

# *A Comprehensive Neurofeedback Bibliography*

*on*

## ***ADD/ADHD***

**by**

**D. Corydon Hammond, PhD**

Professor, Physical Medicine & Rehabilitation  
University of Utah School of Medicine

Frank H. Duffy, M.D., Professor and Pediatric Neurologist at Harvard Medical School, stated in an editorial in the January 2000 issue of the journal Clinical Electroencephalography that the scholarly literature suggests that neurofeedback should play a major therapeutic role in many difficult areas. In speaking about Neurofeedback Dr Duffy said, "In my opinion, if any medication had demonstrated such a wide spectrum of efficacy it would be universally accepted and widely used" (p. v). "It is a field to be taken seriously by all." (p. vii).

The references below are primarily outcome studies and case reports, with an occasional reference to significant conceptual papers or reviews. References will occasionally appear under more than one problem area when the paper deals with more than one disorder.

Nu-Brain International has collected a number of Abstracts and References that are included in this list of research on ADD and ADHD

**Alphabetically Indexed**

**By First Author**

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

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

## EEG Biofeedback: A New Treatment Option For ADD/ADHD

**Marabella A. Alhambra, M.D., Timothy P. Fowler, and Antonio A. Alhambra, M.D.**

*Attention Deficit Disorder is commonly treated with stimulant medications such as Ritalin (methylphenidate). However, this medication has short-term effects and numerous undesirable side effects including insomnia and loss of appetite. This study explores using EEG biofeedback, with its minimal side effects and long-term results, as an alternative to pharmacological treatments for ADD.*

### DISCUSSION

This study evaluates the effect of EEG biofeedback by subjective and objective parameters. Subjective observations from parents showed 86% improvement. There is a good correlation of observed clinical improvement to TOVA score improvement (74%) and changes in QEEG parameters (78%).

Clinical assessment of outcome was conducted 0 to 12 months after completion of the EEG biofeedback sessions. Long term effects or sustained benefits, therefore, could not be evaluated from this study.

Parameters predictive of benefits from EEG biofeedback will be helpful in clinical practice, especially during this era of managed health care. This is beyond the scope of this study. Future studies should address this important issue

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

Eighteen children and one young adult who met the DSM-IV diagnostic criteria for ADHD were treated using Barabasz' alert hypnosis instantaneous neuronal activation procedure (INAP) as an adjunct to neurotherapy. Pre- and posttest means on each subscale (Inattentive, Impulsive and Hyperactive) of the Attention Deficit Disorders Evaluation Scale -- Home Version were compared using a t test

for dependent samples. For each subscale, the mean posttest score was significantly lower than the mean pretest score,  $p < .001$ , indicating parents reported fewer incidents of inattentive, impulsive and hyperactive behaviors in their children following treatment. Ratings provided by the therapist also suggested improvement in the self-monitoring behaviors of the majority of clients, with five of the children no longer meeting the DSM-IV diagnostic criteria for ADHD.

Several threats to internal validity are noted as a result of not having a comparison group, and outcomes cannot be generalized beyond the specific therapist providing the intervention in this study. Nevertheless, the findings are sufficiently impressive to suggest the need for further investigations into the efficacy of the alert hypnosis procedure (INAP) introduced.

Anderson and Barabasz (1999) and Anderson, Barabasz, Barabasz, & Warner (2000, this issue) have reported that the beta-theta EEG ratios of children with attention deficit hyperactivity disorder were higher following Barabasz' alert hypnosis instantaneous neuronal activation procedure (INAP) treatment as part of neurotherapy than at times when neurotherapy was used alone. Because high levels of theta rather than beta EEG brain waves have been associated with lowered attention and concentration, INAP, used as an adjunctive technique with traditional neurotherapy, was judged to be a useful addition in teaching ADHD children to control their brain wave production and, thereby, their levels of attention and concentration.

In addition to EEG data, Arreed Barabasz, who treated the children with ADHD in the study reported by Anderson et al. (2000, this issue), collected data regarding changes in his client's adaptive behavior. The purpose of this paper is to report findings related to those behavioral changes.

**Barabasz, A., & Barabasz, M. (2000). Treating AD/HD with hypnosis and neurotherapy. Child Study Journal, 30(1), 25-42.**

Title: TREATING AD/HD WITH HYPNOSIS AND NEUROTHERAPY.

Authors: [Barabasz, Arreed](#)  
[Barabasz, Marianne](#)

Source: [Child Study Journal](#); 2000, Vol. 30 Issue 1, p25, 18p

Document Type: Article

Subject Terms: \*[ATTENTION-deficit hyperactivity disorder](#)

[\\*HYPNOTISM -- Therapeutic use Treatment](#)

Abstract: Details the Instant Alert Hypnosis procedure or Instantaneous Neuronal Activation Procedure as an adjunct to neurotherapy in the treatment of attention deficit/hyperactivity disorder. Overdiagnosis and complications with traditional diagnostic procedures; Need for diagnostic and treatment advances derived from the neurological basis of the disorder; Efficacy and promise of neurotherapy.

Full Text Word Count: 6628

ISSN: 0009-4005

Accession Number: 3735817

Persistent link to this record: <http://0-search.epnet.com.library.lib.asu.edu:80/login.aspx?direct=true&db=aph&an=3735817>

**Boyd, W. D., & Campbell, S. E. (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.**

## **EEG BIOFEEDBACK IN THE SCHOOLS The Use of EEG Biofeedback to Treat ADHD in a School Setting**

William D. Boyd Advanced Neuropsychology, Inc., Denver, Colorado  
Susan E. Campbell Converse County School District #1, Douglas,  
Wyoming

*Six middle school students diagnosed with attention deficit/hyperactivity disorder were selected for sensorimotor rhythm (SMR) training with EEG biofeedback. The subjects were evaluated following a 72-hour drug-free period with the WISC-III Digit Span subtest and the Test of Variables of Attention (TOVA). Five of the subjects received 20 sessions of EEG biofeedback and one of the subjects received nine sessions of EEG biofeedback. The subjects were evaluated again following a 72-hour drug-free period. Five of the six subjects improved on their combined Digit Span, TOVA Inattention, and TOVA Impulsivity scores. These results supported previous findings that EEG biofeedback can be effective in the treatment of attention deficit/hyperactivity disorder. More importantly, this study demonstrated that EEG biofeedback could be used in an actual school*

*setting. Recommendations for implementing an EEG biofeedback program in the schools were provided.*

**Budzynski, T. H. (1996). Brain brightening: Can neurofeedback improve cognitive process? Biofeedback, 24(2), 14-17.**

**Carmody, D. P., Radvanski, D. C., Wadhvani, S., Sabo, J. J., & Vergara, L. (2001). EEG biofeedback training and attention-deficit/hyperactivity disorder in an elementary school setting. Journal of Neurotherapy, 4(3), 5-27.**

### **EEG Biofeedback Training and Attention-Deficit/Hyperactivity Disorder In an Elementary School Setting**

Dennis P. Carmody, PhD, Diane C. Radvanski, BS, Sonia Wadhvani, BS, Mary Jo Sabo, PhD, Linda Vergara, MS

Background: EEG biofeedback was conducted on site in an elementary school.

Method: An experimental group of eight children ages 8-10 completed 35-47 sessions of EEG biofeedback training over a six-month period. Four participants in the experimental group were diagnosed with Attention-Deficit/Hyperactivity Disorder (ADHD) and four were not diagnosed with ADHD. Eight children in the waitlist control group were matched to the experimental group on age, grade, teacher, and diagnosis. None of the 16 participants were medicated for ADHD.

Results: Attention abilities as measured by the Test of Variables of Attention showed the experimental group of children with ADHD reduced errors of commission and anticipation, indicating a reduction in impulsivity. Teacher reports using the McCarney Scale indicated improvements in attention but no changes in impulsivity and hyperactivity.

Discussion: Several confounds require exploration before attribution of changes are assigned to neurofeedback. Whether the effects are due to the neurofeedback protocols, attendance at individual sessions away from the classroom, the attention of the technician, or the excitement of a special program cannot be determined with this study. It will be necessary to have a placebo group in order to separate systematically the variables in the training program.

**KEYWORDS.** control group, McCarney Scale, neurofeedback, variables of attention

Carter, J. L., & Russell, H. L. (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.

Egner, T., & Gruzelier, J. H. (2001). Learned self-regulation of EEG frequency components affects attention and event-related brain potentials in humans. [NeuroReport](#), [12](#), 4155-4159.

Neuroreport. 2001 Dec 21;12(18):4155-9.

[Related Articles,](#)

[Links](#)



## **Learned self-regulation of EEG frequency components affects attention and event-related brain potentials in humans.**

**Egner T, Gruzelier JH.**

Department of Cognitive Neuroscience and Behaviour, Faculty of Medicine  
Imperial College of Science, Technology and Medicine, St Dunstan's Rd, London  
W6 8RF, UK.

Learned enhancement of EEG frequency components in the lower beta range by means of biofeedback has been reported to alleviate attention deficit hyperactivity disorder (ADHD) symptoms. In order to elucidate frequency-specific behavioural effects and neurophysiological mediators, this study applied neurofeedback protocols to healthy volunteers, and assessed impact on behavioural and electrocortical attention measures. Operant enhancement of a 12-15 Hz component was associated with reduction in commission errors and improved perceptual sensitivity on a continuous performance task (CPT), while the opposite relation was found for 15-18 Hz enhancement. Both 12-15 Hz and 15-18 Hz enhancement were associated with significant increases in P300 event-related brain potential amplitudes in an auditory oddball task. These relations are interpreted as stemming from band-specific effects on perceptual and motor aspects of attention measures.

PMID: 11742256 [PubMed - indexed for MEDLINE]

Fehmi, L. G. (1978). EEG biofeedback, multichannel synchrony training, and attention. Chapter in A. A. Sugarman & R. E. Tarter (Eds.), Expanding Dimensions of Consciousness. New York: Springer.

Fehmi, L. G., & Selzer, F. A. (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., Bosch, J., Fernandez-Bouzas, A., Otero, G., Ricardo-Garcell, J., Barraza, C., Aubert, E., Galan, L., & Valdes, P. (2003). EEG and behavioral changes following neurofeedback treatment in learning disabled children. Clinical Electroencephalography, 34(3), 145-150.

« 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, 28, 1-12.

Hansen, L. M., 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.

**Neurotherapy and Drug Therapy in Combination  
for Adult ADHD, Personality Disorder and Seizure Disorder:  
A Case Report.**

**Lisa M. Hansen, B.S., David L. Trudeau, M.D., and Dixie L. Grace Ph.D.**

*This is a case report of an adult female patient with ADHD, temporal seizure disorder, and Borderline Personality Disorder treated with 30 weekly sessions of SMR neurofeedback and carbamazepine. Post treatment measures showed improvements in*

*T.O.V.A., self report and QEEG. Both neurofeedback and carbamazepine showed the most effect in early treatment. Progress continued after discontinuance of the drug.*

**Jackson, G. M., & Eberly, D. A. (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.**

Biofeedback Self Regul. 1982 Jun;7(2):211-21.

[Related Articles,](#)

[Links](#)

### **Facilitation of performance on an arithmetic task as a result of the application of a biofeedback procedure to suppress alpha wave activity.**

**Jackson GM, Eberly DA.**

An electroencephalographic (EEG) biofeedback procedure was used in a pilot study to decrease the percent of time in alpha wave activity with five mentally retarded adults while engaged in an arithmetic test. Analysis of intrasubject and intersubject data revealed an overall significant decrease in the number of alpha events and percent of time in alpha wave activity as compared to baseline conditions. Such a decrease indicated facilitated attention by EEG definition. A collateral increase in percent of problems completed correctly and decrease in the number of distractible head-turning responses were noted. An automated method of determining head position was used and shown to be reliable in comparison to a human observer.

PMID: 7138953 [PubMed - indexed for MEDLINE]

**Kaiser, D. A., & Othmer, S. (2000). Effect of Neurofeedback on variables of attention in a large multi-center trial. Journal of Neurotherapy, 4(1), 5-15.**

### **Effect of Neurofeedback on Variables of Attention in a Large Multi-Center Trial**

David A. Kaiser, Ph.D. and Siegfried Othmer, Ph.D.

Background. Neurofeedback studies have been criticized for including small numbers of subjects. The effect of SMR-beta neurofeedback training on the Test of Variables of Attention was evaluated in more than 1,000 subjects from thirty-two clinics.



Methods: 1089 subjects (726 children, 324 females, 186 with ADHD or ADD diagnoses) underwent twenty or more sessions of SMR-beta neurofeedback training for attentional and behavioral complaints at thirty-two clinical settings affiliated with EEG Spectrum, Inc. Subjects were evaluated prior to training and at training completion. One hundred and fifty-seven subjects who elected extensive training (forty sessions or more) were tested after both twenty and forty training sessions.

Results: Neurofeedback training produced significant improvement in attentiveness, impulse control, and response variability. Significant clinical improvement in one or more measures was seen in eighty-five percent of those subjects with moderate pre-training deficits.

Conclusions: Neurofeedback training is effective in remediating attentional dysfunction. Nevertheless, large-scale studies with greater control (e.g., wait-list designs) are sorely needed.

KEYWORDS: Neurofeedback, EEG biofeedback, Attention, multi-center, outcome, TOVA

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

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

### **Abstract**

Eighty-six children (ages 9–14) with attention deficit hyperactivity disorder (ADHD) participated in this study. Event-related potentials (ERPs) were recorded in auditory GO/NOGO task before and after 15–22 sessions of EEG biofeedback. Each session consisted of 20 min of enhancing the ratio of the EEG power in 15–18 Hz band to the EEG power in the rest of spectrum, and 7–10 min of enhancing of the ratio of the EEG power in 12–15 Hz to the EEG power in the rest of spectrum with C3-Fz electrodes' placements for the first protocol and C4-Pz for the second protocol. On the basis of quality of performance during training sessions, the patients were divided into two groups: good performers and bad performers. ERPs of good performers to GO and NOGO cues gained positive components evoked within 180–420 ms latency. At the same time, no statistically significant differences between pre- and post-training ERPs were

observed for bad performers. The ERP differences between post- and pretreatment conditions for good performers were distributed over frontal–central areas and appear to reflect an activation of frontal cortical areas associated with beta training.

**Author Keywords:** Attention deficit hyperactivity disorder; Executive functions; Event-related potentials; GO/NOGO paradigm; EEG biofeedback (neurofeedback); Beta training; SMR training

**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, 21(1), 35-49.**

Biofeedback Self Regul. 1996 Mar;21(1):35-49.

[Related Articles.](#)

[Links](#)

Erratum in:

- 1996 Sep;21(3):297.

### **A controlled study of the effects of EEG biofeedback on cognition and behavior of children with attention deficit disorder and learning disabilities.**

**Linden M, Habib T, Radojevic V.**

Mission Psychological Consultants, San Juan Capistrano, California 92675, USA.

Eighteen children with ADD/ADHD, some of whom were also LD, ranging in ages from 5 through 15 were randomly assigned to one of two conditions. The experimental condition consisted of 40 45-minute sessions of training in enhancing beta activity and suppressing theta activity, spaced over 6 months. The control condition, waiting list group, received no EEG biofeedback. No other psychological treatment or medication was administered to any subjects. All subjects were measured at pretreatment and at posttreatment on an IQ test and parent behavior rating scales for inattention, hyperactivity, and aggressive/defiant (oppositional) behaviors. At posttreatment the experimental group demonstrated a significant increase (mean of 9 points) on the K-Bit IQ Composite as compared to the control group ( $p < .05$ ). The experimental group also significantly reduced inattentive behaviors as rated by parents ( $p < .05$ ). The significant improvements in intellectual functioning and attentive behaviors might be explained as a result of the attentional enhancement

affected by EEG biofeedback training. Further research utilizing improved data collection and analysis, more stringent control groups, and larger sample sizes are needed to support and replicate these findings.

Publication Types:

- Clinical Trial
- Randomized Controlled Trial

PMID: 8833315 [PubMed - indexed for MEDLINE]

**Lubar, J. F. (1985). EEG biofeedback and learning disabilities. Theory into Practice, 26, 106-111**

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

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

Biofeedback Self Regul. 1984 Mar;9(1):1-23.

[Related Articles](#),

[Links](#)

### **Electroencephalographic biofeedback of SMR and beta for treatment of attention deficit disorders in a clinical setting.**

**Lubar JO, Lubar JF.**

Six children were provided with long-term biofeedback and academic treatment for attention deficit disorders. Their symptoms were primarily specific learning disabilities, and, in some cases, there were varying degrees of hyperkinesis. The training consisted of two sessions per week for 10 to 27 months, with a gradual phase-out. Feedback was provided for either increasing 12- to 15-Hz SMR or 16- to 20-Hz beta activity. Inhibit circuits were employed for blocking the SMR or beta when either gross movement, excessive EMG, or theta (4-8 Hz) activity was present. Treatment also consisted of combining the biofeedback with academic training, including reading, arithmetic, and spatial tasks to improve their attention. All children increased SMR or beta and decreased slow EEG and EMG activity.

Changes could be seen in their power spectra after training in terms of increased beta and decreased slow activity. All six children demonstrated considerable improvement in their schoolwork in terms of grades or achievement test scores. None of the children are currently on any medications for hyperkinetic behavior. The results indicate that EEG biofeedback training, if applied comprehensively, can be highly effective in helping to remediate children who are experiencing attention deficit disorders.

Publication Types:

- Case Reports

PMID: 6487671 [PubMed - indexed for MEDLINE]

**Lubar, J. F., & Shouse, M. N. (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.**

Biofeedback Self Regul. 1976 Sep;1(3):293-306.

[Related Articles](#),

[Links](#)

**EEG and behavioral changes in a hyperkinetic child concurrent with training of the sensorimotor rhythm (SMR): a preliminary report.**

**Lubar JF, Shouse MN.**

Reduced seizure incidence coupled with voluntary motor inhibition accompanied conditioned increases in the sensorimotor rhythm (SMR), a 12- 14 Hz rhythm appearing over rolandic cortex. Although SMR biofeedback training has been successfully applied to various forms of epilepsy in humans, its potential use in decreasing hyperactivity has been limited to a few cases in which a seizure history was also a significant feature. The present study represents a first attempt to explore the technique's applicability to the problem of hyperkinesis independent of the epilepsy issue. The results of several months of EEG biofeedback training in a hyperkinetic child tend to corroborate and extend previous findings. Feedback presentations for SMR were contingent on the production of 12- 14-Hz activity in the absence of 4- 7-Hz slow-wave activity. A substantial increase in SMR motor inhibition, as gauged by laboratory measures of muscular tone (chin EMG) and by a global behavioral assessment in the classroom. Opposite trends in motor inhibition occurred when the training procedure was reversed and feedback presentations were contingent on the production of 4- 7 Hz in the absence of 12-14-Hz activity. Although the preliminary nature of these results is stressed, the

subject population has recently been increased to establish the validity and generality of the findings and will include the use of SMR biofeedback training after medication has been withdrawn.

PMID: 990355 [PubMed - indexed for MEDLINE]

**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(1), 83-99.**

Biofeedback Self Regul. 1995 Mar;20(1):83-99.

[Related Articles,](#)

[Links](#)

**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.**

**Lubar JF, Swartwood MO, Swartwood JN, O'Donnell PH.**

University of Tennessee, Knoxville 37996-0900, USA.

A study with three component parts was performed to assess the effectiveness of neurofeedback treatment for Attention Deficit/Hyperactivity Disorder (ADHD). The subject pool consisted of 23 children and adolescents ranging in age from 8 to 19 years with a mean of 11.4 years who participated in a 2- to 3-month summer program of intensive neurofeedback training. Feedback was contingent on the production of 16-20 hertz (beta) activity in the absence of 4-8 hertz (theta) activity. Posttraining changes in EEG activity, T.O.V.A. performance, (ADDES) behavior ratings, and WISC-R performance were assessed. Part I indicated that subjects who successfully decreased theta activity showed significant improvement in T.O.V.A. performance; Part II revealed significant improvement in parent ratings following neurofeedback training; and Part III indicated significant increases in WISC-R scores following neurofeedback training. This study is significant in that it examines the effects of neurofeedback training on both objective and subjective measures under relatively controlled conditions. Our findings corroborate and extend previous research, indicating that neurofeedback training can be an appropriate and efficacious treatment for children with ADHD.

Publication Types:

- Clinical Trial
- Randomized Controlled Trial

PMID: 7786929 [PubMed - indexed for MEDLINE]

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

Biol Psychol. 1982 Feb-Mar;14(1-2):99-111.

[Related Articles.](#)

[Links](#)

### **Biofeedback produced slow brain potentials and task performance.**

**Lutzenberger W, Elbert T, Rockstroh B, Birbaumer N.**

Twenty subjects learned to control slow potential (SP) shifts of the brain by means of a biofeedback procedure. Depending upon the pitch of a signal tone, negative SP shifts had to be increased or reduced during intervals of 6 sec each. Visual feedback of the actual SP shift was given. Blocks of training trials alternated with blocks of test trials without any feedback of the SPs. At the end of every test trial a simple arithmetic problem had to be solved by the subjects. Subjects performed the computation in a shorter time interval if an increased negativity preceded task onset as compared to slower response times during suppression of negativity. Results suggest that cortical negativity reflects unspecific preparation for cerebral performance.

PMID: 7104426 [PubMed - indexed for MEDLINE]

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

### **Attention and Neurofeedback Synchrony Training: Clinical Results and Their Significance**

J. T. McKnight, PhD

L. G. Fehmi, PhD

Background. Previous research on information processing by the primate brain prompted further investigation of phase synchronized alpha brain wave activity at five loci in humans. The results of this investigation indicated that a particular form of attention was associated with production of whole brain synchrony.

Method. Patients were treated with a dual approach, a systematic program of attention training coupled with the regular practice of multi channel alpha phase synchrony training. One hundred thirty-two clinical patients were treated for a variety of stress related symptom categories by six therapists in different locations. Patients were rated for symptom intensity, frequency and duration.

Results. It was found that learning to develop this particular form of attention, coupled with the regular practice of multi channel alpha phase synchrony were effective in resolving many common stress related disorders. Analysis of 132 cases using this dual approach found that more than 90 percent of the patients reported an alleviation of symptoms. These positive results were found with stress-induced headache, joint pain, and gastrointestinal disease.

Conclusion. The authors propose that there exists a common mechanism operating in these widely different successful applications; to wit, attentional flexibility, which is achieved through systematic practice of audio taped attention exercises and neurofeedback phase synchrony training. Patients who participated in this program generally reported experiencing a release from their symptoms and from emotional conditioned responses in favor of more flexibility and more stable homeostasis. The significance of this "release experience" is discussed and attention-neurofeedback training is compared to other interventions, which rely exclusively on peripheral modalities of biofeedback training.

KEYWORDS. Attention, biofeedback, neurofeedback, EEG phase synchrony, headaches, hypertension, irritable bowel syndrome, dissolving pain

**Monastra, V. J., (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. J., Monastra, D. M., & 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.**

Appl Psychophysiol Biofeedback. 2002 Dec;27(4):231-49.

[Related Articles,](#)

[Links](#)

**The effects of stimulant therapy, EEG biofeedback, and parenting style on the primary symptoms of attention-deficit/hyperactivity disorder.**

**Monastra VJ, Monastra DM, George S.**

FPI Attention Disorders Clinic, 2102 E. Main Street, Endicott, New York 13760, USA. poppidoc@aol.com

One hundred children, ages 6-19, who were diagnosed with attention-deficit/hyperactivity disorder (ADHD), either inattentive or combined types, participated in a study examining the effects of Ritalin, EEG biofeedback, and parenting style on the primary symptoms of ADHD. All of the patients participated in a 1-year, multimodal, outpatient program that included Ritalin, parent counseling, and academic support at school (either a 504 Plan or an IEP). Fifty-one of the participants also received EEG biofeedback therapy. Posttreatment assessments were conducted both with and without stimulant therapy. Significant improvement was noted on the Test of Variables of Attention (TOVA; L. M. Greenberg, 1996) and the Attention Deficit Disorders Evaluation Scale (ADDES; S. B. McCarney, 1995) when participants were tested while using Ritalin. However, only those who had received EEG biofeedback sustained these gains when tested without Ritalin. The results of a Quantitative Electroencephalographic Scanning Process (QEEG-Scan; V. J. Monastra et al., 1999) revealed significant reduction in cortical slowing only in patients who had received EEG biofeedback. Behavioral measures indicated that parenting style exerted a significant moderating effect on the expression of behavioral symptoms at home but not at school.

Publication Types:

- Clinical Trial

PMID: 12557451 [PubMed - indexed for MEDLINE]

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

Biofeedback Self Regul. 1983 Dec;8(4):585-600.

[Related Articles,](#)

[Links](#)

**Attention and regulation of EEG alpha-attenuation responses.**

**Mulholland T, Goodman D, Boudrot R.**

Two experiments with 16 normal adults of both sexes tested the hypothesis that inattention to a biofeedback display is associated with increased variability of those physiological processes that had been regulated by the biofeedback. Each



experiment was a repeated-measures-on-independent-subjects-design. Dependent variables were the time durations and the mean rms power of two mutually exclusive segments of the parietal-occipital EEG: alpha and not-alpha segments. Independent variables were combination of counting tasks and instructions to look at, listen to, and count visual and auditory flashes and clicks. The durations of alpha and not-alpha segments were controlled or regulated by means of an alpha-contingent visual feedback stimulus. Attention to the feedback stimulus was challenged by instructions to count other, noncontingent stimuli. Control of alpha and not-alpha segments was least for conditions of (1) "sham" feedback, and (2) feedback with instructions to count noncontingent auditory clicks, which were presented 3/sec while the feedback visual stimuli were occurring. A new EEG test of attention and distraction was suggested.

PMID: 6675733 [PubMed - indexed for MEDLINE]

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

Clin Electroencephalogr. 2000 Jan;31(1):30-7.

[Related Articles.](#)

[Links](#)

## **Treatment of attention deficit hyperactivity disorder with neurotherapy.**

**Nash JK.**

Behavioral Medicine Associates, Inc., MN 55434, USA.

Significant public health concerns exist regarding our current level of success in treating ADHD. Medication management is very helpful in 60-70% of patients. Side effects, lack of compliance and the fact that stimulant medications cannot be given late in the day limit the benefits largely to school hours. While stimulants improve behavior and attention, less of an effect has been noted on academic and social performance. Continuing concerns exist about long-term safety, and studies on long-term cardiovascular and neurophysiological effects have not been carried out. Neurotherapy for ADHD offers an effective alternate for patients whose treatment is limited by side effects, poor medication response and in cases in which the patients and/or their parents refuse to consider medications. Studies indicate clinical improvement is largely related to measurable improvements in the EEG signature, evidenced by declining theta/beta ratios over frontal/central cortex and/or reduced theta/alpha band amplitudes.

Publication Types:

- Review
- Review, Tutorial

PMID: 10638350 [PubMed - indexed for MEDLINE]

**Norris, S. L., Lee, C-T., 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.**

**The Effects of Performance Enhancement Training on Hypertension, Human Attention, Stress and Brain Wave Patterns: A Case Study**

S. Louise Norris, PhD, Ching-tse Lee, PhD, Dmitry Burshteyn, PhD, Juan Cea-Aravena

Background: The purpose of this study was to evaluate the effects of alpha-increase neurofeedback training (Performance Enhancement Training) on blood pressure, stress reduction, attention, and observe changes in brainwave patterns. A forty-nine-year-old male college student diagnosed with essential hypertension controlled by medication had undergone twenty-six sessions of alpha-increase biofeedback (8-13 Hz) at PZ electrode site for a period of 15 weeks.

Method: Pre- and post-blood pressure measurements were taken for every session. At the beginning of week number eight, the participant discontinued his medication as advised by his physician. Pre-and post-visual TOVA CPT test was administered to assess the changes in accuracy, reaction time (RT), and RT variability. Osterkamp and Press Self-Assessment Stress inventory was administered before and after training to assess the level of stress. QEEG evaluation was conducted prior, as well as upon completion of the study.

Results: Mean Arterial Blood pressure (MAP) yielded statistically significant results between pre and post sessions within participant blood pressure measurements. The participant's systolic and diastolic blood pressures during the first thirteen sessions were not significantly different from those of the last thirteen sessions when his medication was discontinued, suggesting his ability to control his blood pressure within normal limits without the use of medication. The results of the TOVA test clearly indicate an improvement in individuals' reaction time and the reaction time variability. The results of the Osterkamp and Press Self-Assessment Stress Inventory indicated an improvement in two of the scales: Work and Social Life. Statistical analysis showed that before and after QEEG evaluations were within normal limits.

Norris, S. L., Lee, C., Cea, J., & Burshteyn, D. (1998). Performance enhancement training effects on attention: A case study. Journal of Neurotherapy, 3(1), 19-25.

« Orlando, P. C., & Rivera, R. O. (2004). Neurofeedback for elementary students with identified learning problems. Journal of Neurotherapy, 8(2), 5-19.

Othmer, S., Othmer, S. F., & Kaiser, D. A. (1999). EEG biofeedback: Training for AD/HD and related disruptive behavior disorders. Chapter in J. A. Incorvaia & B. F. Mark-Goldstein, & D. Tessmer (Eds.), Understanding, Diagnosing, & Treating AD/HD in Children and Adolescents. New York: Aronson, 235-297

Patrick, G. J. (1996). Improved neuronal regulation in ADHD: An application of 15 sessions of photic-driven EEG neurotherapy. Journal of Neurotherapy, 1(4), 27-36.

### **Improved Neuronal Regulation in ADHD: An Application of Fifteen Sessions of Photic-Driven EEG Neurotherapy**

**Graham J. Patrick, RN, Ph.D.**

*This study tested a 15-session electroencephalograph (EEG) driven photic stimulation neural training procedure designed to enhance the regulation of brain wave activity and thus improve cognitive functioning in Attention Deficit Hyperactivity Disorder (ADHD) children. The subjects (N=25) were 8-14 year old children of intact families and were screened by a developmental pediatrician for other DSM-4 diagnoses and medical conditions. Some of the subjects were medicated and some were not. A quasi-experimental waiting control group design was used with repeated psychometric tests consisting of the Wechsler Intelligence Scale for Children Third Edition (WISC-3), Raven Progressive Matrices (RPM), Wechsler Individual Achievement Test (WIAT), Achenbach Child Behavior Checklist and Profiles (CBCL-P), the computerized performance Test of Variables of Attention (T.O.V.A.), and two separate EEG measures. No significant changes were noted in any waiting period control group tests. Experimental results revealed highly significant ( $P < .05$  two-tailed) EEG changes, improvements in the WISC-3 processing speed and freedom from distractibility scales, WIAT, CBCL-P, and*

*T.O.V.A. fourth quarter commission error test scores. The results of this study are encouraging. The primary goal was accomplished and the hypotheses were supported by the data. Further study is indicated to explore the effects of longer treatment courses, different training goals, and better data procurement procedures using outcome measures of EEG variability coupled with successful psychometric performance.*

**Pratt, R. R., Abel, H., & Skidmore, J. (1995). The effects of neurofeedback training with background music on EEG patterns of ADD and ADHD children. International Journal of Arts Medicine, 4(1), 24-31.**

**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.**

Biol Psychol. 2000 Jul;53(2-3):177-215.

[Related Articles,](#)

[Links](#)



## **Operant conditioning of left-hemispheric slow cortical potentials and its effect on word processing.**

**Pulvermuller F, Mohr B, Schleichert H, Veit R.**

MRC Cognition and Brain Sciences Unit, Medical Research Council, 15 Chaucer Road, CB2 2EF, Cambridge, UK. friedmann.pulvermuller@mrc-cbu.cam.ac.uk

This study investigated whether language-related cognitive processes can be modified by learned modulation of cortical activity. Study participants received feedback of slow cortical potentials (SCPs) recorded above left-hemispheric language cortices and were reinforced for producing negative and positive shifts upon two different discriminative stimuli. In all subjects who achieved reliable control of left-hemispheric brain responses, substantial modification of word processing was observed. Behavioral modification could be documented in two experiments in which word probes were presented following discriminative stimuli. When negative shifts of the EEG were required, lexical decisions on words were substantially speeded, while they were slowed during positivity conditions. There was no indication for any performance difference between conditions in control subjects who failed to achieve control over SCPs after feedback training. This result was replicated in an experiment using lateralized-tachistoscopic stimulus presentation. Comparisons of word and pseudoword responses in both experiments indicated that behavioral modification was most pronounced for word responses. It was also not seen in a simple reaction time task

not involving language materials. This argues against a global effect related to perception, visuo-spatial attention, or motor processes. We conclude that linguistic processes can be influenced by modification of cortical activity due to operant conditioning. In closing, tentative explanations of the present results based on theories of language and attention processes are being discussed.

PMID: 10967232 [PubMed - indexed for MEDLINE]

**Rasey, H. W., Lubar, J. E., McIntyre, A., Zoffuto, A. C., & Abbott, P. L. (1996). EEG biofeedback for the enhancement of attentional processing in normal college students. Journal of Neurotherapy, 1(3), 15-21.**

### **EEG Biofeedback for the Enhancement of Attentional Processing in Normal College Students**

**Howard W. Rasey, B.A., Joel F. Lubar, Ph.D., Anne McIntyre, Ph.D.,  
Anthony C. Zoffuto, B.S., and Paul L. Abbott, B.A.**

*College students diagnosed as free of any neurological or attention deficit disorder received EEG biofeedback to enhance beta (16-22 hertz) activity while simultaneously inhibiting high theta and low alpha (6-10 hertz) activity in order to evaluate improvements in attentional measures. Following short-term treatment (mean number of sessions=20), subjects were evaluated as either learners or non-learners based upon standard pre-versus post-treatment neurofeedback measures. Attention quotients taken from pre and post-treatment measurements using the Intermediate Visual and Auditory (IVA) Continuous Performance Test identified significant improvements in attentional measures in learners, while non-learners showed no significant improvements. Results suggest that some "normal" young adults can learn to increase EEG activity associated with improved attention. Twenty sessions, however, even for this population may represent the lower limit for achieving significant improvement.*

**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. (2002). Neurofeedback for AD/HD: A ratio feedback case study. Journal of Neurotherapy, 6(3), 9-35.

## **Neurofeedback for AD/HD: A Ratio Feedback Case Study and Tutorial**

Thomas Rossiter, PhD

Introduction. The case study of a 13-year-old AD/HD male treated with neurofeedback is the subject matter for a tutorial on Ratio feedback.

Method. Neurofeedback was conducted at C3 (increase 15 to 18 Hz, decrease 2 to 10 Hz) and C4 (increase 12 to 15 Hz, decrease 2 to 7 Hz). Protocols provided visual and auditory feedback based on the Ratio of slow wave activity to be suppressed divided by fast wave activity to be enhanced.

Results. The patient demonstrated marked improvement in processing speed and variability on the Test of Variables of Attention-Auditory, a 19-point increase in IQ on the Kaufman Brief Intelligence Test, significant behavioral improvement based on parental (Behavior Assessment System for Children) and patient (Brown ADD Scale) reports, and a 7.5 grade equivalent increase in reading scores (Kaufman Test of Educational Achievement-Brief Form). At the 17-month follow-up parent questionnaires indicated that the patient's behavioral gains had been maintained or were slightly improved. EEG data showed significant declines in the C4/SMR Ratio (10\*2 to 7 Hz/12 to 15 Hz) and 2 to 7 Hz amplitude, a tendency toward an increase in 12 to 15 Hz amplitude, a significant increase in 8 to 11 Hz amplitude, and a decline in 22 to 30 Hz amplitude. Beta activity (15 to 18 Hz) was unchanged. An unexpected finding was that C3/Beta (10\*2 to 10 Hz/15 to 18 Hz) and C4/SMR protocols had similar effects on the EEG even though they targeted different bands to enhance and suppress. It appears that suppression of slow wave activity (2 to 7 Hz) may be the active component in both Ratio protocols and that fast wave enhancement either plays a minor (12 to 15 Hz) or no role (15 to 18 Hz).

Discussion. The findings cast doubt on the assumption that the C3/Beta and C4/SMR protocols have unique effects on EEG activity. Nevertheless, they may have differential effects on brain functions related to the training sites employed. It would be useful to analyze EEG changes in successfully treated individual AD/HD patients as a first step toward understanding the effects of various treatment protocols. What the protocols are intended to do, and the actual effects on the EEG may be different. If there are active components common to the various AD/HD treatment protocols reported in the literature, this is one way of beginning to recognize them. Brain maps collected before, during, and at the conclusion of treatment would enhance our understanding of treatment effects of various neurofeedback protocols, lead to more focused and productive research, and ultimately facilitate the development of more efficient treatment paradigms.

Keywords. AD/HD, neurofeedback, ratio feedback, tutorial

**Rossiter, T. R. (1998). Patient directed neurofeedback for ADHD. Journal of Neurotherapy, 2(4), 54-63.**

## **Patient-Directed Neurofeedback For AD/HD**

Thomas R. Rossiter, Ph.D.

*The study reports on Patient-Directed neurofeedback for Attention Deficit/Hyperactivity Disorder (AD/HD). Therapist involvement was limited to 10 treatment sessions used to train the patient or parents of younger children to use the equipment, to monitor treatment, and to make changes in the treatment protocol as necessary. The remaining 50 sessions were conducted at home using inexpensive, easy to operate, 1 or 2 channel Lexicor PODs. Results from the initial 6 patients, ages 7 to 45, are reported. Thirteen of 24 Test of Variables of Attention (TOVA) measures (attention, impulsivity, reaction time and variability) were below average ( $SS < 90$ ) at baseline. After 30 neurofeedback sessions, only 5 TOVA variables remained below average. It is concluded that Patient-Directed neurofeedback may be an effective alternative to Therapist-Directed treatment for many AD/HD patients and can be delivered at substantially less cost.*

**Rossiter, T. R., & La Vaque, T. J. (1995). A comparison of EEG biofeedback and psychostimulants in treating attention deficit/hyperactivity disorders. Journal of Neurotherapy, 1, 48-59.**

### **A Comparison of EEG Biofeedback and Psychostimulants in Treating Attention Deficit/Hyperactivity Disorders**

**Thomas R. Rossiter and Theodore J. La Vaque**

The study compared treatment programs with EEG biofeedback or stimulants as their primary components. An EEG group (EEG) was matched with a stimulant group (MED) by age, IQ, gender and diagnosis. The Test of Variables of Attention (TOVA) was administered pre and post treatment. EEG and MED groups improved ( $p < .05$ ) on measures of inattention, impulsivity, information processing, and variability, but did not differ ( $p > 0.3$ ) on TOVA change scores. The EEG biofeedback program is an effective alternative to stimulants and may be the treatment of choice when medication is ineffective, has side effects, or compliance is a problem.



Russell, H. L., & Carter, J. L. (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, C. J., & Rosenfeld, P. (1995 ). A controlled study of EEG biofeedback as a treatment for attention-deficit disorders. In "Proceedings of the 26<sup>th</sup> Annual Meeting of the Association for Applied Psychophysiology and Biofeedback" pp. 131-134.

Sheer, D. E. (1975). Biofeedback training of 40-Hz EEG and behavior. Chapter in N. Burch & H. I. Altshuler (Eds.), Behavior and Brain Electrical Activity. New York: Plenum.

Sheer, D. E. (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.

Shouse, M. N., & Lubar, J. F. (1979). Sensorimotor rhythm (SMR) operant conditioning and methylphenidate in the treatment of hyperkinesia. Biofeedback & Self-Regulation, 4, 299-311.

Shouse, M. N., & Lubar, J. F. (1979). Operant conditioning of EEG rhythms and Ritalin in the treatment of hyperkinesia. Biofeedback & Self-Regulation, 4(4), 299-311.

Biofeedback Self Regul. 1979 Dec;4(4):299-312.

[Related Articles,](#)

[Links](#)

**Operant conditioning of EEG rhythms and ritalin in the treatment of hyperkinesia.**

**Shouse MN, Lubar JF.**



Enhanced voluntary motor inhibition regularly accompanies conditioned increases in the sensorimotor rhythm (SMR), a 12--14-Hz Rolandic EEG rhythm in cats. A similar rhythm, presumably SMR, has also been identified in the human EEG. The clinical effectiveness of SMR operant conditioning has been claimed for epilepsy, insomnia, and hyperkinesia concurrent with seizure disorders. The present report attempts to follow up and replicate preliminary findings that suggested the technique's successful application to hyperkinesia uncomplicated by a history of epilepsy. SMR was defined as 12--14-Hz EEG activity in the absence of high-voltage slow-wave activity between 4 and 7 Hz. Anticipated treatment effects were indexed by systematic behavioral assessments of undirected motor activity and short attention span in the classroom. EEG and behavioral indices were monitored in four hyperkinetic children under the following six conditions: (1) No Drug, (2) Drug Only, (3) Drug and SMR Training I, (4) Drug and SMR Reversal Training, (5) Drug and SMR Training II, (6) No Drug and SMR Training. All hyperkinetic subjects were maintained on a constant drug regimen throughout the phases employing chemotherapy. Contingent increases and decreases in SMR occurred in three of four training subjects and were associated with similar changes in classroom assessments of motor inactivity. Combining medication and SMR training resulted in substantial improvements that exceeded the effects of drugs alone and were sustained with SMR training after medication was withdrawn. In contrast, these physiological and behavioral changes were absent in one highly distractible subject who failed to acquire the SMR task. Finally, pretraining levels of SMR accurately reflected both the severity of original motor deficits and the susceptibility of hyperkinetic subjects to both treatments. Although the procedure clearly reduced hyperkinetic behavior, a salient, specific therapeutic factor could not be identified due to the dual EEG contingency imposed combined with associated changes in EMG. Despite these and other qualifying factors, the findings suggested the prognostic and diagnostic value of the SMR in the disorder when overactivity rather than distractibility is the predominant behavioral deficit.

PMID: 526475 [PubMed - indexed for MEDLINE]

**Swingle, P. G. (2001). Parameters associated with rapid neurotherapeutic treatment of common ADD (CADD). Journal of Neurotherapy, 5(4), 73-84.**

#### **CURRENT CONCEPTS IN NEUROTHERAPY**

##### **Parameters Associated with Rapid Neurotherapeutic Treatment of Common ADD (CADD)**

Paul G. Swingle, PhD

Abstract: Although there are many types of ADD/ADHD, a common form of ADD (CADD) in children (high theta/beta ratio at Cz) can be successfully treated

in less than 15 sessions. The increased efficacy relative to the standard beta enhance/theta suppress protocol results from precise but brief diagnosis, home cognitive exercises with a theta suppression harmonic, disentraining and/or entraining visual stimulation, and clear treatment termination parameters. A single case example and data from 30 patients show the usual course of treatment.

KEYWORDS: EEG, ADD, CADD, children

**Swingle, P. G. (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.**

### **Subthreshold 10-Hz Sound Suppresses EEG Theta: Clinical Application for the Potentiation of Neurotherapeutic Treatment of ADD/ADHD**

**Paul G. Swingle, Ph.D., C. Psych.**

*The purpose of this article is to present the details of a newly developed home treatment protocol that provides immediate enhancement of attention and also markedly shortens the frequency and duration of office-based neurofeedback treatment of ADD/ADHD. The critical component of the treatment is the self-administration of a blend of tones embedded in filtered white noise (SUB/ALPHA) that immediately suppresses EEG theta with resultant immediate enhancement of attentional focus. Data from four studies indicating the suppressive effect of SUB/ALPHA on clinical and nonclinical populations are presented*

**Tansey, M. A. (1984). EEG sensorimotor rhythm biofeedback training: Some effects on the neurological precursors of learning disabilities. International Journal of Psychophysiology, 3, 85-99.**

1: Int J Psychophysiol. 1984 Feb;1(2):163-77.

[Related Articles,](#)

[Links](#)

### **EEG sensorimotor rhythm biofeedback training: some effects on the neurologic precursors of learning disabilities.**

**Tansey MA.**

This study presents a clinical treatment regime for pathological interhemispheric dysfunction with respect to a population of learning disabled boys. The results obtained replicate and extend earlier findings with respect to operantly

conditioned increases in amplitude of sensorimotor transactions and its positive effect on learning disability. Specifically, the biofeedback, and subsequent conditioning, of increased 14 Hz neural discharge patterns (sensorimotor rhythm-SMR) over the central Rolandic cortex, appeared to increase bilateral sensorimotor transactions resulting in substantive reduction/remediation in the learning disabilities of the recipients of such EEG biofeedback training.

PMID: 6542077 [PubMed - indexed for MEDLINE]

**Tansey, M. A. (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 Journal of Psychophysiology, 3, 85-89.**

Int J Psychophysiol. 1985 Nov;3(2):85-99.

[Related Articles,](#)

[Links](#)

**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.**

**Tansey MA.**

Eight boys, ages 7 years 11 months to 15 years 3 months, were provided with long-term--symptom duration--sensorimotor rhythm biofeedback training for the remediation of their learning disabilities. Concurrently, the simultaneous recording of five frequency bands of brainwave activity (5 Hz, 7 Hz, 10 Hz, 12 Hz and 14 Hz), from one active electrode equidistant from reference and ground, was intended to provide a glimpse of the 'brainwave signature' reflective of the dynamic and synergistic processes involved in such cerebro-neural activation and the brain's global response to such an alteration in the sensorimotor subnetwork. Overall, the main effect of this procedure, for the biofeedback and subsequent conditioning of increased 14 Hz neural discharge patterns over the central Rolandic cortex in a clinical office setting, seems to be to increase bilateral sensorimotor transactions resulting in substantive remediation of the learning disabilities of the recipients of such training--by way of internally exercising of, and/or recruitment of additional neural activation within, the sensorimotor subnetwork/matrix. Observation of the changing brainwave signatures showed a tendency for decreased slow wave activity concomitant with increases in fast wave activity, for cases with a Full Scale I.Q. within the range of 76 and 85; with those cases with a Full Scale I.Q. within the range of 102 and 116 exhibiting increased amplitudes over most of the monitored bands, but with the increases being much less at the slower frequencies. It is noteworthy that those four subjects

with either a significant Verbal greater than Performance, or Performance greater than Verbal, I.Q. Score discrepancy exhibited no less than a 40% greater increase in the lower of the two I.Q. scores; indicating that this SMR training procedure also resulted in an increased symmetry in the interhemispheric interactions reflective of the higher cortical functions for these no longer learning disabled boys.

PMID: 4077617 [PubMed - indexed for MEDLINE]

**Tansey, M. A. (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. A. (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. A. (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.**

Biofeedback Self Regul. 1993 Mar;18(1):33-44.

[Related Articles.](#)

[Links](#)

### **Ten-year stability of EEG biofeedback results for a hyperactive boy who failed fourth grade perceptually impaired class.**

**Tansey MA.**

Ten years ago, the first successful application of a clinical, private-practice based, EEG 14-Hz biofeedback training regimen for the treatment of learning disorders was performed by the author. After the 10-year-old boy, with presenting symptomatology including a developmental reading disorder, hyperactivity, and an educational classification of perceptually impaired, continued symptom free for a period of two years, his case was submitted for publication. Ten years after his termination from successful treatment, his ongoing normal social and academic functioning is noted and his EEG brainwave signature examined and compared with a population of 24 "used-to-be" learning disabled, one-half of which had a pretreatment state including the educational classification of perceptually impaired. This 10-year follow-up confirms the long-term stability of the results of this EEG 14-Hz biofeedback regimen. Current findings on recent medical research identifying a major cerebral locus of dysfunction for hyperkinesis and how it supports the electrode placements of this clinical office

setting regimen is also discussed.

Publication Types:

- Case Reports

PMID: 8448238 [PubMed - indexed for MEDLINE]

**Tansey, M. A., & Bruner, R. L. (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.**

Biofeedback Self Regul. 1983 Mar;8(1):25-37.

[Related Articles,](#)

[Links](#)

**EMG and EEG biofeedback training in the treatment of a 10-year-old hyperactive boy with a developmental reading disorder.**

**Tansey MA, Bruner RL.**

The serial application of electromyographic (EMG) and sensorimotor (SMR) biofeedback training was attempted with a 10-year-old boy presenting a triad of symptoms: an attention deficit disorder with hyperactivity, developmental reading disorder, and ocular instability. Symptom elimination was achieved, for all three aspects of the triad, following the procedure of first conditioning a decrease in EMG-monitored muscle tension and then conditioning increases in the amplitude of sensorimotor rhythm over the Rolandic cortex. The learned reduction of monitored EMG levels was accompanied by a reduction in the child's motoric activity level to below that which had been achieved by past administration of Ritalin. In addition, the attention deficit disorder with hyperactivity was no longer diagnosable following the EMG biofeedback training. The learned increase in the amplitude of monitored SMR was accompanied by remediation of the developmental reading disorder and the ocular instability. These results remained unchanged, as ascertained by follow-ups conducted over a 24-month period subsequent to the termination of biofeedback training.

Publication Types:

- Case Reports

PMID: 6882815 [PubMed - indexed for MEDLINE]

**Thompson, L., & Thompson, M. (1998). Neurofeedback combined with training in metacognitive strategies: Effectiveness in students with ADD. [Applied Psychophysiology & Biofeedback](#), [23\(4\)](#), 243-263.**

Appl Psychophysiol Biofeedback. 1998 Dec;23(4):243-63.

[Related Articles,](#)

[Links](#)

**Neurofeedback combined with training in metacognitive strategies: effectiveness in students with ADD.**

**Thompson L, Thompson M.**

ADD Centre, Mississauga, Ontario, Canada.

A review of records was carried out to examine the results obtained when people with Attention Deficit Disorder (ADD) received 40 sessions of training that combined neurofeedback with the teaching of metacognitive strategies. While not a controlled scientific study, the results, including pre- and post-measures, are consistent with previously published research concerning the use of neurofeedback with children. A significant addition is that a description of procedures is included. The 111 subjects, 98 children (age 5 to 17) and 13 adults (ages 18 to 63), attended forty 50-min sessions, usually twice a week. Feedback was contingent on decreasing slow wave activity (usually 4-7 Hz, occasionally 9-11 Hz) and increasing fast wave activity (15-18 Hz for most subjects but initially 13-15 Hz for subjects with impulsivity and hyperactivity). Metacognitive strategies related to academic tasks were taught when the feedback indicated the client was focused. Some clients also received temperature and/or EDR biofeedback during some sessions. Initially, 30 percent of the children were taking stimulant medications (Ritalin), whereas 6 percent were on stimulant medications after 40 sessions. All charts were included where pre- and post-testing results were available for one or more of the following: the Test of Variables of Attention (TOVA, n = 76), Wechsler Intelligence Scales (WISC-R, WISC-III, or WAIS-R, n = 68), Wide Range Achievement Test (WRAT 3, n = 99), and the electroencephalogram assessment (QEEG) providing a ratio of theta (4-8 Hz) to beta (16-20 Hz) activity (n = 66). Significant improvements ( $p < .001$ ) were found in ADD symptoms (inattention, impulsivity, and variability of response times on the TOVA), in both the ACID pattern and the full-scale scores of the Wechsler Intelligence Scales, and in academic performance on the WRAT 3. The average gain for the full scale IQ equivalent scores was 12 points. A decrease in the EEG ratio of theta/beta was also observed. These data are important because they provide an extension of results from earlier studies (Lubar, Swartwood, Swartwood, & O'Donnell, 1995; Linden, Habib, & Radojevic, 1996). They also demonstrate that systematic data collection in a private educational setting produces helpful information that can be used to monitor students' progress and improve programs. Because this clinical work is

not a controlled scientific study, the efficacious treatment components cannot be determined. Nevertheless, the positive outcomes of decreased ADD symptoms plus improved academic and intellectual functioning suggest that the use of neurofeedback plus training in metacognitive strategies is a useful combined intervention for students with ADD. Further controlled research is warranted.

Publication Types:

- Clinical Trial

PMID: 10457815 [PubMed - indexed for MEDLINE]

**« Thornton, K. E., & Carmody, D. P. (2005). Electroencephalogram biofeedback for reading disability and traumatic brain injury. Child & Adolescent Psychiatric Clinics of North America, 14(1), 137-162.**

**Tinius, T. P., & Tinius, K. A. (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.**

Appl Psychophysiol Biofeedback. 1998 Dec;23(4):243-63.

[Related Articles.](#)

[Links](#)

**Neurofeedback combined with training in metacognitive strategies: effectiveness in students with ADD.**

**Thompson L, Thompson M.**

ADD Centre, Mississauga, Ontario, Canada.

A review of records was carried out to examine the results obtained when people with Attention Deficit Disorder (ADD) received 40 sessions of training that combined neurofeedback with the teaching of metacognitive strategies. While not a controlled scientific study, the results, including pre- and post-measures, are consistent with previously published research concerning the use of neurofeedback with children. A significant addition is that a description of procedures is included. The 111 subjects, 98 children (age 5 to 17) and 13 adults (ages 18 to 63), attended forty 50-min sessions, usually twice a week. Feedback was contingent on decreasing slow wave activity (usually 4-7 Hz, occasionally 9-11 Hz) and increasing fast wave activity (15-18 Hz for most subjects but initially 13-15 Hz for subjects with impulsivity and hyperactivity). Metacognitive strategies related to academic tasks were taught when the feedback indicated the



client was focused. Some clients also received temperature and/or EDR biofeedback during some sessions. Initially, 30 percent of the children were taking stimulant medications (Ritalin), whereas 6 percent were on stimulant medications after 40 sessions. All charts were included where pre- and post-testing results were available for one or more of the following: the Test of Variables of Attention (TOVA, n = 76), Wechsler Intelligence Scales (WISC-R, WISC-III, or WAIS-R, n = 68), Wide Range Achievement Test (WRAT 3, n = 99), and the electroencephalogram assessment (QEEG) providing a ratio of theta (4-8 Hz) to beta (16-20 Hz) activity (n = 66). Significant improvements ( $p < .001$ ) were found in ADD symptoms (inattention, impulsivity, and variability of response times on the TOVA), in both the ACID pattern and the full-scale scores of the Wechsler Intelligence Scales, and in academic performance on the WRAT 3. The average gain for the full scale IQ equivalent scores was 12 points. A decrease in the EEG ratio of theta/beta was also observed. These data are important because they provide an extension of results from earlier studies (Lubar, Swartwood, Swartwood, & O'Donnell, 1995; Linden, Habib, & Radojevic, 1996). They also demonstrate that systematic data collection in a private educational setting produces helpful information that can be used to monitor students' progress and improve programs. Because this clinical work is not a controlled scientific study, the efficacious treatment components cannot be determined. Nevertheless, the positive outcomes of decreased ADD symptoms plus improved academic and intellectual functioning suggest that the use of neurofeedback plus training in metacognitive strategies is a useful combined intervention for students with ADD. Further controlled research is warranted.

Publication Types:

- Clinical Trial

PMID: 10457815 [PubMed - indexed for MEDLINE]

**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 Journal of Psychophysiology, 47, 75-85.**





## **The effect of training distinct neurofeedback protocols on aspects of cognitive performance.**

**Vernon D, Egner T, Cooper N, Compton T, Neilands C, Sheri A, Gruzelier J.**

Department of Cognitive Neuroscience and Behaviour, Imperial College London, Charing Cross Hospital, St. Dunstons Road, London W6 8RF, UK.

d.vernon@ic.ac.uk

The use of neurofeedback as an operant conditioning paradigm has disclosed that participants are able to gain some control over particular aspects of their electroencephalogram (EEG). Based on the association between theta activity (4-7 Hz) and working memory performance, and sensorimotor rhythm (SMR) activity (12-15 Hz) and attentional processing, we investigated the possibility that training healthy individuals to enhance either of these frequencies would specifically influence a particular aspect of cognitive performance, relative to a non-neurofeedback control-group. The results revealed that after eight sessions of neurofeedback the SMR-group were able to selectively enhance their SMR activity, as indexed by increased SMR/theta and SMR/beta ratios. In contrast, those trained to selectively enhance theta activity failed to exhibit any changes in their EEG. Furthermore, the SMR-group exhibited a significant and clear improvement in cued recall performance, using a semantic working memory task, and to a lesser extent showed improved accuracy of focused attentional processing using a 2-sequence continuous performance task. This suggests that normal healthy individuals can learn to increase a specific component of their EEG activity, and that such enhanced activity may facilitate semantic processing in a working memory task and to a lesser extent focused attention. We discuss possible mechanisms that could mediate such effects and indicate a number of directions for future research.

PMID: 12543448 [PubMed - indexed for MEDLINE]

**Wadhvani, S., Radvanski, D. C., & Carmody, D. P. (1998). Neurofeedback training in a case of attention deficit hyperactivity disorder. Journal of Neurotherapy, 3(1), 42-49.**

**Warner, D.A., 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.