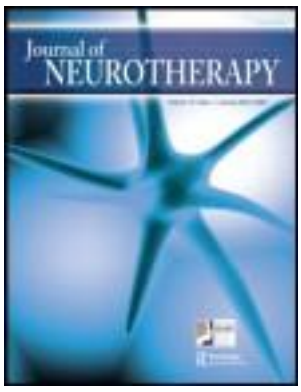

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Efficacy of Neurofeedback for Children in the Autistic Spectrum: A Pilot Study

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Efficacy of Neurofeedback for Children in the Autistic Spectrum: A Pilot Study

Betty Jarusiewicz, PhD

ABSTRACT. *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.

Betty Jarusiewicz is Founder, Principal Investigator and Program Director, Atlantic Research Institute, Inc. She serves on the Board of Directors of EEG Spectrum International, Inc. (ESII). NeuroCybernetics, Inc., a subsidiary of ESII, developed the software used in this study.

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KEYWORDS. Autism, autistic spectrum, neurofeedback, control group, Autism Treatment Evaluation Checklist (ATEC), EEG biofeedback

INTRODUCTION

Consideration of Neurofeedback Therapy for Individuals with Autistic Symptoms

Neurofeedback (EEG biofeedback) has been shown to be beneficial for a number of symptoms that apply to individuals in the autistic spectrum. Symptoms benefited include seizures (Sterman, 1993; Lantz & Sterman, 1992), hyperactivity (Lubar & Shouse, 1976), attention problems (Lubar, Swartwood, Swartwood, & O'Donnell, 1995; Swingle, 1996), and anxiety (Thomas & Sattlberger, 1997). Processing of information (ability to do school work), sleep disorders, and obsessive-compulsive behaviors have also benefited. These studies followed the research of Hauri (1981), Hauri, Percy, Hellekson, Hartmann and Russ (1983), Tansey (1990), Sterman (1993), Sterman, Kaiser and Veigel (1996), Arabanal (1995), Mann, Sterman and Kaiser (1996), and Linden, Habib and Radojevic (1996).

Kaiser and Othmer (1995) reported that neurofeedback training produced significant improvements in measures of inattention, impulsivity and response variability. Their investigation focused on attentional processes by using the Test of Variables of Attention (TOVA) including 530 children and adults with attentional problems. They noted that the greatest improvement occurred for subjects with the severest deficits prior to training. This information could be especially important when considering the use of neurofeedback for individuals in the autistic spectrum, as many could be considered to have severe deficits of attention. Rossiter and La Vaque (1995) compared neurofeedback and psychostimulants in the treatment of attention deficit and hyperactivity disorders. Their study showed that neurofeedback is as effective as stimulants and may be the treatment of choice, especially where medication is ineffective, has side effects, or where compliance may be a problem.

Sichel, Fehmi and Goldstein (1995) concluded that mild autism may be considered a form of attentional limitation or rigidity and that neurofeedback led to a positive outcome in their case.

Goldstein (2000) states that we need to ask "Is the treatment effective?" in the context of testing potential new therapies without delay

and that we need not wait for basic science to uncover underlying causes (p. 425). Wolery (2000) notes that the questions facing investigators studying the treatment of individuals with autism are: (a) can we describe the factors associated with the variability in their behavior and learning, and (b) can we derive treatment programs from those factors that ensure positive outcomes for all individuals with autism? Schreibman (2000) notes that the broadest empirical effectiveness has been shown in the behavioral model. Neurofeedback could be considered for development into a viable treatment program for autism as it is non-invasive has proven success with symptoms in other disorders similar to those of autism, and nothing else has shown success in a time frame that will allow for cost/benefit evaluations. Initial positive outcomes for this therapy were seen in autistic children in our practice. We designed and undertook this study to establish if neurofeedback could be shown to be efficacious for children in the autistic spectrum.

Diagnosis and Measurement of Typical Autistic Behaviors

The Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV, 1994) uses a checklist type listing of behaviors for physicians to identify a spectrum of behaviors that can be called autism. If six behaviors are matched to the child, the child is then diagnosed autistic. The listing of behaviors crosses a number of types of behaviors (communication, social behavior, hyperactivity, etc.), resulting in the fact that a child diagnosed within the autistic spectrum may look very different from others with the same diagnosis. Also it is difficult to measure the extent of impairment, as the severity of the total impairment may reflect the severity of an individual behavior or reflect the additive effects of multiple negative or impaired behaviors. Various tools that include more specific details associated with the diagnosis of autism have been developed such as the Checklist for Autism in Toddlers (CHAT), the Childhood Autism Rating Scale (CARS), the Parent Interview for Autism (PIA), the Gilliam Autism Rating Scale (GARS), and the Behavior Rating Instrument for Autistic (BRIAC) (cf. Autism Awakening 4 Doctors website, 2000).

The New York State Health Department website (2000) lists the following tools: ABC (Autism Behavior Checklist), ADI-R (Autism Diagnostic Interview-Revised), and PL-ADOS (Pre-Linguistic Autism Diagnostic Observation Schedule). As yet no single tool has been universally used for research purposes. In research situations, measurement of changing autism behaviors has proven to be particularly difficult as:

(a) the treatments vary so significantly as to type and action, and (b) each individual varies so significantly in their specific behaviors and in their response to treatment.

The Autism Treatment Effectiveness Survey, published by the Autism Research Institute, is a database where data has been gathered on the web and elsewhere, listing parent's opinions of the success of various treatment strategies for autism. They include various drugs, secretin, EEG biofeedback (neurofeedback), sensory integration, auditory integration training, hyperbaric oxygen, vitamin and other supplement therapy, Applied Behavioral Analysis (ABA), speech and occupational therapies, and dietary change. This survey is informative but it also highlights the need for more uniform standards in assessing therapeutic effectiveness.

The Autism Research Institute has developed a checklist, Autism Treatment Evaluation Checklist (ATEC), to specifically measure the effectiveness of various treatments. The ATEC is a questionnaire for parents and teachers, developed by Dr. Bernard Rimland and S. M. Edelson (n.d.) of the Autism Research Institute (ARI). It was not initially intended for diagnosis but as a mechanism for building a large database on autism-related symptoms and behaviors. As this database is expanded with data from individuals with other identified disorders and "typical" children ARI suggests it may also be used as a diagnostic tool.

This simple easy-to-use test was selected as the primary basis of measurement for our pilot study. This tool allows for immediate scoring of results. It consists of four subtests: Speech/Language Communication (14 items), Sociability (20 items), Sensory/Cognitive Awareness (18 items), and Health/Physical/Behavior (25 items). The ATEC is available on the web at <*www.autism.com/atec*>. Subsequent to beginning this pilot study we became aware of a more standardized set of measurements that can be used for researchers as described by Lord (2000), which we intend to use in future studies, along with our current methods. Similarly, we included videotaping (Greenspan, 1992) and EEG recordings in the hopes of corroborating ATEC test results; however, these analyses are not yet complete and will be reported in a future paper.

METHOD

Participants

Forty participants responded to a request for volunteers for this study presented to a group of parents of children with autism. All children in

this study had received a diagnosis on the autism spectrum by their physician, as report by their parents. The children were divided into pairs, matching gender, age, and extent of autism as best as possible. Each pair was then randomly divided into a group for neurofeedback training and a control group. Controls were assured that they too would be trained with neurofeedback at the conclusion of the approximately six to eight months. Procedures and possible side effects were fully explained. Informed consent was obtained for all subjects from parents and appointments for the individuals to be trained were made. See Table 1 for demographics of the final trained and control groups.

The Atlantic Research Institute's Institutional Review Board consisting of a psychiatrist, general practitioner, parents of children in the autistic spectrum, and individuals active in autism research funding groups approved our study plan.

Materials and Procedures

An interview process was conducted with the parents to ascertain particular problem areas and family histories were collected. The Autism Treatment Evaluation Checklist (ATEC) was used to establish the severity of autism prior to training and at the completion of this study. Fifteen-minute videos of free play were used with a process similar to the Functional Emotional Assessment Scale (FEAS) described by Dr. Stanley Greenspan showing behaviors before and after training.

The Othmer Assessment (1997) was conducted for each child to determine areas of over-, under- and unstable arousal. These results guided

TABLE 1. Neurofeedback and Control Group Demographics

		Average Autism Spectrum Level[a]				
Age		Speech	Socialization	Sensory	Health	Total
Training Group (11 males, 1 female)						
Mean	7 years	14	15	18	19	65
Range	4 -13 years	6-25	2-25	10-25	8-42	26-109
Control Group (11 males, 1 female)						
Mean	7 years	12	15	15	21	63
Range	4 -11 years	4-24	2-24	4-26	8-36	29-90
Checklist Maximums		28	40	36	75	180

[a] From Autism Treatment Evaluation Checklist (ATEC), used with permission from the Autism Research Institute.

neurofeedback protocol selection for each child, following those recommended in the training courses provided by EEG Spectrum International, Inc., using NeuroCybernetics (Encino, California) software (version 3.10).

The following initial protocols were followed for 30-minute sessions. Participants were rewarded for activity at electrode site C4 (referenced to the contralateral ear) in 10-13 Hz range, or lower, depending on a child's level of autism as determined by ATEC, with inhibits of 2-7 Hz and 22-30 Hz. The choice of 2-7 Hz inhibit was due to the significant amounts of delta and theta in all of the children's spectrals. Adjustments to protocols were made as needed. Fifty-seven percent of all sessions in this study applied this protocol.

If the child had problems with vocalization during training an F7 electrode placement (right ear reference) was used with a 15-18 Hz reward and inhibits at 2-7 Hz and 22-30 Hz. If after 5 minutes the child did not show signs of over-stimulation, additional five-minute increments were added, up to a possible 30-minute duration of the session. This protocol was used 15% of the time. Most often the stimulative training was followed by C4 electrode placement, with 2-7 and 22-30 Hz inhibits for calming.

For clients who required help with socialization and communication, a bipolar F3-F4 electrode placement was employed with 7-10 Hz to 14.5-17.5 Hz rewards and 2-7 Hz and 22-30 Hz inhibits. If the clinician noted inappropriate laughter or giggling, this protocol was discontinued. This protocol was used 12% of the time.

If emotional instability was a symptom, a bipolar T3-T4 electrode was used, beginning with 9-12 Hz rewards and 2-7 and 22-30 Hz inhibits. Protocol frequencies were adjusted up or down depending on the requirements of the child as determined by the clinician (up if too weepy or sad; down if additional reduction in anxiety/hyperactivity was required). This protocol was used 13% of the time.

Children generally received one to three training sessions per week, with two sessions per week being the most common schedule.

RESULTS

Twelve of the 20 experimental group children completed sufficient training for data to be analyzed; they completed 20 sessions or more (20 to 69 range, mean of 36 sessions). Eight children dropped out of the

study: seven due to family considerations and one due to illness not connected to autism.

All 12 children who received neurofeedback training showed improvement in their condition based on the ATEC and parent interviews. As shown in Table 2, ATEC levels improved significantly after neurofeedback training, from 8% to 56%, with an overall average reduction of 26% ($p < .001$). Sociability improved 33% ($p < .01$); speech/language/communication, 29% ($p < .001$); health, 26% ($p < .015$); and sensory/cognitive awareness, 17% ($p < .001$).

The control group showed a slight but insignificant improvement in all categories (3% total average) over a similar period of time, $p > .05$. One child in the control group did show marked improvement due to an unknown mechanism.

ATEC level reductions following neurofeedback training do not appear to be related to the initial level of autism as both groups exhibited very similar initial ATEC levels.

Parent Interview Process

When parents of the participants were interviewed and asked what problem behaviors they most wished to see addressed for their children they indicated: socialization (12), vocalization (12), school work (9), anxiety (9), tantrums (4) and sleep (4). Upon completion of the study, the parents were asked to what extent their children were helped in each

TABLE 2. Autism Treatment Evaluation Checklist (ATEC) Results for Neurofeedback and Control Groups

	Average Autism Spectrum Level				
	Speech	Socialization	Sensory	Health	Total
Training Group					
Pre-training	14	15	18	19	65
Post-training	10	10	15	14	48
Improvement	4	5	3	5	17
	29%	33%	17%	26%	26%
Control Group					
At pre-training dates	12	15	15	21	63
At post-training dates	12	14	15	20	61
Improvement	0	1	0	1	2
	0%	7%	0%	5%	3%

ATEC used with permission from the Autism Research Institute.

category on a scale of 1-10, with 10 being the most improvement. They indicated that all were helped in the areas that they wished, but to different degrees. Socialization was identified as being helped, ranging from 2 to 9 (a mean of 5), vocalization from 3 to 10 (a mean of 5), school work from 3 to 9.5 (a mean of 5), anxiety from 2 to 8 (a mean of 3), tantrums from 2.5 to 6.5 (a mean of 4), and sleep (with all parents reporting a level of 9). Most of the parents from the control group did not wish to discuss the lack of behavioral improvements over the time of the training; therefore we did not receive sufficient data from the control group to document the details of this assessment.

DISCUSSION

This study presents evidence of the efficacy of neurofeedback for individuals in the autistic spectrum. Additional studies will be valuable replicating and expanding this work by using: (a) newly accepted standard measurements of diagnosis and levels of autism, as described by Lord (2000), (b) more detailed sets of video corroborating evidence as the type described by Greenspan (1992), (c) statistical analysis of spectral EEG changes, (d) improved protocol development generated in part by new neurofeedback software, (e) potential data obtained by QEEG developmental analysis, and (f) improved statistical approaches to participant behavior changes.

One of the issues in working with children in the autistic spectrum relates to the family environment, making it difficult to predict which candidates would complete the process and have symptom improvements. Families with children requiring significant extra help are under stress and frequently become overwhelmed. Often differences between the parents of a child affect therapies chosen and their success. Counseling and sharing with others in similar circumstances can assist in maintaining equilibrium.

In reviewing the family histories of the trained group, it was noted that 56% of all families in the trained group evidenced addiction, 56% AD/HD, 56% learning disabilities and/or late speech, and 56% anxiety and/or depression. These issues may be factors in the dropout rate. We did not obtain sufficient data regarding family histories from the control group to review this issue.

Work must be done to establish reasonable methodologies of measurements of change in the field of autism research as well as in the entire field of neurofeedback. The Autism Treatment Review Checklist

(ATEC) has the benefit of being free, easily available, and can be used with all individuals (teachers, parents, other therapists) working with the participant. The more accepted research approach is the methodology developed by Lord which is much more expensive and conducted by an expert clinician who may access information from a number of sources.

As to specific protocols, we noticed that after an initial positive period in using a T3-T4 protocol, either improvement stopped or the child became angry and/or regressed. Also we noted that protocols for assisting underarousal conditions might, at times, cause the children to begin to giggle or laugh inappropriately. Sartori, Biraben, Taussig, Bernard and Scarabin (1999) described inappropriate laughter as possible gelastic seizures. Therefore we considered it appropriate to stop using any of these protocols (F7, C3, F3-F4) using stimulatory frequencies, as this unusual behavior may be indicative of seizure activity. We started late in the process with F3-F4, but would recommend greater use in the future, as all who used it found great benefit with no down sides.

Future studies are needed to replicate this data by other clinicians with other types of software and hardware. The addition of pre- and post-QEEGs may also lead to greater understanding of any underlying types of brain issues, which can lead to better training methods.

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