Abstracts and Summaries of Selected Controlled Studies of Neurofeedback Treatment for Various Clinical Disorders

ATTENTION DEFICIT DISORDER

Neurofeedback training for ADD/ADHD has been found to be associated with increased IQ scores (often averaging 10 IQ points in published studies), improvements in academic performance, impulsiveness, hyperactivity, and sleep patterns, and increased attention span, concentration, and memory. 4 abstracts follow.

Electroencephalographic biofeedback in the treatment of attention-deficit/hyperactivity disorder. (Review article)
Monastra, V. J., Lynn, S., Linden, M., Lubar, J. F., Gruzelier, J., & LaVaque, T. J.

Historically, pharmacological treatments for attention-deficit/hyper-activity disorder (ADHD) have been considered to be the only type of interventions effective for reducing the core symptoms of this condition. However, during the past three decades, a series of case and controlled group studies examining the effects of EEG biofeedback have reported improved attention and behavioral control, increased cortical activation on quantitative electroencephalographic examination, and gains on tests of intelligence and academic achievement in response to this type of treatment.

This review paper critically examines the empirical evidence, applying the efficacy guidelines jointly established by the Association for Applied Psychophysiology and Biofeedback (AAPB) and the International Society for Neuronal Regulation (ISNR). On the basis of these scientific principles, EEG biofeedback was determined to be “probably efficacious” for the treatment of ADHD. Although significant clinical improvement was reported in approximately 75% of the patients in each of the published research studies, additional randomized, controlled group studies are needed in order to provide a better estimate of the percentage of patients with ADHD who will demonstrate such gains in clinical practice.

FPI Attention Disorders Clinic, Endicott, New York 13760, USA. drmonastra@stny.rr.com

Levesque, J., Beauregard, M., and Mensour, B.
Neuroscience Letters 394: 216-221

Attention Deficit Hyperativity Disorder (AD//HD) is a neurodevelopmental disorder mainly characterized by impairments in cognitive functions. Functional neuroimaging studies carried out in individuals with AD/HD have shown abnormal functioning of the anterior cingulate cortex (ACC) during tasks involving selective attention. In other respects, there is mounting evidence that neurofeedback training (NFT) can significantly improve cognitive functioning in AD/HD children. In this context, the present functional magnetic resonance imaging (fMRI) study was conducted to measure the effect of NFT on the neural substrates of selective attention in children with AD/HD. Twenty AD/HD children—not taking any psychostimulant and without co-morbidity--participated in the study. Fifteen children were randomly assigned to the Experimental (EXP) group (NFT), whereas the othr five children were assigned to the Control (CON) group (no NFT). Subjects from both groups were scanned 1 week before the beginning of the NFT (Time 1) and 1 week after the end of this training (Time 2), while they performed a Counting Stroop task. At Time 1, for both groups, the Counting Stroop task was associated with significant loci of activation in the left superior parietal lobule. No activation was noted in the ACC. At Time 2, for both groups, the Counting Stroop task was still associated with significant activation of the left superior parietal lobule. This time, however, for the EXP group only there was a significant activation of the
right ACC. These results suggest that in AD/HD children, NFT has the capacity to normalize the functioning of ACC, the key neural substrate of selective attention.

Centre de Recherche en Neuropsychologie Experimentale et Cognition (CERNEC), Departement de psychologie, Universite de Montreal, Canada

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

Monstra V.J., Monastra D.M., George S.

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.

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

EPILEPSY

Neurofeedback has been found to be helpful with all kinds of epilepsy, including grand mal, complex partial, and petit mal (absence) seizures. Uncontrolled epileptic seizures have also been effectively treated using neurofeedback. Training often requires 50 sessions or more. Treatment outcome studies of closed and open head brain injuries are also now beginning to be seen.

Research in this area began in the early 1970’s and is very extensive and rigorous, including blinded, placebo-controlled, cross-over studies (reviewed in Sterman, 2000). Although the larger proportion of seizure patients are adequately controlled by medication, most of the individuals who have been treated with neurofeedback in research studies are among the most severe epilepsy patients, where anticonvulsant drug therapy was unable to control their seizures. In this most severe group of patients, researchers have found that neurofeedback training on average produces a 70% reduction in seizures. In these severe cases of medically intractable epilepsy, neurofeedback has been able to facilitate greater control of seizures in 82% of patients, often reducing the level of medication required, a very positive result, given the long-term negative effects of some medications.

Neurofeedback treatment of epilepsy: from basic rationale to practical application

Sterman MB, Egner T.

The treatment of epilepsy through operant conditioning of the sensorimotor rhythm electroencephalogram has a 35-year history. Neurophysiological studies have shown that the phasic oscillation reflects an inhibitory
state of the sensorimotor system. Operant learning of sensory motor rhythm production results in an upregulation of excitation thresholds within the thalamocortical sensory and motor circuitry, which in turn is associated with reduced susceptibility to seizures. The clinical benefits derived from this neurofeedback training protocol, particularly in patients that are nonresponsive to pharmacotherapy, have been documented in many independent laboratories. Recent advances in computer technology have resulted in the availability of relatively inexpensive high-quality equipment for the application of neurofeedback therapy, thus presenting a viable and promising treatment alternative to the interested clinician.

Functional MRI Research Center, Columbia University, New York, New York

**Foundation and practice of neurofeedback for the treatment of epilepsy**

Egner, T and Sterman, MB


This review provides an updated overview of the neurophysiological rationale, basic and clinical research literature, and current methods of practice pertaining to clinical neurofeedback. It is based on documented findings, rational theory, and the research and clinical experience of the authors. While considering general issues of physiology, learning principles, and methodology, it focuses on the treatment of epilepsy with sensorimotor rhythm (SMR) training, arguably the best established clinical application of EEG operant conditioning.

The basic research literature provides ample data to support a very detailed model of the neural generation of SMR, as well as the most likely candidate mechanism underlying its efficacy in clinical treatment. Further, while more controlled clinical trials would be desirable, a respectable literature supports the clinical utility of this alternative treatment for epilepsy. However, the skilled practice of clinical neurofeedback requires a solid understanding of the neurophysiology underlying EEG oscillation, operant learning principles and mechanisms, as well as an in-depth appreciation of the ins and outs of the various hardware/software equipment options open to the practitioner.

It is suggested that the best clinical practice includes the systematic mapping of quantitative multi-electrode EEG measures against a normative database before and after treatment to guide the choice of treatment strategy and document progress towards EEG normalization. We conclude that the research literature reviewed in this article justifies the assertion that neurofeedback treatment of epilepsy/seizure disorders constitutes a well-founded and viable alternative to anticonvulsant pharmacotherapy.

Department of Neurobiology, School of Medicine, UCLA, USA. msterman@ucla.edu

**READING DISABILITY and TRAUMATIC BRAIN INJURY**

*Electroencephalogram biofeedback for reading disability and traumatic brain injury.*

Thornton KE, and Carmody DP


The application of electroencephalogram (EEG) biofeedback with reading disability and traumatic brain injury (TBI) is relatively recent. There are many studies regarding the effectiveness (improving attention and IQ scores) of EEG biofeedback in patients with attention deficit hyperactivity disorder who are known to have a high rate of comorbidity for learning disabilities. This suggests the possibility that EEG biofeedback specifically aimed at remediating reading disability and TBI would be effective. This article provides strong initial support for this idea and provides reason to believe that assessment and training under task conditions are likely to be fruitful. Given the significance of these problems and the absence of very effective alternatives for remediation
of these conditions, efforts to complete the needed research seem warranted. Clinical use of this intervention seems to be warranted with informed consent.

Center for Health Psychology, Suite 2A, 2509 Park Avenue, South Plainfield, NJ 07080, USA. ket@chp-neurotherapy.com

**ALCOHOLISM**

**Alpha-theta brainwave training and beta-endorphin levels in alcoholics.**  
Peniston EG, Kulkosky PJ.  
Alcohol Clinical Experimental Research 13(2):271-9, 1989

An alpha-theta brainwave biofeedback training program was applied as a novel treatment technique for chronic alcoholics. Following a temperature biofeedback pretraining phase, experimental subjects completed 15 30-min sessions of alpha-theta biofeedback training. Compared to a nonalcoholic control group and a traditionally treated alcoholic control group, alcoholics receiving brainwave training (BWT) showed significant increases in percentages of EEG record in alpha and theta rhythms, and increased alpha rhythm amplitudes. Alcoholics receiving BWT showed a gradual increase in alpha and theta brain rhythms across the 15 experimental sessions. These experimentally treated alcoholics showed sharp reductions in self-assessed depression (Beck’s Depression Inventory) compared to the control groups. Alcoholics receiving standard medical treatment (abstinence, group psychotherapy, antidepressants) showed a significant elevation in serum beta-endorphin levels at the conclusion of the experiment. This neuropeptide is an index of stress and a stimulant of caloric (e.g., ethanol) intake. Application of brainwave treatment, a relaxation therapy, appears to counteract the increase in circulating beta-endorphin levels seen in the control group of alcoholics. 13-month follow-up data indicate sustained prevention of relapse in alcoholics that completed [15 sessions].

Veterans Administration Medical Center, Fort Lyon, Colorado 81038

**Other Clinical Applications of Neurofeedback Training**

D. Corydon Hammond, Ph.D. of the University of Utah Department of Medicine, has published a comprehensive review of neurofeedback that is available online at http://www.isnr.org/information/whatisnfb.pdf. The following is from Dr. Hammond’s review:

“Neurofeedback has shown good research support for its effectiveness in treating anxiety (Hammond, 2005a; Moore, 2000). It is also being used to work with other clinical problems such as [dissociative identity disorder (Manchester, et al.); depression (Baehr, Rosenfeld & Baehr, 2001; Hammond, 2001, 2005c); chronic fatigue syndrome (Hammond, 2003, 2004), autism (Jarusiuwicz, 2002; Scolnick, 2002; Siehel, Fehmi, & Goldstein, 1995); Parkinson’s tremors (Thompson & Thompson, 2002), tinnitus (Gosepath et al., 2001; Schenk et al., 2005; Weiler et al., 2001); physical balance, swallowing, gagging and incontinence (Hammond, 2005b); cerebral palsy (Ayers, 2004); and essential tremor. Neurofeedback is also being utilized in peak performance training, for instance in enhancing musical performance (Egner & Gruzelier, 2003), dance performance (Raymond et al., 2005), and with athletes [the 2006 champion soccer team all trained in neurofeedback prior to winning the World Cup], business executives, and for cognitive and memory enhancement in normal individual (Hanslmayer et al., 2005; Rasey, Lubar, McIntyre, Zoffuto & Abbott, 1996; Vernon et al., 2003), which has been referred to as “brain brightening: when used to counter the effects of normal aging (Budzynski, 1996( However, these areas of application do not yet have strong research validation.)”
ANXIETY

A review of EEG biofeedback treatment of anxiety disorders
Moore NC.

Alpha, theta and alpha-theta enhancements are effective treatments of the anxiety disorders (Table 1). Alpha suppression is also effective, but less so (Table 2). Perceived success in carrying out the task plays an important role in clinical improvement. Research is needed to find out how much more effective they are than placebo and which variables are important for efficacy. Variables needing study are: duration of treatment, type and severity of anxiety, number and type of EEG waveforms used, pretreatment with other kinds of feedback, position and number of electrodes, and presence of concomitant medication.

Brain Research Center, Mercer University School of Medicine, Macon, GA 31207, USA.

POST TRAUMATIC STRESS DISORDER

Alpha-theta brainwave neuro-feedback therapy for Vietnam veterans with combat-related post-traumatic stress disorder
Peniston EG, Kulkosky PJ.

The Minnesota Multiphasic Personality Inventory (MMPI) was used to assess personality changes in Vietnam combat veterans with post-traumatic stress disorder (PTSD), after either traditional medical treatment (TC) or alpha-theta brainwave neurofeedback therapy (BWT). Application of brainwave training for thirty 30-minute sessions resulted in decreases in MMPI T-scores on clinical scales labeled hypochondriasis, depression, hysteria, psychopathic deviate, masculinity-femininity, paranoia, psychasthenia, schizophrenia, hypomania, and social introversion-extroversion. The traditional medical control group showed decreases in T-scores only on the scale labeled schizophrenia. All fourteen BWT patients initially receiving psychotropic medication reduced their dosages after treatment, but only one of thirteen TC patients reduced dosage. A thirty month follow-up study showed that all fourteen TC patients had relapsed, in contrast to only three of fifteen BWT patients. These findings indicate that application of alpha-theta brainwave training is a more efficacious treatment modality in the treatment of PTSD and preventing relapse.

Veterans Admin. Medical Center, Fort Lyon, Colorado 81038 (following is a description of the study rather than the original abstract.)

DEPRESSION

Clinical Use of an Alpha Asymmetry Neurofeedback Protocol in the Treatment of Mood Disorders: Follow-Up Study One to Five Years Post-Therapy
Elsa Baehr, PhD, J. Peter Rosenfeld, PhD, Rufus Baehr, PhD

Background: This study reports on three of six patients who have completed an average of 27 neurofeedback sessions using a patented alpha asymmetry protocol for the treatment of depression.

Method: The follow-up data, from one to five years post therapy, were derived from a single session re-test using the same alpha asymmetry protocol and the Beck Depression Inventory.
Results: The three patients originally diagnosed as having unipolar depression reached the training criteria for the non-depressed range by the end of their initial training, and they have maintained their normal scores for right hemisphere alpha asymmetry training over time. The follow-up Beck Depression Inventory scores were also within the normal range.

Discussion: This finding is contrary to the previously held demonstrations by Davidson andHenriques regarding the stability of decreased left anterior cortical activation in remitted depression. While some patients have reported mood changes with life’s vicissitudes, none have experienced clinical depression since they have terminated therapy.

AUTISM  
Efficacy of Neurofeedback for Children in the Autistic Spectrum: A Pilot Study  
Betty Jarusiewicz, PhD  
The Journal of Neurotherapy 6: 2002

Background: The efficacy of neurofeedback training was evaluated in 12 children in the autistic spectrum with matched controls, based on established training protocols for other conditions with similar symptoms.

Method: Twenty-four autistic children were divided into two groups, matched by sex, age, and disorder severity. One group received neurofeedback training and the second acted as a control group. Responses to the Autism Treatment Evaluation Checklists (ATEC) and parental assessments of problem behaviors were analyzed to evaluate the effectiveness of neurofeedback training for this condition.

Results: Neurofeedback training resulted in a 26% average reduction in total ATEC rated autism symptoms, compared to 3% for the control group. Parental assessments reported improvement in all behavioral categories: socialization, vocalization, anxiety, schoolwork, tantrums, and sleep, compared with minimal changes in the control group.

Discussion: Autistic spectrum children who underwent neurofeedback training showed significant improvements in autism symptoms and behaviors. The magnitude of improvement was independent of initial severity or age.

Effects of electroencephalogram biofeedback with Asperger’s syndrome  
Scolnick, B.  
International Journal of Rehabilitation Research 2005 28(2): 159-63:

This article reports the pilot study of electroencephalogram (EEG) biofeedback to improve focusing and decrease anxiety in 10 adolescent boys diagnosed with Asperger’s syndrome attending a therapeutic day school. Five of the boys dropped out of the study before 12 sessions were completed. The analysis of pre- and post-intervention quantitative EEGs for the five students who completed the study showed a trend to “normalization”, but did not reach statistical significance. All five boys who completed 24 sessions showed improved behavior as rated by parents and teachers, but other factors, such as maturation could not be ruled out as causes of the improvement. The challenges facing this research and proposals for further exploration are outlined.

Center for Psychiatric Rehabilitation and Recovery, Sargent College, Boston University, 940 Commonwealth Avenue, Boston, MA 02215, USA. scolnick@bu.edu
The following is information regarding ongoing research on autism and neurofeedback at the University of San Diego. Dr. Pineda’s work has just received funding from the National Institutes of Health and will be expanded.

Bridge Grant – Cure Autism Now 2005 Proposal:
Effectiveness of Neurofeedback Training on Autism Spectrum Disorders
Jaime Pineda, Ph.D., University of California, San Diego
25 April 2006 From New Scientist Print Edition (report on pilot study proposed above):

Figuring out how the brain produces autistic behavior has been a challenge because the manifestations vary both in severity as well as expression. However, the discovery of “mirror neurons” provides a common basis for some of the major behavioral deficits seen in autism spectrum disorder (ASD). Mirror neurons are specific brain cells that fire when we pick something up, feel the texture of a surface, smell something unpleasant, or even when we experience emotions. What is unique is that these same cells also fire when we observe someone else performing similar actions. Studies indicate that mirror neurons may underlie the ability to imitate.

Some have suggested that this provides a mechanism for the development of language, or that the mirror system is required to develop a “theory of mind” (the ability to understand another’s mind). Finally, studies have found that facial expressions activate the mirror system and hence empathy may depend on it. Therefore, the existence of mirror activity in the human brain provides a neural bridge between imitation learning and higher-order social cognition. ASD individuals lack many of these seemingly simple social skills and have difficulty understanding sensations or perspectives other than their own. Dr. Pineda’s research group has recently published data suggesting that ASD individuals have a dysfunctional mirror neuron system. This project will examine the effectiveness of an experimental treatment for ASD known as Neurofeedback Training.

Neurofeedback is a non-invasive procedure in which the brain is trained subconsciously to increase or decrease the level of specific brain rhythms. The training requires that electrodes be placed on the scalp and for an individual to relax and watch a video that either plays or stops depending on high/low mirror neuron activity. Through such training the hope is that the dysfunctional mirror system may become normalized, potentially then allowing ASD individuals to improve imitation skills and react with greater sensitivity to other people’s actions.

Brain training can change autistic behaviour
NEUROFEEDBACK practice may be able to alleviate some of the symptoms of autism, according to a pilot study on eight children with the disorder.

The technique involves hooking people up to electrodes and getting them to try and control their brain waves. In people with autism, the “mu” wave is thought to be dysfunctional. Since this wave is associated with “mirror neurons” - the brain cells that underpin empathy and understanding of others - Jaime Pineda at the University of California, San Diego, wondered if controlling it through neurofeedback could exercise faulty mirror neurons and improve their function.

He attached sensors to the necks and heads of eight children with autism and had them watch a video game of a racing car going round a track. For all of the children, sitting still and concentrating kept the car traveling around the track, but five of them were also able to harness their mu waves and use them to adjust the car’s speed.

After 30 sessions over 10 weeks, Pineda found that the five children’s mu brainwaves had changed and they performed better on tasks involving imitation, typically difficult for people with autism. Pineda presented his
work at the annual meeting of the Cognitive Neuroscience Society in San Francisco last week.

“This seems to indicate the children improve,” Pineda says. How long the effects will last, though, is unknown.

There are non-peer-reviewed reports of HEG neurotherapy effectiveness in managing behavior, increasing social contact, and raising school performance from Thailand in a large school program where all the children are autistic. The data reported to the developer of HEG from this program are promising and can be accessed upon request. However from the organizational perspective, this information would not yet qualify for consideration.

Positive Outcome With Neurofeedback Treatment In a Case of Mild Autism
Arthur G. Sichel, Lester G. Fehmi, and David M. Goldstein

This article looks at the experience of Frankie, an autistic 8 and 1/2 year old boy. He was diagnosed mildly autistic by several specialists. One specialist claimed he was brain damaged and “autistic-like” and that there was no hope for improvement. At Frankie’s mother’s request, neurotherapy diagnosis and treatment was begun. After 31 sessions, Frankie showed Positive changes in all the diagnostic dimensions defining autism in DSM-111-P. This has profound implications for treatment in a field with few low-risk alternatives.

Introduction: The DSM-III-R (American Psychiatric Association, 1987) defines autism as “characterized by qualitative impairment in the development of reciprocal social interaction, in the development of verbal and nonverbal communication skills, and in imaginative activity. Often there is a markedly restricted repertoire of activities and interests…”

The mother of an 8 1/2 year old autistic boy contacted one of the authors seeking treatment for her son, Frankie. She was at first referred elsewhere but returned and we agreed to evaluate him. The first referral was to Jonathan Cowan who, in verbal communication to one of the authors, reported symptom amelioration in EEG treatment of an autistic child.

Pretreatment Behavior: Frankie exhibited a seeming lack of awareness of the existence of others. He once forgot his glasses after a training session. When he came for his next session, one of the authors held his glasses up for him to take. He did not appear to visually focus on or attend to the author. He focused on the glasses. He reached out and took them, looked at them, looked up, as though focusing on the wall through and behind the author, put on the glasses and walked away. The author had the distinct impression of being looked through, never looked at or attended to.

Frankie did not seek comfort when distressed. He showed no imitation of his siblings and did not engage in social play. His mother reported that he did not vocalize until the age of three, when he began to babble. She said she has worked a great deal on his verbal communication. Verbalizations appeared quite minimal at the beginning of treatment. He did not make eye contact, did not look at the person or smile in social approach. He had a fixed stare in social situations.

Frankie did not change facial expression or respond verbally when addressed. However, he usually did as his mother directed. Directions were simple and responses were slow. When questions were asked of him, his mother would repeat the question until he made some minimal response and she would interpret that response to the neurofeedback provider. He showed very little imaginative play. He read with a monotonous tone of voice. His brief sentences often had odd inflection, almost a sing song quality. He referred to himself as “Frankie” and rarely spoke unless spoken to.

He displayed stereotyped body movements in the form of hand flapping. He was attached to a number of objects which he insisted on carrying around with him. In summary, pretreatment behavior included symptoms
which meet the diagnostic criteria for Autistic Disorder listed in the DSM-III-R, sections A, B, C and D.

**Patient Assessment:** Two separate psychologists, each in private practice, one also a school psychologist, diagnosed him autistic. A neurologist specializing in autism, who is on the faculty of a medical school, diagnosed him autistic. A special education professor at a state college said he was autistic-like but brain damaged and said there was no hope for improvement. His mother said the psychologists and physician described him as high level or mildly autistic.

A test of variables of attention (T.O.V.A.) was administered. It is used as an aid in diagnosing attention deficits in children and adults. He did not respond to the tester, but appeared to be participating in the test during practice and during the test. His T.O.V.A. performance showed a variability score which was statistically interpreted by comparison with age related norms to be consistent with an attention deficit disorder.

Electrical activity of the brain was recorded at 19 sites (jasper, 1958) using a Lexicor Neurosearch-24 while Frankie was engaged in six different activities (sitting still with eyes closed, with eyes opened, reading, listening, doing a mental arithmetic task and drawing). Calculation of the percent power ratios of theta to beta brain wave activity showed the kind of deviations from normal which are seen in attention deficit disorders (i.e., percent power ratios above 3). Mean ratios, averaged across the five conditions in which his eyes were open, were highest in the parietal and central regions, as shown in Table 1. For the three parietal sites, averaged across the five eyes opened conditions, the pre-therapy theta (4-8 Hz) to beta (13-21 Hz) ratios were 4.07 (P3), 3.98 (PZ) and 3.63 (P4).

**Neurotherapy:** Because of high theta/beta ratios and with his mother’s urging, it was decided to give Frankie the kind of theta/beta/EMG treatment which is being used successfully for attention deficit disorders (cf. 4, 5, 6, 7, 8).

As of this writing, Frankie has received 31 sessions of training in which he has been rewarded for raising his SMR (12-15 Hz) and decreasing theta (4-8 Hz) activity at various brain loci on the sensory-motor strip and parietal lobe. EEG training during early sessions was provided by an EEG Spectrum and for later sessions on the Lexicor using the Biolex program, based on Frankie’s choice of computer game. Both utilized a monopolar electrode placement with the ear lobes as reference and ground. Training emphasis was given to parietal activity based upon patient assessment, with the sites showing the highest ratios receiving the most neurotherapy.

**Post Treatment Behavior:** The following description of changes since initiation of neurofeedback training comes from his mother, from a female caretaker who has seen him daily for 3-4 hours per day, and from our own observations. His mother reported significant changes after three training sessions. She said he was talking more and had been affectionate with his siblings. For the first time in his life he played with his sister, and even kissed her, and he put his arm around his older brother.

Over the course of training Frankie’s behavior continued to change. He began attending to and reacting to others. He started making eye contact. He presented his biofeedback trainers with valentine cards he had made; he appeared shy while presenting them and seemed thrilled when the cards were praised.

After 31 neurofeedback sessions he notices his sister’s distress and tries to interfere when she resists taking a bath or going to bed. He seeks comfort when he reads something upsetting. He imitates his older brother and plays with his brother, his sister and a friend. He no longer tires easily and no longer has trouble falling or staying asleep. His headaches are significantly reduced, as is his tendency to appear anxious and worried. He is much less shy and withdrawn.

At this point in treatment, Frankie’s verbalizations are still limited and responses continue to appear slow. He now sometimes makes eye contact and no longer has a fixed, vacant stare in social situations. He engages in a lot of imaginative play with his sister. He now reads with some expression. He does not speak much and speaks monotonously, but a singsong quality was not present during later sessions. He now refers to
himself as ‘T’ He initiates conversations at home and asks for what he wants. Before, he frequently engaged in a repetitive jumping activity. Now, he rarely does this. Before, he showed great attachment to a number of unusual objects, insisting on carrying them around. He now carries markedly fewer things around with him.

He is evaluated annually by a speech therapist. His most recent evaluation was just prior to this writing. The speech therapist reported that he has improved one whole diagnostic category since his last evaluation. Last year he was found to have profound language deficits (over 40 months delay in development). This year he showed severe language deficits (30 months delay). The speech therapist specified that no hand flapping or self-stimulating behavior was observed. He did confuse pronouns and omit articles. He could not follow two and three step commands and echolalia was present. However, he had improved so much that, for the first time, the speech therapist was able to use age appropriate tests. In summary, Frankie has demonstrated positive changes on all the diagnostic dimensions defining autism in DSM-III-R.

**Brain Wave Changes:** QEEG mapping of Frankie’s brain activity was repeated after completion of 31 sessions of neurotherapy. The pre- and post-neuro therapy theta to beta percent power ratio for each of the 19 sites recorded, averaged across the five eyes opened conditions, are shown in Table 1. Prior to neurotherapy, seven sites had percent power ratios above 3.00 (see values denoted by asterisk), and the highest ratio (4.07) was at P3.

As shown in Table 1, two sites (P3 and CZ) remain slightly above 3.00 after neurotherapy. Fifteen of the 19 sites showed reduction in their power ratios after neurotherapy. Ranked among the largest reductions in percent power ratios were the changes that occurred at P3 and PZ. These represent the sites which received the predominant proportion of training time.

**Discussion:** The behavioral changes and the brain wave changes in this 8-year-old autistic boy are viewed as a positive outcome of neurotherapy. These results are suggestive that neurotherapy can be an effective treatment for some of the symptoms of mild autism. It would be interesting to follow possible further gains with additional neurotherapy sessions.

The core deficit in autism as discussed by Pennington (1991) is the inability to imagine what is going on inside another person in terms of thoughts, feelings and images. It seems reasonable that one has to discriminate and be able to represent these internal states to oneself before one can imagine what internal states another person might be experiencing. Neurotherapy has led to the reduction of the power ratios in the parietal region, where Frankie’s ratios were highest prior to neurotherapy, and where the experience of his body is mediated. The findings reported here support the hypothesis that neurotherapy training has led Frankie to pay attention to the experience of his body, or to attend to it or experience it differently, we suggest both more objectively and more intimately. We believe this newly learned and qualitatively different way of attending to and experiencing his body has had profound consequences (Fehmi, In press).

The same type of neurotherapy which is used to treat attention deficit disorders has initiated a process which reduced autistic symptoms and supported the development of normal patterns of social interaction and communication. This has profound implications for treatment in a field with few low risk alternatives. These results are consistent with the view that a basic defining characteristic of autism is the failure to pay attention appropriately to the experience of one’s body. That is, mild autism may be profitably considered a form of...
attentional limitation or rigidity to which other attention treatments may also be useful (cf. 10). The authors look forward to further clinical research with mild autistic patients to support or refute the above findings and interpretations.

References


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