of the effectiveness of EEG neurofeedback training for ADHD in a clinical setting as measured by changes in TOVA, scores, behavioral ratings, and WISC-R performance. *Biofeedback & Self-Regulation*, 20 (1), 83-99.

Lutzenberger W, Elbert T, Rockstroh B & Birbaumer N (1982). Biofeedback produced slow brain potentials and task performance. *Biological Psychology*, 14, 99-111.

McKnight, J & Fehmi, L (2001). Attention and neurofeedback synchrony training: Clinical results and their significance. *Journal of Neurotherapy*, 5 (1-2), 45-62.

Monastra, V (2005). Electroencephalographic biofeedback (neurotherapy) as a treatment for attention deficit hyperactivity disorder: Rationale and empirical foundation. *Child & Adolescent Psychiatric Clinics of North America*, 14 (1), 55-82.

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

Monastra, V, Monastra, D & George, S (2002). The effects of stimulant therapy, EEG biofeedback and parenting style on the primary symptoms of attention-deficit/hyperactivity disorder. *Applied Psychophysiology & Biofeedback*, 27(4), 231-249.

Mulholland, T, Goodman, D & Boudrot, R. (1983). Attention and regulation of EEG alpha- attenuation responses. *Biofeedback & Self-Regulation*, 8 (4), 585-600.

Nash, J (2000). Treatment of attention-deficit hyperactivity disorder with neurotherapy. *Clinical Electroencephalography*, 31 (1), 30-37.

Norris, S, Lee, C, Burshteyn, D & Cea-Aravena, J. (2001). The effects of performance enhancement training on hypertension, human attention, stress, and brain wave patterns: A case study. *Journal of Neurotherapy*, 4(3), 29-44.

- Norris, S, Lee, C, Cea, J & Burshteyn, D. (1998). Performance enhancement training effects on attention: A case study. *Journal of Neurotherapy*, 3 (1), 19-25.
- Othmer, S, Othmer, S & Kaiser, DA (1999). EEG biofeedback: Training for AD/HD and related disruptive behavior disorders. Chapter in J Incorvaia, B Mark-Goldstein & D Tessmer (Eds.), *Understanding, Diagnosing, & Treating AD/HD in Children and Adolescents*. NY: Aronson, 235-297.
- Orlando, P & Rivera, R (2004). Neurofeedback for elementary students with identified learning problems. *Journal of Neurotherapy*, 8(2), 5-19.
- Patrick, G (1996). Improved neuronal regulation in ADHD: An application of 15 sessions of photic-driven EEG neurotherapy. *Journal of Neurotherapy*, 1(4), 27-36.
- Perreau-Linck, E, Lessard, N, Lévesque, J, Beauregard, M (2010). Effects of neurofeedback training on inhibitory capacities in ADHD children: A single-blind, randomized, placebo-controlled study. *Journal of Neurotherapy* 14(3), 229 -242.
- Pratt, RR, Abel, H & Skidmore, J (1995). The effects of neurofeedback training with background music on EEG patterns of ADD and ADHD children. *International Jrnal of Arts Medicine*, 4 (1), 24-31.
- Putnam, J, Othmer, S, Othmer, S & Pollock, V (2005). TOVA results following interhemispheric bipolar EEG training. *Journal of Neurotherapy*, 9(1), 37-52.
- Pulvermuller, F, Mohr, B, Schleichert, H & Veit, R (2000). Operant conditioning of left-hemispheric slow cortical potentials and its effect on word processing. *Biological Psychology*, 53, 177-215.
- Rasey, H, Lubar, J, McIntyre, A, Zoffuto, A & Abbott, P (1996). EEG biofeedback for the enhancement of attentional processing in normal college students. *Journal of Neurotherapy*, 1(3), 15-21.
- Rockstroh, B, Elbert, T, Lutzenberger, W & Birbaumer, N (1990). Biofeedback: Evaluation and therapy in children with attentional dysfunction. Chapter in A. Rothenberger (Ed.), *Brain and Behaviour in Child Psychiatry*. Berlin: Springer Verlag, pp. 345-357.
- Rossiter, T (2004). The effectiveness of neurofeedback and stimulant drugs in treating AD/HD: Part I. Review of methodological issues. *Applied Psychophysiology & Biofeedback*, 29 (2), 135-140.
- Rossiter, T (2005). The effectiveness of neurofeedback and stimulant drugs in treating AD/HD: Part II. Replication. *Applied Psychophysiology & Biofeedback*, 29 (4), 233-243.
- Rossiter, T (2002). Neurofeedback for AD/HD: A ratio feedback case study. *Journal of Neurotherapy*, 6 (3), 9-35.
- Rossiter, T (1998). Patient directed neurofeedback for ADHD. *Journal of Neurotherapy*, 2 (4), 54-63.
- Rossiter, T & La Vaque, T (1995). A comparison of EEG biofeedback and psychostimulants in treating attention deficit/hyperactivity disorders. *Journal of Neurotherapy*, 1, 48-59.
- Russell, H & Carter, J (1997). EEG Driven Audio-Visual Stimulation Unit for Enhancing Cognitive Abilities of Learning Disordered Boys: Final Report. Washington, D.C.: U.S. Department of Education (SBIR), Contract number RA94130002.
- Scheinbaum, S, Zecker, S, Newton, CJ & Rosenfeld, P (1995). A controlled study of EEG biofeedback as a treatment for attention-deficit disorders. In *Proceedings of the 26th Annual Meeting of the Association for Applied Psychophysiology and Biofeedback*, pp. 131-134.
- Sheer, D (1975). Biofeedback training of 40-Hz EEG and behavior. Chapter in N Burch & H Altshuler (Eds.), *Behavior and Brain Electrical Activity*. NY: Plenum.
- Sheer, D (1977). Biofeedback training of 40-Hz EEG and behavior. Chapter in J. Kamiya et al., *Biofeedback and Self-Control 1976/1977. An Annual Review*. Chicago: Aldine.
- Shin, D, Lee, J, Lee, S, Kim, I & Kim, S (2004). Neurofeedback training with virtual reality for inattention and impulsiveness. *Cyberpsychology & Behavior*, 7 (5), 519-526.
- Shouse, M & Lubar, J (1979). Operant conditioning of EEG rhythms and Ritalin in the treatment of hyperkinesis. *Biofeedback & Self-Regulation*, 4 (4), 299-311.
- Stankus, T (2008). Can the brain be trained? Comparing the literature on the use of EEG biofeedback/ neurofeedback as an alternative or complementary therapy for attention deficit disorder. *Behavioral & Social Sciences Librarian*, 26 (4), 20-56.
- Strehl, U, Leins, U, Goth, G, Klinger, C, Hinterberger, T & Birbaumer, N (2006). Self-regulation of slow cortical potentials: A new treatment for children with attention-deficit/hyperactivity disorder. *Pediatrics*, 118, 1530-1540.
- Swingle, P (2001). Parameters associated with rapid neurotherapeutic treatment of common ADD (CADD). *Journal of Neurotherapy*, 5(4), 73-84.
- Swingle, P (1996). Sub threshold 10-Hz sound suppresses EEG theta: Clinical application for the potentiation of neurotherapeutic treatment of ADD/ADHD. *Journal of Neurotherapy*, 2 (1), 15-22.

- Tansey, M (1984). EEG sensorimotor rhythm biofeedback training: Some effects on the neurological precursors of learning disabilities. *International Journal of Psychophysiology*, 3, 85-99.
- Tansey, M (1990). Righting the rhythms of reason: EEG biofeedback training as a therapeutic modality in a clinical office setting. *Medical Psychotherapy*, 3, 57-68.
- Tansey, M (1991). Wechsler (WISC-R) changes following treatment of learning disabilities via EEG biofeedback in a private practice setting. *Australian Journal of Psychology*, 43, 147-153.
- Tansey, M & Bruner, R (1983). EMG and EEG biofeedback training in the treatment of 10-year old hyperactive boy with a developmental reading disorder. *Biofeedback & Self-Regulation*, 8(1), 25-37.
- Tansey, M (1985). Brainwave signatures--An index reflective of the brain's functional neuroanatomy: Further findings on the effect of EEG sensorimotor rhythm biofeedback training on the neurologic precursors of learning disabilities. *International Jnl of Psychophysiology*, 3, 85-89.
- Tansey, M (1993). Ten-year stability of EEG biofeedback results for a hyperactive boy who failed fourth grade perceptually impaired class. *Biofeedback & Self-Regulation*, 18, 33-44.
- Thomas, J (2011). Brain brightening: Neurotherapy for enhancing cognition in the elderly. In P Hartman-Stein & A LaRue (Eds.) *Enhancing Cognitive Fitness in Adults*, NY: Springer.
- Thomas, J (in press) Neurofeedback: A new modality for treating brain problems, *Archives of medical psychology*.
- Thompson, L & Thompson, M (1998). Neurofeedback combined with training in metacognitive strategies: Effectiveness in students with ADD. *Applied Psychophysiology & Biofeedback*, 23 (4), 243-263.
- Thornton, K & Carmody, D (2005). Electroencephalogram biofeedback for reading disability and traumatic brain injury. *Child & Adolescent Psychiatric Clinics of North America*, 14(1), 137-162.
- Tinius, T & Tinius, K (2001). Changes after EEG biofeedback and cognitive retraining in adults with mild traumatic brain injury and attention deficit disorder. *Journal of Neurotherapy*, 4 (2), 27-44.
- Vachon-Preseau, E Achim, A & Benoit-Lajoie, A (2009). Direction of SMR and beta change with attention in adults. *Journal of Neurotherapy* 13(1), 22 ? 29.
- Valdez, M (1985). Effects of biofeedback-assisted attention training in a college population. *Biofeedback & Self-Regulation*, 10 (4), 315-324.
- Vernon, D, Egner, T Cooper, N Compton, T, Neilands, C, Sheri, A & Gruzelier, J (2003). The effect of training distinct neurofeedback protocols on aspects of cognitive performance. *International Jnl of Psychophysiology*, 47, 75-85.
- Wadhvani, S, Radvanski, D & Carmody, D (1998). Neurofeedback training in a case of attention deficit hyperactivity disorder. *Journal of Neurotherapy*, 3 (1), 42-49.
- Walker, J & Norman, C (2006). The neurophysiology of dyslexia: A selective review with implications for neurofeedback remediation and results of treatment in twelve consecutive patients. *Journal of Neurotherapy*, 10(1), 45-55.
- Warner, D, Barabasz, A & Barabasz, M (2000). The efficacy of Barabasz's alert hypnosis and neurotherapy on attentiveness, impulsivity and hyperactivity in children with ADHD. *Child Study Journal*, 30 (1), 43-49.
- Williams, J (2010). Does neurofeedback help reduce attention-deficit hyperactivity disorder? *Journal of Neurotherapy*, 14(4), 261-279.
- Xiong, Z, Shi, S & Xu, H. (2005). A controlled study of the effectiveness of EEG biofeedback training on children with attention deficit hyperactivity disorder. *Journal of Huazhong University of Science & Technology*, 25 (3), 368-370.

ref: Biofeedback for ADD

ADD Evaluations

Biofeedback Articles