AN INVESTIGATION OF THE EFFECTIVENESS OF COMPUTER-ASSISTED BIOFEEDBACK FOR STUDENTS DIAGNOSED AS HAVING AUTISM SPECTRUM DISORDER: THE RELATIONSHIP BETWEEN THE USE OF COMPUTER-ASSISTED BIOFEEDBACK AND ON-TASK BEHAVIOR.

by

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ABSTRACT

Using a single-subject multiple baseline design across participants, this study examined the impact of computer-assisted biofeedback to promote engagement of students diagnosed as having autism spectrum disorder. The study was conducted in a public school classroom setting. Specifically the on-task behavior during an individualized academic activity was investigated. Three 9-10 year old children participated in the study. In the baseline phase, data was collected on speed to engagement and percentage of time on-task during an academic activity. A 15-second momentary time sampling procedure was used for a 5 minute session each day of the week for a five week period to measure the participant's engagement. In the intervention phase, the participants completed a three to four minute computer-assisted biofeedback session prior to the academic activity and collection of data on engagement. In addition, data were collected on performance level of the academic activity. Data were also collected on educator and parent perception of generalization of self-regulation of behavior. The data suggest: (a) speed to engagement increased when using a computer-assisted biofeedback program for all participants; (b) time on-task improved over baseline conditions for all participants; (c) academic achievement was impacted by computer-assisted biofeedback for one participant; and (d) educators perceived a generalization of self-regulation of behavior, while parents did not indicate any generalization of self-regulation of behavior occurred in the home environment.

This is dedicated to my mom and dad.

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CHAPTER I

INTRODUCTION

Individuals diagnosed with Autism Spectrum Disorders (ASD), also known as Pervasive Developmental Disorders (PDD), typically display qualitative impairments in communication, social skills, and a limited range of interests and activities (Autism Society of America, 2005), including repetitive and stereotyped patterns of behavior. According to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM IV- American Psychiatric Association, 2000), the term "PDD" is not a specific diagnosis, but an umbrella term where the specific diagnoses are defined. Nevertheless, ASD and PDD are sometimes used interchangeably (World Health Organization, 1993). The DSM IV also states that individuals within the autism spectrum are likely to exhibit one or more comorbid disorders and symptoms, including hyperactivity, attentional difficulties, seizure disorders, mental retardation, depression, and anxiety.

The many combinations of impairments possible and the variability of severity present quite a challenge for the individual with ASD and those trying to support them throughout their lives. The deficits displayed by individuals with ASD are quite frequently the catalyst for serious behavioral issues in the classroom and often create obstacles for students with ASD in all areas of their life (Baker, et al., 2002). Unfortunately, finding effective approaches to serve children with ASD continues to challenge teachers, parents and experts (Simpson, 2005).

Anxiety and frustration are common feelings exhibited by individuals with ASD and often lead to maladaptive behavior (Buron, 2003). Children beginning school are expected follow directions, follow the class routine, and participate in and be on-task during class activities (Gilberts, Agran, Hughes, & Wehmeyer, 2001). Frustration experienced by young children may contribute to creating obstacles as these children move through the school system. Managing this frustration is difficult for the child and presents educators with problems for which few options are currently available.

Teaching relaxation techniques is one strategy that has been used with children to reduce anxiety and frustration (Mullins & Christian, 2001). Additional supports and measurable outcomes may be provided through the infusion of computer-assisted biofeedback with the relaxation techniques may provide additional support and measurable outcomes for children with ASD. Through the use of computer-assisted biofeedback and relaxation, the student may be provided with an opportunity to learn how to self regulate their behavior.

One computer-assisted biofeedback that may show promise is Freeze-Frame. Freeze-Frame is a computer-based self management program based on principles of biofeedback, is a simple, easy to use interactive software program that displays heart rhythms through the use of a finger or ear sensor and uses simple visual images to help the user manage heart rhythms and achieve a state of relaxation. Once the stress level is lowered, and the anxiety and/or frustration subside, challenges faced many in the pursuit of attaining daily adaptive behavior and academic goals can be lessened. Stress, anxiety, and frustration are feelings that may surface at any given time. However, finding an intervention that can help a child to understand, cope, and overcome stress and frustration throughout their life could truly change many lives for the better.

Biofeedback training, although not new, is a cognitive-behavioral approach gaining attention and showing promise. Simpson (2005) states cognitive behavioral interventions hold promise as effective interventions which will likely increase in utilization as further supportive empirical evidence emerges. There is the potential to alter behavior by teaching an individual to actively participate in understanding and modifying their own thoughts and behavior (Mayer, Lochman, & Van Acker, 2005). The purpose of this research project is to determine the effectiveness of infusing computer-assisted biofeedback with relaxation techniques on the engagement of children with ASD. The study is designed to promote self management of behavior ultimately targeting the increase of on-task and task performance behavior among children with ASD.

An Overview of Autism Spectrum Disorders

Autism Spectrum Disorders (ASD) are complex developmental disabilities that affect from two to six children per 1,000 children (National Institute of Mental Health, 2005). There is no known cause or cure. ASD stems from a neurological disorder that affects the typical functioning of the brain (Autism Society of America, 2005). Magnetic Resonance Imaging (MRI) scans have shown differences in the size brain in individuals with ASD versus typical individuals (Kagan & Pozen, 2005). To date, researchers continue to investigate several causal theories, including the link between heredity, genetics and medical problems (Larsson, et al., 2005; Kuehn, 2006).

The Autism Society of America reports that symptoms typically appear during the first three years of life and affect each individual differently. These symptoms include impairments in communication and social skills, as well as a limited range of interests and activities. An individual with ASD may exhibit any combination of these symptoms in any degree of severity.

According to the Autism Society of America (ASA), about 1.5 million Americans are living with some form of autism. This number includes over 100,000 students, 3-21 years of age, diagnosed with autism and served under the Individuals with Disabilities Act (IDEA) (2004). Based on statistics from the U.S. Department of Education (2003), from 2000 to 2001 alone, students identified with autism increased by 24 percent. The ASA estimates that the prevalence of autism could reach 4 million Americans in the next decade, and the overall incidence of autism is consistent around the world. Autism is also consistently four times more prevalent in boys than in girls. Autism touches all races, ethnicities, socio-economic classes, lifestyles, and educational levels (Lawton, 2005).

There is a great variability of characteristics among individuals with ASD (Koegel & Koegel, 2000). The manual used by professionals as a guide to diagnosing disorders, the Diagnostic and Statistical Manual of Mental Disorders (DSM IV; American Psychiatric Association, 2000) includes a description of ASD ranging from autistic disorder to Asperger's Disorder. IQ's range from the very low to the very high and symptoms range from delays in language and challenges with social interactions to aggressive and/or self-injurious behavior and/ or extreme sensory sensitivities.

There are no medical tests for specifically diagnosing autism. However, medical tests are often given to confirm or rule out other medical conditions or disorders (Mandell, Novak, & Zubritsky, 2005). A diagnosis of autism spectrum disorder is made by a physician or mental health professional by observing an individual's communication, behavior, and developmental levels. An accurate diagnosis and early identification is crucial in developing an appropriate and effective educational and treatment program (Koegel & Koegel, 2000). A total of five disorders are identified under the category of Pervasive Developmental Disorders: (1) Autistic Disorder, (2) Rett's Disorder, (3) Childhood Disintegrative Disorder, (4) Asperger's Disorder, and (5) Pervasive Developmental Disorder Not Otherwise Specified, or PDDNOS. If a child has symptoms of Autistic Disorder or Asperger’s Disorder, but does not meet the specific criteria for either, the diagnosis is called pervasive developmental disorder not otherwise specified (PDD-NOS). Rett’s Disorder and Childhood Disintegrative Disorder are rare, very severe disorders that are included in the autism spectrum disorders. This study included children diagnosed with classic autism and PDD-NOS.

Statement of the Problem

There is a staggering growth in the number of children being diagnosed with ASD and limited effective interventions (Simpson, 2005). Children with narrowed communication skills and/or poor social development are particularly at risk for the development of problem behaviors (Borthwick-Duffy, 1996). These children are also at risk for exclusion and isolation from educational settings, social relationships, typical home environments, and community activities (Sprague & Ryan, 1993). Research does suggest that autism can be managed effectively using comprehensive behavioral and educational treatment programs (Gresham, Beebe-Frankenberger, & MacMillan, 1999), but educators and researchers must develop and implement research-based methods designed to support individuals with ASD at this critical time. Unfortunately, problem behaviors are pervasive and young children with autism are particularly at risk for developing problem behaviors (Horner, Carr, Strain, Todd & Red, 2002).

An Overview of Biofeedback

The basic use of biofeedback is to provide individuals with increased information about what is going on inside their bodies and their brains. The prefix "bio" means life and the word "feedback" means to return information to its origin (Raposa, 2003). The term "biofeedback" is a new term that cannot be found in many dictionaries. According to the American Heritage Stedman's Medical dictionary, biofeedback is a training technique that enables a person to gain some element of voluntary control over autonomic body functions and is based on the principle that a desired response is learned when received information indicates a specific thought or action has produced the desired response. The term was coined in the late 1960s to describe laboratory procedures that were being used to train research subjects to alter bodily function, including blood pressure and heart rate, that are not usually controlled voluntarily (Nemours, 2006). Biofeedback is a technique through which individuals can learn to control physiological functions controlled by the autonomic nervous system, by monitoring its status (Sarafino, 1997).

Schwartz (1982), a psychophysiologist, proposed that biofeedback refers to a group of experimental procedures in which an external sensor is used to provide a subject with information about his body processes, to regulate body function.

There are two general types of biofeedback. One is the traditional form of biofeedback which measures the bodily responses from the neck down, called peripheral biofeedback. The second type, neurofeedback or EEG biofeedback, measures brainwave activity from the neck up (EEG Spectrum, 2005). Traditional biofeedback measures the body's stress response, like a polygraph machine. Some of the measures include EMG (electromyograph: measures muscle tension), thermal (measures blood flow in fingers and toes), heart rate and respiration (measures variability of heart rate and changes in breathing,), SCL or EDR (skin conductance level or electodermal response, measures arousal). Traditional biofeedback is often used to learn relaxation skills and to lower anxiety, as well as to treat a variety of stress-related medical conditions such as chronic pain, tension headaches, and muscle tension.

Neurofeedback utilizes biofeedback to guide individuals to regulate their brain activity (Butnik, 2005). Neurofeedback is a technique used to train the brain to help improve its ability to regulate bodily functions (EEG Spectrum, 2005). Sensors are placed on the scalp and brainwaves are monitored and displayed using video and audio signals.

The computer-based self management program based on principles of biofeedback that is being used in this study, Freeze-Framer, is more of traditional form of biofeedback because there are no sensors attached to the scalp measuring brain waves. Freeze-Framer differs from other commercial devices that simply measure heart rate, the program measures the beat-to-beat changes in heart rate and shows the user the rhythmic patterns of the heart over time. This is called heart rate variability (HRV) analysis. In addition to seeing heart rhythm in real-time, coherence or entrainment level is displayed as an accumulated score. Entrainment is used to describe two or more waves, or systems, in coherence. These physiological systems can include the heart’s rhythmic patterns, brain, nervous, respiration, and blood pressure rhythms, and are considered automatic functions of the body. Increased physiological coherence is associated with improved cognitive performance, emotional balance, mental clarity, and health outcomes (McCraty, Atkinson, Tomasino, Goelitz, & Mayrovitz, 1999).

The device operates from a finger or ear sensor, which continuously monitors the user’s pulse and sends information to the computer. The information is interpreted and displayed on the computer screen as a real-time graph of changing heart rhythms. Students can literally ‘see’ how their attitudes and physical behaviors affect their heart rhythms and performance. Through an understanding of the program and basic strategies for managing heart rate, students can learn to make internal shifts by learning to stabilize their emotions and balance their nervous systems (Institute of HeartMath, 2005). Also students can view the changes that this internal shift has made to their physiology. Ultimately, students can learn to stabilize their emotions and balance their nervous systems (Institute of HeartMath, 2005).

Freeze-Framer contains three interactive games that engage the users as they learn to master their own physiology. By watching an instrument give continuous measurements of a bodily function, a person can experiment with different thoughts, feelings, and sensations and get immediate feedback on the effects.

Synchronized electrical activity in the brain and nervous system holds the key to our ability to perceive, feel, focus, learn, reason, and perform at our best (Institute of HeartMath, 2005). Unmanaged emotional reactions to stress not only lead to behavior problems in young people but also create physiological conditions that inhibit learning (McCraty et al., 1999). For individuals with ASD, learning to control, or cope, with their emotions and their behaviors could be a life altering skill that has the potential to remove many barriers to quality of life experiences.

Purpose of the Study

The purpose of this study is to analyze the effectiveness of computer-assisted biofeedback software on the achievement of adaptive behavior goals, specifically on-task behavior and task performance, for students with ASD in a school setting. Currently there are no published peer reviewed studies using computer assisted biofeedback treatment with children diagnosed with ASD in a school setting. However, multiple studies have shown the effectiveness of EEG biofeedback in the clinical setting for students with ASD and ADHD (Jarusiewicz, 2002; Othmer, 2000; Thompson & Thompson, 1998; & Lunt & Kang, 1997). These studies include participants as young as four years of age. The cognitive level of the participants in these studies was not specifically reported due to the difficulty in measuring the severity of impairment of individuals with ASD. Currently, there is a great need for experimental research to determine the efficacy of biofeedback in school settings. The significance of this study is its potential to educate teachers and related service professionals on the beneficial aspects of cognitive-behavioral interventions such as biofeedback programs available in the school for individuals with ASD.

A review of the literature on interventions for managing behavior of students with autism has revealed a huge research-to-practice gap when implementing scientific-based interventions (Bodfish, 2004). Numerous interventions proven to be scientifically valid are either not being used at all, not being used with fidelity, or being implemented incorrectly (Simpson, 2005). Cook et al. (2003) attribute this failing to teacher education and to reliance on advertising and word-of-mouth for obtaining information rather than research literature. To address this failing, Cook et al. (2003) make the following recommendations: (a) make the literature base accessible, (b) enhance teacher training and the role of teacher educators, and (c) provide support to the teachers to implement and maintain effective practices. Research findings need to be presented in a way that are easy to understand and in a practical, usable fashion. This study intends to bridge the research-to-practice gap by investigating a scientifically validated principle with students in the classroom.

Research has shown the efficacy of using relaxation training and biofeedback to reduce anxiety and impulsive behaviors in children with and without disabilities. McCraty et al. (1999) reported that middle school students, through the use of learned relaxation skills, were able to positively control their physiological stress. These students exhibited significant improvements in the areas of stress and anger management, risky behavior, work management and focus, and relationships with family, peers and teachers. The improvements were sustained over six months.

Glasser (1996) has published several studies about the critical need for students to develop an internal locus of control. Miller, Fitch, and Marshall (2003), report that exceptional education students, on average, have a more external locus of control than typical students. As far back as two decades ago, Porter and Omizo (1984), found biofeedback-induced relaxation training increased internal locus of control in hyperactive adolescent boys. Computer-assisted biofeedback holds promise as an instrument students could use to develop an internal locus of control.

Glasser also uses the term “choice theory” which holds that people can control only their own behavior. Computer assisted biofeedback could be the tool needed to illustrate that control. Adding to this potential is Othmer (2003), who states that stability of the brain is the target of biofeedback training, with a variety of symptoms subsiding once this is accomplished. He also states that application of biofeedback for children with attention deficit hyperactivity disorder (ADHD) is quite common, and it is an emerging field for individuals with ASD. Thus, biofeedback should be considered for development as a viable treatment program for individuals with ASD.

Although biofeedback has been used for conditions including seizure disorders, mood disorders, and ADHD for the past 30 years, most existing biofeedback research studies report success for children that are conducted in clinical settings (Rojas & Chan, 2005). Most research has been conducted one-on-one in a controlled setting, with a trained counselor. The proposed project will explore the use of biofeedback as an intervention for students with ASD in the classroom, ultimately affecting the students' ability to self manage their behavior.

The results of this research study sought to contribute to the literature in the area of using biofeedback as an intervention in the classroom for students' with ASD. This study will provide meaningful information to teacher educators, therapists, counselors, parents, administrators, and teachers and sought to gather the information needed to build a bridge between research and practice on the use of biofeedback with students with ASD in a classroom setting.

Research Questions

1. Does computer-assisted biofeedback in the classroom increase speed to engagement of an academic activity? (Decreasing the latency between the time the students are presented with a writing activity and the time the students begin their work.)
2. Does computer-assisted biofeedback in the classroom increase time on-task working on an academic activity? Duration of time on-task was estimated by momentary time sampling.
3. Does computer-assisted biofeedback in the classroom increase the performance of an academic activity?
4. Does generalization of self-regulation of behavior carryover to other areas of classroom and home environments?

Dependent Measures

1. Direct observation of the latency of speed to engagement and duration of time on-task when given an individualized writing task by participants were measured by the research team.

    a. Speed to engagement was recorded in seconds from the time the teacher and/or paraprofessional placed the writing task in front of the student to the time the student began the activity by placing his/her writing implement to the paper and making meaningful marks on the paper. (Directions were given to the student prior to the start of the measurement.)

    b. A percentage of the duration of time on-task was estimated by momentary time sampling.

    c. Performance level of the individualized writing task was investigated through a comparison of performance during baseline and performance level during intervention as measured by a writing rubric. The differences in performance are described for each individual.

    d. Generalization of self-regulation of behavior in classroom and home environments was investigated using the Parent and Teacher Survey of Intervention.

2. Parent and teacher survey of intervention was completed after the intervention phase of study to assess generalization of the intervention.

3. Researcher anecdotal records were kept to document specific events and information on a day-to-day basis.

Independent Measure

The independent variable is the Freeze Frame computer-based self management program based on the principles of biofeedback. The Freeze-Framer Program is a scientifically-validated, interactive learning system that has improved learning, performance, and behavior, and was used as an intervention to promote positive behavior change. Visual displays are used to help the user self regulate physiological systems. The program includes colorful games that motivate the students to learn how to manage their physiological state and heart rhythm.

Research Design

The experimental design used in this study was a single-subject multiple baseline design (Kazdin, 1982) to evaluate the effectiveness of computer-assisted biofeedback for students with ASD in the classroom.

Three participants began the baseline phase. Data was collected for a 5-10 minute period during an academic activity. Participant 1 began the intervention phase once the data were stable. During intervention, the student completed a 3 to 4 minute computer-assisted biofeedback session immediately before the academic activity. Baseline continued with the other students. Once the data for Participant 1 had an established trend, the intervention was implemented with Participant 2. Baseline data continued to be collected for Participant 3. Once the data for Participant 2 had an established trend, the intervention was implemented with Participant 3.

Significance of the Study

Although biofeedback is not a cure for ASD, further research into the possible benefits including the reduction of anxiety as measured by heart rate variability, and an increase in self management of behavior of individuals with ASD is necessary. Using computer-assisted biofeedback as a strategy for individuals with ASD creates an environment to learn in comfortable surroundings, typically alone. Ease of use in the classroom as opposed to teacher interventions requiring more time is another significant variable. Computer-assisted biofeedback also caters to the strengths of individuals with ASD by providing visual feedback. Ultimately, computer-assisted biofeedback has the potential to enhance the quality of life of individuals with ASD.

Definition of Terms

Autism Spectrum Disorders (ASD)

According to the definition set forth in the DSM-IV (American Psychiatric Association, 2000), Autism Spectrum Disorders, also referred as Pervasive Developmental Disorders (PDD), are characterized by severe and pervasive impairment in several areas of development: social interaction skills; communication skills; or the presence of stereotyped behavior, interests, and activities.

Autistic Disorder

Autistic Disorder is four times more common in boys than in girls. Children with Autistic Disorder have moderate to severe communication, socialization, and behavior problems. Many children with autistic disorder also have mental retardation.

Pervasive Developmental Disorder – Not Otherwise Specified (PDD-NOS)

According to the definition set forth in the DSM-IV (American Psychiatric Association, 2000), the essential features of PDD-NOS are: severe and pervasive impairment in the development of reciprocal social interaction or verbal and nonverbal communication skills; stereotyped behaviors, interests, and activities; and the criteria for Autistic Disorder are not met because of late age onset, atypical and/or sub threshold symptomotology are present.

Biofeedback

Biofeedback is defined as a psychophysiologic process in which subtle information is amplified regarding how a person's body and brain are operating. Through the use of instrumentation, this subtle information is then mirrored back to that person (Dossey, Keegan, Kolkmeier, & Guzzetta, 1989; Fuller, 1977).

Neurofeedback

Neurofeedback is also referred as EEG biofeedback and measures brainwave activity from the neck up. EEG biofeedback is operationally defined as a unique neurophysiological approach used by professionals trained in electroencephalographic biofeedback to train individuals to consciously recognize and control their own brain-wave patterns (Lubar, 1995).

Entrainment

Entrainment is used to describe two or more waves, or physiological systems, in coherence. These systems could include the heart's rhythmic patterns, brain, nervous, respiration, and blood pressure rhythms and systems, and are considered automatic functions of the body. High coherence or entrainment level is associated with improved learning and behavior.

Freeze-Framer

The Freeze-Framer is a computer-based learning system based on the principles of biofeedback. It is an easy to use interactive software program that displays your heart rhythms and shows an individual how stress may affect them. It is described as a heart rhythm coherence training system. It helps an individual learn to self-generate coherence and track progress.

Heart rate variability

Heart rate variability is a measure of neurocardiac function that reflects heart-brain interactions and autonomic nervous system dynamics (McCraty, 1999). Beat-to-beat changes in heart rate are measured and displayed by rhythmic patterns over time. This is called heart rate variability (HRV) analysis. Low heart rate is associated with a more relaxed state and high heart rate is associated with stress and anxiety.

Assumptions

Participants are assumed to be representative of 9 to 10 year old students with ASD. The students were able to recognize and respond to visual stimuli. The students were able to use breathing and imagery techniques. The students were willing to participate. The students had limited tactile defensiveness. The parents provided consent for their child to be involved in the study. The students had a good attendance record. The intervention will increase the student's ability to self manage their behavior, ultimately increasing time on-task. The treatment will be beneficial to the participants and their families.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

An extensive search for literature on Autism Spectrum Disorders (ASD) and computer-assisted biofeedback as an intervention for these individuals provided no data-based research articles. Though, several studies using neurofeedback on children with ADHD were found (Monastra, Lnn, & Linden, 2005; Butnik, 2005; deBeus, Ball, & deBeus, 2004) as well as a few on children with ASD (Othmer, 2003; Jarusiewicz, 2002; Sichel, 1995), none were found that specifically used computer-assisted biofeedback with children with ASD. HoweverStudents with ASD were reported to respond well to computer tasks (Spencer, 1996) and rely on visual strengths (Peterson, Bondy, Frost, & Finnegan, 1995) to gather information.

The following review of literature discusses characteristics and challenges of individuals with ASD as well as interventions commonly used with individuals with ASD. The principles, effectiveness and challenges of biofeedback are presented along with computer assisted biofeedback. Next, relaxation, a key component in biofeedback treatment, is discussed. This is followed by a review of the relationship between time on-task and achievement. The chapter summary concludes the review of the literature.

AUTISM SPECTRUM DISORDER

Characteristics of Students with ASD

Over sixty years ago, Leo Kanner (1943) first described autism as a disorder affecting communication skills and interpersonal relationships. Almost 60 years later, the National Research Council (2001) describes individuals with ASD as having deficits that affect the most vital aspects of quality of life, including interacting with other people, communicating ideas and feelings, and understanding what others feel or think.

According to the Diagnostic and Statistical Manual of Mental Disorders: DSM IV, (APA, 2000) autism is characterized by: A total of six (or more) items from (1), (2), and (3), with at least two from (1), and one each from (2) and (3):

(1) qualitative impairment in social interaction, as manifested by at least two of the following:

- (a) marked impairment in the use of multiple nonverbal behaviors such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction
- (b) failure to develop peer relationships appropriate to developmental level
- (c) a lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest)
- (d) lack of social or emotional reciprocity

(2) qualitative impairments in communication as manifested by at least one of the following:

(a) delay in, or total lack of, the development of spoken language (not accompanied by an attempt to compensate through alternative modes of communication such as gesture or mime)

(b) in individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others

(c) stereotyped and repetitive use of language or idiosyncratic language

(d) lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level

(3) restricted repetitive and stereotyped patterns of behavior, interests, and activities, as manifested by at least one of the following:

(a) encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus

(b) apparently inflexible adherence to specific, nonfunctional routines or rituals

(c) stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements)

(d) persistent preoccupation with parts of objects

The DSM IV (APA, 2000) states that autism is also characterized by delays or abnormal functioning in at least one of the following areas, with onset prior to age 3 years: (1) social interaction, (2) language as used in social communication, or (3) symbolic or imaginative play. The final criteria in the DSM IV states the disturbance is not better accounted for by Rett's Disorder or Childhood Disintegrative Disorder.

Individuals with ASD can exhibit any combination of these behaviors in any degree of severity. Two children, both with the same diagnosis, can act completely different from one another and have varying capabilities. Koegel & Koegel (2000) state that variability may best describe the characteristics of individuals with autism including aggressive and/or self-injurious behavior in some cases. Persons with autism may exhibit some of the following traits; resistance to change, difficulty in expressing needs, repeating words or phrases in place of normal, responsive language, laughing (and/or crying) for no apparent reason showing distress for reasons not apparent to others, preference to being alone, tantrums, difficulty in mixing with others, not wanting to cuddle or be cuddled, little or no eye contact, unresponsive to normal teaching methods, sustained odd play, spinning objects, obsessive attachment to objects, apparent over-sensitivity or under-sensitivity to pain, no real fears of danger, noticeable physical over-activity or extreme under-activity, uneven gross/fine motor skills and non responsive to verbal cues, acting as if deaf, although hearing tests in normal range (Autism Society of America, 2005). Sensory integration problems are also extremely common (NIMH, 2005).

In terms of social deficits, the criteria for autism and Aspergers are identical. Individuals with Aspergers are aware of other people and desire friendship. They are often involuntarily socially isolated because approaches towards others tend to be inappropriate and peculiar (Bloch-Rosen, 1999). Difficulties in social interactions often lead to limited eye contact with other people in social situations and do not have the ability to relate to them through conversation. In autism, attachment to family members is more atypical, and broader social patterns are marked by withdrawal and aloofness (Klin & Volkmar,1997). Computer assisted biofeedback has the potential to provide training in self management of behavior as well as to be used as a tool to develop a coping mechanism for individuals with ASD that struggle on a day to day basis in a variety of situations.

Challenges for Students with ASD

A major theme of Vygotsky's social development theory is that social interaction plays a fundamental role in the development of cognition. Vygotsky (1978) states: "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological) and then inside the child (intrapsychological)". The social and communication deficits of individuals with ASD limit the opportunity to develop cognition. Thus, students with ASD present educators with unique challenges.

Autism consists of a “triad of impairments” (Wing, 1996), social, communication and a tendency toward rigidity and inflexibility in thinking, language, and behavior (Moore, et al., 2005). Researchers suggest that at the core of these deficits is the “theory of mind deficit” (Howlin, Baron-Cohen, & Hadwin, 1999). Theory of mind research attempts to explain how children come to understand social action in both themselves and others and develop the ability to take the perspective of another person (Atwood, 2000). The theory of mind deficit can affect many aspects of an individual with ASD’s life including causing anxiety and frustration. Computer-assisted biofeedback has the potential be a tool for individuals with ASD to learn to self manage behavior and cope in situations that cause anxiety and frustration.

Appropriate social skills are also extremely challenging for individuals with ASD. Social skills training needs to be planned for and facilitated throughout the day in various settings. Specific activities and interventions need to be used to meet age-appropriate and individualized social goals (Simpson & Myles, 1998). The development of social skill interaction with peers and adults should also be emphasized.

One common characteristic of individuals with ASD is that they often do not acquire functional communication as a social means of meeting their needs and desires (Simpson, 2005). Communication is a critical area for individuals with ASD. Communication skills are needed to participate in all aspects of life, including school, work, and community. Appropriate means to communicate need to be provided and taught. A functional communication system for both verbal and nonverbal students is essential. Thus, effective teaching techniques for both vocal and alternative modes of communication should be applied consistently across settings. Koegel, Koegel, Hurley & Frea (1992) found that when children are taught to engage in appropriate communicative behaviors, inappropriate behaviors such as aggression, self-injury, and self-stimulation decrease.

Challenging behaviors are frequently exhibited by individuals with ASD. A great majority of the time the challenging behaviors are attributed to high levels of stress and anxiety or general frustration (Buron, 2003.) Often, exhibiting these behaviors leads to a restrictive educational placement. Intervention strategies that address challenging behaviors are critical for the student with ASD. Interventions must incorporate assessment information about the contexts in which the behaviors occur and the function of the behavior for the student.

Self-determination, self-regulation and self-management involves incorporating the student as an active participant in the education program (Koegel, Frea, & Surratt, 1994) and increasing one's ability to be independent. A clear mandate of IDEA is to maximize all students' involvement in the general curriculum. How best to accomplish this is not clear. Wehmeyer, Field, Doren, Jones, & Mason (2004) advocate that promoting and enhancing self-determination has the potential to promote access to the general curriculum. Additionally, Koegel & Koegel (2000) state that self-management can be used for extended periods of time in the absence of an intervention and is easily adapted for use in a wide variety of natural environments.

The above mentioned challenges represent key deficits for most students with ASD. We must continue to seek ways to assist students with ASD to address their needs with best practice and research-based instructional methods. The education plan for a student with ASD should be based on the individual's unique needs and strengths. Educators have a responsibility to use this information to provide the best possible educational opportunity for each student. One proposed solution, cognitive behavioral interventions, has been associated with successful outcomes for students with ASD (Simpson, 2005). The computer-assisted biofeedback being used in this study focuses on teaching individuals with ASD to manage their own behavior like many cognitive behavioral interventions (Heflin & Simpson, 1998).

Interventions used for Students with ASD

Interventions used with individuals with ASD should include written goals and objectives which increase a student's independence, maintain a student's skills over time in a range of naturalistic settings, and increase a student's ability to respond to the environment (Simpson, 2005). A comprehensive assessment of needs is recommended as the first step and will become the blueprint for that child's educational plan (Horner, et al., 2002).

Different assumptions exist about what is possible and what is important in providing education for students with ASD. However it is clear that two main goals that educators should focus on when developing interventions are: (1) promoting social independence and (2) promoting social responsibility (Delandshere, 2004). These goals should be universal for all students.

Olley (1999) notes that a comprehensive and individualized curriculum that promotes independence and skills needed for adult functioning can result with the designing of an individualized curriculum based on individual assessments and preferences. This is important as children with ASD may demonstrate a variety of manifestations of the disorder and require services accordingly. Hence, the goal of an intervention for students with ASD should be to reduce problem behavior and facilitate engagement in learning (Horner, et al., 2002).

An immense amount of literature exists describing best practices but there is little empirical evidence of a single curriculum or intervention that ties these strategies together. Iovannone et al. (2003) identify 6 core elements that have empirical support and argue they should be included into any instructional program for students with ASD. These elements include: (a) individualized supports and services for students and families, (b) systematic instruction, (c) comprehensible/structured learning environments, (d) specialized curriculum content, (e) functional approach to problem behavior, and (f) family involvement. Computer-assisted biofeedback could be used in a way that does tie all of these core elements together.

Clearly, parents and professionals need to work together to achieve optimal gains for the child. Teachers should have some understanding of the child's behavior and communications skills at home, and parents should let teachers know about their expectations as well as what techniques work at home. Open communication between school staff and parents can lead to better evaluation of a student's progress (Kelley & Samuels, 1977). Furthermore, cooperation between parents and professionals can lead to increased success for the individual with autism (Simpson, de Boer-Ott, & Smith-Myles, 2003).

Several treatment approaches, sometimes referred to as curriculums, have been developed to address the range of social, language, sensory, and behavioral difficulties. While some of these treatments have not been validated scientifically, there are a number of treatment approaches that do have empirical support. Treatments with empirical support include: Applied Behavioral Analysis (ABA) (Lovaas, 1987); Treatment and Education of Autistic & related Communication Handicapped Children (TEACCH) (Mesibov, 1997); Functional Curriculum (Neel & Billingsley, 1989); Picture Exchange System (PECS) (Frost & Bondy, 1994); Floor Time (Greenspan, Wieder, & Simons, 1998); Social Stories (Gray & Garand,1993); Sensory Integration (SI) (Ayers, 1979), Inclusion (Rogers, 1993), and Cognitive-behavioral Interventions (CBI) (Mayer, et al., 2005).

Behavior treatments incorporating research based supported procedures have proven to be very effective for individuals with ASD. For example, many educational and treatment programs include techniques developed through applied behavior analysis to address the behavioral challenges presented by individuals with ASD. Some programs that focus exclusively on challenging behaviors include different types of behavior techniques meant to determine the cause of the behaviors and/or replace them. Still other programs are based on learning new skills such as communication. Intensive or comprehensive behavior programs (Lovaas, 1987) incorporate both the acquisition of new skills and the replacement or elimination of maladaptive behavior.

Behavioral psychology and applied behavior analysis are widely acknowledged as making contributions to the knowledge of environmental variables that have a direct effect on student outcomes (Kauffman, 2001). The majority of research in ABA to date has been conducted with individuals with developmental disabilities. Research based on applied behavior analysis has been positively regarded for its ability to discover functional relationships between student behavior and environmental stimuli. However, it has also been criticized for focusing on relatively insignificant outcomes as opposed to more "clinically significant" gains like social acceptance or quality of life (Duchnowski, Kutash, & Friedman, 2002). A great advantage of behavioral programs is that they can be carried out across home, school and work environments. Positive Behavior Support is a form of applied behavior analysis that looks at the entire context of the individual's behavior and plans behavioral interventions that are sensitive to the values, desires and characteristics of the individual (Janney & Snell, 2000).

There are a number of procedures that have been used to effectively teach a variety of skills to individuals with ASD a wide variety of skills. Applied Behavior Analysis or ABA is a science which involves the application of basic behavioral practices (positive reinforcement, repetition, and prompting), and the use of systematic data tracking (Cooper, Heron, & Heward, 1987). Many of the interventions used to treat children with autism are based on the ABA theory and the premise behavior rewarded is more likely to be repeated than behavior ignored.

Although ABA is a collection of practices, many people use the term to describe a specific treatment approach with subsets that include discrete trial training or Lovaas training (Lovaas, 1987). Lovaas training includes discrete trial training (DTT) is an intensive approach that can be emotionally draining for a child with autism. DTT includes about 40 hours a week of one-on-one training and is not used in typical educational curriculums.

The Treatment and Education of Autistic and Related Communication Handicapped Children (TEACCH) program was developed by Eric Schopler in the 1970's and is based at the University of North Carolina at Chapel Hill. It is a structured teaching program that includes a focus on the principle of modifying the environment to accommodate the needs of individuals with ASD (Schopler, Mesibov, & Hearsey, 1995). The four main components of the process incorporated in TEACCH are; physical organization, visual schedules, work systems, and task organization. Physical organization refers to the layout of the area for teaching academic and community skills. This organization is designed to provide students with visual boundaries of different areas. Visual schedules convey to the students the type and sequence of upcoming activities. Work systems promote independence. They visually specify what work is to be done, how much, and when the work is complete. Finally, task organization focuses on exactly what needs to be done within a task and the final outcome.

Functional curriculums include training in life skills, independent living skills, daily living skills, vocational and career education, and career development concepts (Neel & Billingsley, 1989). The key consideration in determining whether to teach an academic skill in a functional curriculum is, whether the student will be able to use this information currently or in the future (Wehman & Kregel, 1995). The functionality of an academic skill is defined by the student and their family based on their home and community environments.

The Picture Exchange System (PECS) is an augmentative communication program designed for individuals with ASD and other disabilities who lack expressive language (Frost & Bondy, 1994). The first step is determining the student's preferred reinforcers. Using PECS, students learn to exchange a picture for this desired item. Research indicates positive results of participants generalizing functional communication skills across time and settings (Bondy & Frost, 1994; Schwartz, Garfinkle, & Bauer, 1998). This approach is widely used in preschool and elementary school classrooms (Simpson, 2005).

Floor Time was developed by Stanley Greenspan and is a play-based interactive intervention approach that emphasizes individual differences, child-centered interests, and affective interactions between a child and a caregiver (Greenspan, Wieder, & Simons, 1998). Floor time is an intervention designed to assist children in reestablishing critical missed developmental or functional milestones, and reestablishing the developmental sequence that was interrupted (Simpson, 2005).

Social Stories are individualized cognitive interventions that describe social cues and appropriate responses associated with different social situations (Gray & Garand, 1993). Social stories are low cost and easy to implement. Subsequently, they are widely used. Several studies reported social stories were effective in addressing a target behavior (Bledsoe, Myles & Simpson, 2003; Hagiwara & Myles, 1999; Norris & Datillo, 1999).

Sensory Integration (SI) refers to the capacity of an individual to internally organize sensory input (Simpson, 2005). The SI theory is based on the belief that some children suffer from a neural dysfunction which causes the nervous system to insufficiently receive and process incoming information (Ayers, 1979). According to Ayers, indicators of SI dysfunction include oversensitivity or under reaction to stimuli; unusually high or low level of activity; coordination problems; delays in speech, language, or motor skills; behavior problems; and/or poor self-concept. A review of the literature on sensory processing disorder revealed sensory integration was either effective or equally effective as other approaches (Polatajko, Kaplan, & Wilson, 1992). Proponents of SI state that benefits of its use include improvement in mental processing and organization of sensations, resulting in adaptive responses and increased satisfaction (Myles et al., 2000).

One goal of inclusion is to educate children with ASD with neuro-typical children in the general education setting, to the maximum extent possible (Rogers, 1993). Some children with ASD who are placed in general education settings have a 1:1 aide and have a modified curriculum to accommodate specific learning strengths and deficits. Selective, partial, and full inclusion are all possibilities and the goal and effectiveness must be determined by each child's individual education plan (Dybvik, 2004). Increased skill achievement of developmental and academic outcomes have been reported as a result of students with ASD being placed in inclusive environments (Odom & McEvoy, 1988; Wang & Baker, 1986). The greatest benefits noted have been in children who cognitively match their classmates. A team approach in planning is essential for success.

Cognitive-behavioral interventions (CBI) have been successfully used in a variety of settings to address anger/aggression, anxiety, impulsive behavior, social skill deficits, and related behavior problems (Kendall, 1991; Larson & Lochman, 2002). Several CBI techniques and strategies, including self monitoring and self management, fall under this category. They are used to alter behavior by teaching individuals to actively participate in understanding and modifying their own thoughts and behavior (Mayer, et al., 2005).

One positive outcome of the No Child Left Behind (NCLB) (2002) legislation is the expectation that practices should be supported by standards derived from scientific evidence as to their effectiveness (Nelson, 2004). The difficulty this imposes is that these standards are based on norm-referenced assessments which typically do not align with the needs of students with ASD. Individuals with ASD are typically visual thinkers and norm-referenced assessments are typically developed by, and for, language based thinkers. These assessments do not accurately assess most individuals with ASD. Thus, groups of special education professionals and organizations continue to work on developing standards for validating contemporary single-subject, quantitative, and qualitative research methodologies (Odom, Gersten, Horner, Thompson, & Brantlinger, 2003). Nelson (2004) reports that the criteria used to identify research-based practices include the following elements: (a) the use of sound experimental or evaluation design and appropriate analytical procedures, (b) empirical validation of effects, (c) clear implementation procedures, (d) replication of outcomes across implementation sites, and (e) evidence of sustainability.

Several interventions used in schools with students with ASD have met the NCLB research-based criteria but are not being used with fidelity or being implemented incorrectly. Interventions that have met research-based criteria include contingent praise, pre-correction, direct instruction, curriculum-based measurement, group contingencies, positive reinforcement, overcorrection, and some psychopharmacological interventions (Nelson, 2004). Additional interventions and respective uses include: token economies to increase positive social behaviors (Smith & Farrell, 1993); response cost and time out from positive reinforcement to decrease aggressive behavior (Costenbader & Reading-Brown, 1995); precision requests to increase compliance (DeMartini-Scully, Bray, & Kehle, 2000); self-monitoring to increase on-task behavior and academic productivity (Lloyd, Bateman, Landrum, & Hallahan, 1989); and classwide peer tutoring to increase rates of academic engagement (Delquadri, Greenwood, Whorton, Carta, & Hall, 1986). The problem is that these practices largely aren't being applied in the classroom with fidelity (Cook & Schirmer 2003). As a result, some research studies including these interventions don't always meet the research criteria. One example is the use of praise in a study by Strain et al. (1983). They found that teacher attention followed student compliance just 10 percent of the time, and for the 82 percent of the children in their study who were rated low in social adjustment, no positive consequences for compliance ever occurred. The knowledge about what works exists, but for a variety of reasons, the interventions are not applied at all or they are not applied as they were designed (Cook et al., 2003).

Pyschopharmacolgy is yet another emerging field in treating the broad range of symptoms of ASD. The use of medication as an intervention for problematic symptoms exhibited by children and youth with ASD is common and controversial among parents and professionals (Tsai, 2000). According to Tsai , certain medications are highly effective in treating a variety of neuropsychiatric disorders that develop in some children with ASD. However, many medications have side effects that need to be considered. This points to the need of further investigation of partnerships between educational and medical interventions.

According to a 2001 National Research Council (NRC) report, intervention at an early age is a key component of successful programs for children with autism. Emphasis on the earliest possible screening, diagnosis, and eligibility for autism services, evaluations, and ongoing assessment and the immediate implementation of appropriate effective autism interventions is suggested. The NRC also reported a general consensus that the following features provide a common foundation of all successful intervention programs for children with ASD: (a) tailored to the needs of each individual with specific adaptations that match that student's specific profile, age, stage of development, and emergent potentials, (b) highly structured and consist of skill-oriented teaching and treatment programs, (c) include frequent informal reassessment and systematic data-based tracking of skill growth, (d) individual motivational strategies and systems should be used consisting of a combination of extrinsic and intrinsic motivators, (e) teaching area should be structured, organized, and distraction free environments which incorporate one-on-one or small group instruction, (f) activities and routines should be predictable yet flexible with wait time kept to a minimum, (g) multiple settings and consistency of methodology across time and settings to promote generalization, (h) personnel should be well trained and continuously evaluated for competence and consistency (i) include family centered choice with life-span planning, (j) comprehensive home programming and parent training within a team approach, and (k) intervention strategies should be maintained full-day and year-round from preschool through adulthood. These features provide the theoretical foundation for this study.

Practical and ethical considerations in the education of students with ASD have made well-controlled research studies with random assignment problematic and practically impossible. The National Research Council (2001) reports that a number of comprehensive programs report results on their effects, but interpretations of the results have been limited by several factors. These include lack of fidelity of treatment or generalization data, inadequate descriptions of the children and families who participate in studies, and problems in selecting contrast groups. Consequently, the literature contains a “mix of science, anecdotal reports, and unproven theories” (Olley,1999). This is of concern as many interventions and programs with and without a solid research base, are becoming popular through reports made by magazines, television, and the internet (Feinberg & Vacca, 2000).

A sound body of research exists on best practices for students with ASD, but there is no one practice or program that is equally appropriate or effective for all students with ASD (Prizant & Rubin, 1999). However, it is clear that overall, effective programs are more similar than different in terms of the use of certain techniques catering to the strengths of individuals with ASD. Due to the extreme differences of strengths and deficits among individuals with ASD, it appears that each student must truly have an individualized curriculum consisting of a mixture of research-based best practices.

BIOFEEDBACK

Principles of Biofeedback

A simple definition of biofeedback is that information is fed back to an individual about that individual's biological functions. Biofeedback is also considered a coaching and training process which helps people learn how to change mood and patterns of behavior by changing one or more of the their physiological functions. With biofeedback, some form of technology is used to provide information beyond the ability of normal senses about one or more of the body's functions. As such, "biofeedback" refers to the biological signals that are returned to an individual in order for that individual to manipulate them (Porter, 2003). The person first receives the information as feedback to increase awareness or consciousness of the changes in the body/mind function. The feedback is then used to learn to develop the ability to regulate or control the functions measured. Many functions of the body, such as blood pressure, take place without much conscious awareness. Many more, like heart rate and breathing can be trained to self regulate at a more efficient level. Biofeedback is a technique through which individuals can acquire voluntary control over a physiological function, controlled by the autonomous nervous system, by monitoring its status (Sarafino, 1997).

EEG biofeedback is a learning process that enables persons to alter their brain waves. The goal of EEG biofeedback is to train the brain to focus and reduce the number of slow-moving brainwaves and increase the number of fast moving brain waves (Porter, 2003). When information about a person's own brain wave characteristics is made available to him, he/she can learn to change them. It can be considered as exercise for the brain.

In evaluating the studies in the overall broad area of the neurofeedback treatment of anxiety disorders, EEG biofeedback qualifies for the evidence-based designation of being an efficacious treatment (Hammond, 2005). EEG biofeedback is technology that offers an additional treatment alternative for modifying behavior. It has the advantage of not being as invasive as many therapies and has been associated with few side effects or adverse reactions.

Effectiveness of Biofeedback

There have been several studies that have shown the efficacy of using biofeedback to reduce impulsive behaviors in children with ADHD (Monastra, et al., 2005; deBeus, et al., 2004; Butnik, 2005). An investigation of literature articles found one research study in a therapeutic day school investigating the efficacy of biofeedback in the treatment of children with ASD. Scolnick (2005) reported on a pilot study of electroencephalogram (EEG) biofeedback to improve focusing and decrease anxiety in 10 adolescent boys diagnosed with Asperger's syndrome. At baseline, each child had a quantitative EEG conducted. The biofeedback intervention consisted of two 30 minute sessions per week of the child playing a video game that was controlled based on the child's brainwaves. A trend to normalization was noted, though it not reach statistical significance. However, all five boys who completed 24 sessions showed improved behavior as rated by parents and teachers.

Orlando and Rivera (2004) conducted a study using neurofeedback for sixth, seventh and eighth grade students identified with learning problems. The study concluded that biofeedback training is effective in improving reading quotients and may be an effective supplement to special education in improving IQ and reading performance. Carmody et al., (2001) used biofeedback training with eight students labeled ADHD in a school setting. Teacher reported improvements in attention for all four in the experimental group. In 1995, Rossiter & LaVaque explored the use of EEG biofeedback as an alternative and/or adjunctive approach to pharmacological treatments for ADHD. Forty-six students ages 8-21 participated in the study. Two groups of 23 received either medication or sessions of biofeedback treatment. The results indicated that the EEG biofeedback program was an effective alternative to stimulants and may be the treatment of choice when medication is ineffective, has side effects, or compliance is a problem. Furthermore, Lubar (1997) reported effects of biofeedback being much more longstanding than what is reported for stimulant medication, which is clearly more time limited. The research thus far is promising and has implications for students with ASD. A thorough search for literature found no formal research studies have investigated the use of biofeedback as a classroom intervention with students with ASD. This study is designed to empirically examine the use of biofeedback with students with ASD in the classroom.

Computer-assisted Biofeedback

Computer-assisted biofeedback training in this study was conducted using the Freeze-Framer software program. The Freeze-Framer Program is a scientifically-validated, interactive learning system that has improved learning, performance, and behavior (McCraty, 1999) for individuals of a variety of ages. McCraty assessed changes in cognitive performance associated with states of increased heart rhythm coherence. Thirty subjects were randomly divided into matched control and experimental groups based on age and gender. Cognitive performance was assessed by determining subjects' reaction times in an auditory discrimination task before and after practicing the emotional self-management technique to increase cardiac coherence. The results of McCraty’s study support the hypothesis that the changes in brain activity that occur during states of increased psychophysiological coherence lead to changes in the brain's information processing capabilities. Results suggest that by using heart-based interventions to self-generate coherent states, individuals can significantly enhance cognitive performance.

In EEG brainwave self-regulation training, a computer screen is utilized to display the individual’s brainwave activity. Through a series of tasks and exercises, the individual can be shown the brain’s reaction to stimuli. With knowledge of these reactions, the individual can be taught how to change the reactions through the effects of proper breathing and changing the thought focus, e.g., improved concentration through proper focus and relaxation (Institute of HeartMath, 2005). There is a growing body of research indicating that children respond to this process of learning to self-regulate and increase their EEG frequencies and amplitude activities by improving their behavior and increasing their grades (Monastra, et al., 2005; Tansey, 1993). Monastra et al. critically examined studies of the effects of EEG biofeedback over the last thirty years. The empirical evidence 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. Tansey (1993) followed up, after 10 years, a 10 year old boy diagnosed with developmental reading disorder, hyperactivity, and an educational classification of perceptually impaired who completed a biofeedback training regimen. His study reported long-term stability of the results of the biofeedback training including normal social and academic functioning. This is of interest for individuals working with students with ASD as they appear to have a natural affinity for computers and the controlled environment provided by the computer (Moore et al., 2005; Moore and Taylor 2000).

Using the Freeze Framer, students can be provided the opportunity to learn to alter their heart rate, and ultimately learn to control their physiological reactions which can enable the student to control problematic impulsive behaviors. Heart rate variability is a measure of neurocardiac function that reflects heart-brain interactions and autonomic nervous system dynamics (McCraty & Singer, 2002). The heart rate variability screen in the Freeze-Framer software program provides the needed feedback to the student allowing for adjustments to be made. Using computers as a means of instruction appears to have several benefits for students with ASD (Higgins & Boone, 1996). One benefit is that computers can provide consistency and consist of multilevel interactive functions that may be appealing to the students. Computers also use software programs that are very structured, can be individualized and can be used independently (Yamamoto & Maya, 1999). Ultimately, for individuals with ASD, self-regulation of physiological reactions could provide opportunities to be included in many aspects of society that might otherwise not be available.

Challenges of Using Biofeedback

Using biofeedback with students with ASD has its challenges. Among these challenges is fidelity of using the biofeedback software program. Another challenge is the minimum amount of time that must be completed with the individual’s finger or ear connected to the sensor. Cognitive ability of the individual is another concern. This is compounded as measuring the cognitive ability of an individual with ASD is a difficult task in most cases. Most assessment tools are developed for language based learners which is not representative of most individuals with ASD. Still another challenge is the ability to recognize the relationship between the visual representation of the heart rate variability and physiological changes that the individual makes. Having this ability is imperative for successful use of any biofeedback software program.

Relaxation and Biofeedback

Relaxation is a key component in biofeedback treatment of many disorders, particularly those brought on or made worse by stress, anxiety, or frustration (Critchley, et al., 2001). The reasoning for this is based on what is known about the effects of stress on the body. A brief summary of the argument is that stressful events produce strong emotions, which arouse certain physical responses. These physical responses can cause cognitive and physical limitations. Feelings like frustration and anxiety cause the neural activity in the two branches of the autonomic nervous system to get out of sync (Institute of HeartMath, 2005). This in turn affects the synchronized activity in the brain, disrupting our ability to think clearly. Lazarus (1981) defined stress as the transaction in which demands are seen to exceed coping skills. Research reveals relaxation techniques and increased coping skills have an impact on performance demands (D'Zurilla, 1986).

Time On-Task and Achievement

The relationship between achievement, or learning, and on-task behavior or academic engaged time and achievement or learning is strong and has been clearly established in the literature (Cancelli, Harris, Friedman, & Yoshida, 1993; Curry, 1984; Greenwood, Horton & Utley, 2002; Nystrand & Gamoran, 1989). In an investigation of students' engaged academic behavior, Frederick (1977) found that high-achieving students were academically engaged 75 percent of the time, compared to 51 percent for low-achieving students. Gresham, (1996) found that many students with differing types of exceptionalities function well below national normative levels in measures of cooperation, assertion, and self-control while demonstrating elevated scores for externalizing behavior problems, hyperactivity, and inattention. Combined, these educational characteristics leave students with exceptionalities vulnerable to disengaging from tasks requiring independent work (Rock, 2005). Strategies that may be beneficial to this effort are self-management and/or self-monitoring of behavior. Researchers have successfully used self-monitoring interventions within the context of special and general education settings to increase students' academic engagement and productivity for more than two decades (Dunlap et al., 1995; Haas-Warner, 1992). Carr & Punzo (1993) documented that self-monitoring is an effective behavioral intervention to increase academic engagement, decrease disruption, and enhance academic skills including productivity and accuracy. Computer-assisted biofeedback can provide students with an opportunity to learn the skills needed to self manage and self monitor their behavior ultimately increasing time on-task and achievement.

Summary

Research on various models and methods for managing behavior for students with ASD effectively in the classroom is in short supply. A majority of what is published in research journals focuses on diagnostic issues and characteristics of the disorders. The National Research Council's (NRC) Committee on Educational Interventions for Children with Autism in 2001 found that only 5 percent of the thirteen intervention methods studies in autism they investigated met the NRC's criteria for internal and external validity and none reached the criteria for generalization. Due to the fact that intervention research requires more time and effort in terms of ethical and environmental control, it is clear why intervention research is much less prevalent in the literature. Another challenge facing future researchers in the field is that there is not a consensus on desired outcomes for students with ASD. Educational programs have been criticized for deemphasizing academic achievement while promoting behavioral control (Knitzer, Steinberg & Flesch, 1990). The lack of intervention research coupled with disagreement among professionals about desired outcomes leaves future researchers with a huge challenge.

Ultimately, when dealing with students with ASD, it is unlikely that a uniformly applied, uniformly effective “packaged” intervention will be discovered in the near future. Interventions must be designed to fit the characteristics of individual children and in relevant environments. Most importantly, skill, willingness, and perseverance of the interventionists will have the biggest effect on the student (Sasso, Conroy, Peck Stichter, & Fox, 2001). Based on the NRC Report, 2001, there is an urgent need to increase the quantity and improve the quality of research to determine the efficacy of currently available treatment options. The dissemination of adequate research-based information is imperative in order to maximize the potential benefit for each student.

This research study explored the classroom use of computer-assisted biofeedback as an intervention for students with ASD. The purpose was to investigate whether computer-assisted biofeedback as an intervention combined with the behavioral approach is an effective treatment for individuals with ASD targeting significant goals of self management of behavior and achievement.

CHAPTER III

METHODOLOGY

Introduction

The purpose of this study was to analyze the effectiveness of computer-assisted biofeedback software for students with ASD in a school setting. For the purpose of identifying implications for practice and research, subjects and subject data were obtained from the Special Education Departments of a large metropolitan school district in the southeastern United States. A letter of human subjects approval (Appendix A), Orange County Public Schools Research Approval (Appendix B), a parental consent form (Appendix C), teacher consent (Appendix D), and a child assent script (Appendix E) are included in the appendices.

Specifically, this study investigated on-task behavior during an independent individualized writing assignment following a computer-assisted biofeedback session. Students with ASD often exhibit hand-flapping, spinning, self-talk, humming, drumming, and pacing during times of high anxiety and frustration (Church, et al., 2000). The use of computer-assisted biofeedback has the potential to provide the participants a visual representation of what was happening in their body. By using relaxation strategies already taught, including breathing and imagery strategies, the participants could view how these strategies affect their body. Ultimately, the computer-assisted biofeedback was used to provide the participants a visual tool which allowed them to monitor their anxiety and self-regulate their behavior.

The computer-assisted biofeedback training was conducted using the Freeze-Framer software program. This computer assisted biofeedback program was used as an intervention to promote positive behavior and academic change for students with ASD. Heart rate variability is displayed on the computer screen in real time as the strategies are practiced. An ear sensor detects each pulse and the time interval between consecutive heartbeats is computed. The speed of the participants' heart rate is plotted on a beat-to-beat basis and the heart rhythm patterns are analyzed for coherence. Coherence reflects autonomic nervous system balance and entrainment of the body's inner systems. A smoother wave-like heart rate variability pattern indicates a more balanced autonomic nervous system and a higher ratio of physiological entrainment (McCraty, 1999).The output of the entrainment algorithm is used to control three fun games that are designed to reinforce emotional self-management skills. These colorful games help to motivate the participant to learn how to manage physiological state and heart rhythm. For the purpose of this study, the participants only utilized the Heart Rate Variability Screen and the three minute meadow game, in which a black-and-white nature scene gradually transforms into a beautiful landscape filled with color, running water and animals as students demonstrate changes in heart rate coherence. The participants were prompted to use the breathing and imagery strategies while using the Freeze-Framer.

The quantitative measures included direct observation by the research team of the participants' latency of speed to engagement and duration of time on-task when given an individualized writing task. Speed to engagement was measured in seconds from the time the teacher or paraprofessional placed the writing task in front of the participant to the time the participant begins the activity by placing his/her writing utensil to the paper. Directions were given to the participant prior to the start of the measurement. A percentage of the duration of time on-task was measured by using a momentary time sampling of 15 second intervals. Basic descriptive statistics involving the measures listed above along with corresponding percentages and mean percentages were recorded and summed during baseline and throughout the study, individually and cumulatively for all participants. The data were plotted and graphed for visual inspection. The careful experimental control over the intervention in the classroom facilitated the use of visual inspection as being appropriate for the study (Kazdin, 1982).

The qualitative methods included parent and teacher surveys regarding the intervention. These surveys were used to determine the parent and teacher's overall opinion of the intervention as well as whether or not generalization of self-regulation of behavior occurred in the classroom and home environments. Evidence was gathered systematically throughout the implementation of the program through the researcher's anecdotal records (Appendix L) and the participants' acquisition of the strategy. Performance level of the individualized writing task was determined based on a comparison of performance during baseline and performance level during intervention as measured by a writing rubric. The differences in performance are described for each participant.

Research Questions

1. Does computer-assisted biofeedback in the classroom increase speed to engagement of an academic activity? (Decreasing the latency between the time the students are presented with a writing activity and the time the students begin their work.)
2. Does computer-assisted biofeedback in the classroom increase time on-task working on an academic activity? Duration of time on-task was estimated by momentary time sampling.
3. Does computer-assisted biofeedback in the classroom increase the performance of an academic activity?
4. Does generalization of self-regulation of behavior carryover to other areas of classroom and home environments?

Research Design

The experimental design used to evaluate the effectiveness of computer-assisted biofeedback for students with ASD, including PDD in the classroom was multiple baseline design across participants (Kazdin, 1982). A single-subject research method was chosen as it focuses on the individual, provides a practical methodology for testing educational and behavioral interventions, provides a practical research methodology for assessing experimental effects under typical educational conditions, and is a cost-effective approach to identifying educational and behavioral interventions that are appropriate for large scale analysis (Horner, et al., 2005). The purpose of single subject research design is to document causal or functional relationships between independent and dependent variables (Horner et al.). The unique feature of these designs is the ability to conduct experimental research with a small sample size, even a number as small as one single case (Kazdin). Another important reason to use a single-subject design in this study is the unique characteristics of the participants. Kazdin states that the most fundamental requirement of single case experimentation is dependence on repeated observations of performance over time.

Design Review

Multiple baseline designs are used to demonstrate how an intervention alters the target behavior. One target behavior is selected for two or more participants or groups in the same setting. The effects are demonstrated by introducing the independent variable, or intervention, to different baselines at different points in time. Once a stable rate of performance is established in the data under baseline conditions, the intervention is introduced to one of the subjects while the others remain in baseline (Kazdin, 1982). The staggered introduction of the intervention at different points in time for multiple participants demonstrates experimental control for most threats to internal validity and external validity. (Horner, et al., 2005). Cooper, Heron, & Heward (1987) state the most important advantage of the multiple baseline design is that it does not require withdrawal of a seemingly effective treatment to demonstrate experimental control. Cooper, et al., (1987) also state that a multiple baseline across subjects design is not a single-subject design in the "true sense" because each subject does not serve as his/her own control. Predictions based on one subjects' behavior must be verified by the other subjects' behavior and replication of the effect is dependent on the behavior of other subjects.

Description of Participants

Selection

Three students participated in the study. There were two females and one male. The two females were fraternal twins. All participants were 9 years of age at the beginning of the study and were 10 years of age at the conclusion of the study. Two of the participants had a diagnosis of Autism/Pervasive Developmental Disorder and one student had the diagnosis of Pervasive Developmental Disorder. One participant was assigned by the school district as functioning at the 3rd grade level, another as functioning between the 1st and 2nd grade level, and the third participant as functioning between the Kindergarten and 1st grade level. Descriptions and demographic information of the participants is provided in Table 1.

All participants were attending an elementary school in a large metropolitan school district in the southeastern United States. All participants were in a self-contained classroom and in Exceptional Student Education programs. The researcher and special education teacher identified the students for involvement in the study. The following selected criteria was used: (1) diagnostic label of ASD in cumulative file, (2) an adaptive behavior IEP goal, (3) ability to follow directions, (4) student willingness to participate, (5) parental consent, (6) student attendance, (7) reported by teacher to be able to focus on visual stimuli, and (8) limited tactile defensiveness.

Consent to participate in the study was obtained from the Institutional Review Board (IRB) at the University of Central Florida, the Senior Director of Program Services for research in the Orange County School District, the principal of the school, the teacher and paraprofessionals in the classroom, the participants' parent, and the participants.

Table 1

Participant Demographics

Participant	Date of Birth	Ethnicity	Gender	Diagnosis	Medication	Grade level functioning
1	4/14/96	W	F	Autism/PDD	None	3rd
2	4/14/96	W	F	Autism/PDD	None	1^{st} – 2nd
3	5/13/96	W	M	PDD	None	K – 1st

Note: PDD indicates Pervasive Developmental Disorder. W indicates Caucasian. M indicates male. F indicates female.

Setting

The computer-assisted biofeedback software was used in a self-contained classroom of students with ASD located in a primarily metropolitan area in the southeastern part of the United States. Along with one teacher, there are two para-professionals and eleven students in the classroom. The teacher was a Certified Associate Behavior Analyst and a first year teacher.

The computer-assisted biofeedback was used once a day, 5 times per week, during the same time period, between 9:30 a.m. and 10:30 a.m. each morning. The software and finger or ear sensor was located at an assigned computer for the participants in the classroom. A member of the research team was with each participant facilitating the use of the software. The academic activity, and individualized writing task designed to meet an Individualized Education Program (IEP) goal, took place at the participants' assigned work area in the classroom. After the participant had begun the intervention phase of the study, the participant went directly from the computer to his/her assigned work area to complete an individualized writing task.

Research Team

The facilitator involved in this study was the researcher, a doctoral student at the University of Central Florida in the Department of Child, Family and Community Sciences. The researcher majored in Exceptional Education and participated in the implementation of pilot studies utilizing computer-assisted biofeedback with children diagnosed with ASD or Emotional Behavior Disorders. The researcher also had experience in teaching, data collection and psychoeducational testing with children grades k-12 with varying exceptionalities. The second facilitator was a doctoral student at the University of Central Florida in the Exceptional Education program and also had experience in teaching, data collection and psychoeducational testing with children with disabilities. The research team was trained in data collection procedures as well as the intervention implementation protocol. The facilitator implemented the Freeze-Framer intervention. The facilitator observed and recorded speed to engagement and on-task behavior. The second facilitator completed observations and recorded data to determine inter-rater reliability. The teacher and/or a paraprofessional conducted the presentation and collection of the writing assignment activity. The teacher and paraprofessionals completed a survey on the intervention at the end of the study. A parent of each participant also completed a survey on the intervention at the end of the study.

Dependent Measures

One dependent variable was speed to engagement of an academic activity. Direct observation of the latency of speed to engagement was measured in seconds from the time the teacher and/or paraprofessional placed the writing task in front of the student to the time the student began the activity by placing his/her writing implement to the paper.

Another dependent variable was time on-task during a five minute academic activity. Each participant was given an individualized writing task based on an IEP goal.

For Participant 1 the academic activity/writing task was to write a word from a choice of four words that best completed each sentence. For Participant 2 the writing task was to complete eight short sentences by writing an identical sentence below one that was already printed. For Participant 3 the writing activity was to trace the same sentence over six times. Directions were given to the student prior to the start of the measurement. Direct observation of duration of time on-task when given an individualized academic/writing task was measured by using momentary time sampling on 15 second intervals. Momentary time sampling provides an estimate of the duration of behavior by recording the presence or absence of behaviors immediately following specified time intervals (Cooper et al., 1987), in this case every fifteen seconds. Momentary time sampling was chosen due to data was being collected on more than one participant at a time. The percentage of time on-task was calculated and reported.

Performance level of the individualized writing task was determined based on a comparison of performance during baseline and performance level during intervention as measured by a writing rubric. Generalization of self-regulation of behavior in classroom and home environments were investigated using the Parent and Teacher Survey of Intervention instrument (Appendices F & G). The instrument was distributed and collected by the teacher following the last day of intervention. The survey results are in the discussion section. Researcher anecdotal records were recorded immediately after each session to document specific events or information as needed. Anecdotal records consisted of statements made by the participants or educators along with observable events that took place in the classroom during the data collection period.

Independent Measure

The Freeze-Framer is a computer-based self management program based on the principles of biofeedback that provides feedback of a person's heart rhythm patterns which, in turn, allows them to see and better understand how stress and different emotions are affecting their autonomic nervous system dynamics. It does this by measuring the naturally occurring changes in beat-to-beat heart rate, which is called heart rate variability (HRV) analysis. A finger or ear sensor may be used. In this study all participants used the ear sensor. Common methods of HRV analysis typically quantify the amount of variability in a given recording. Additional information can be gained by heart rhythm pattern analysis, which is unique to the Freeze-Framer (Institute of Heartmath, 2005). Twelve steps are included in the Freeze-Framer Implementation Checklist (Appendix H).

The Freeze-Frame v2.0 Interactive Learning System package included: Freeze-frame 2.0 software, a quick-start guide booklet, a computer-based tutorial, a USB interface device, a USB finger tip pulse sensor (an optional ear sensor may be purchased separately), a USB extension cable, a music CD, help menu and multimedia tutorial, and free technical support. Minimal operating system requirements include a Pentium II compatible processor 233MHz or faster, Microsoft Windows 98, ME, 2000, or XP, 450 MB of available disk space, 800 x 600 resolution, a 16-bit color display or better, a CD-ROM drive, and an available USB port.

Procedures and Data Collection

Once approval for human subject research was gained from the University of Central Florida Internal Review Board, the researcher contacted the Orange County School Board for approval. The researcher outlined the details of the study to the principal and the principal wrote a letter of support for the study (Appendix K). The research study was then explained to the teacher and paraprofessionals in detail. This was followed by a demonstration of the intervention. The teachers and paraprofessionals signed a statement of informed consent (Appendix D). Students with ASD were identified by the teacher and researcher as participants and an informational letter about the intervention and possible benefits was sent to the parents. Informed Consent of the parents was obtained (Appendix C) and a child assent script (Appendix E) was read to the students before the study began. Demographic information was collected from all participants (Appendix I). After all consent forms were obtained, the study began.

During baseline, each of the three participants was observed during the individualized academic/writing activity for a period of five to ten minutes. Three stopwatches were attached to a clipboard with Velcro and labeled one for each participant. Each stopwatch had two modes that were used in the data collection process. Mode 1 was used to measure the speed to engagement of an academic activity. The "start" button was pressed when the student was presented with activity and the "stop" button was pressed when the participants' pencil first touched the paper. The latency was kept in Mode 1 on the stopwatch and recorded at the end of the data collection session. The mode button on the stopwatch was then immediately pressed and the "start" button for Mode 2 was pressed. Mode 2 provided running time displayed digitally. This allowed the researcher to easily determine 15 second intervals for the momentary time sampling. Every 15 seconds the researcher(s) would record a “checkmark” if the participant was attending to the paper by looking at it or writing on the paper appropriately. Writing on the paper appropriately was defined as writing name, date, or completing worksheet per the directions. An “x” mark would be recorded if the participant was attending to stimuli other than the activity or writing on the activity inappropriately. If the participant did not begin the activity within five minutes, five minutes latency was recorded for speed to engagement and 0 percent time on-task was recorded.

Baseline data was collected five times per week at approximately the same time each day, from 9:30 to 10:30 a.m.. A pattern of responding that could predict the pattern of future performance was established by recording a minimum of five data points for each dependent measure for each participant. Participant 1 began the intervention phase once the data trend stabilized. This revealed a pattern that allowed prediction of future responding. While the intervention was implemented with Participant 1, baseline was continued with Participant 2 and Participant 3. Once the data for Participant 1 had an established pattern, the intervention was implemented with Participant 2. Baseline data was continued to be collected for Participant 3. Once the data for Participant 2 has an established pattern, the intervention was implemented with Participant 3.

No intervention was provided, other than the characteristic instruction that occurred within these settings during each participant’s typical school day. Interventions and routines already in place were continued. Interventions in place and used by the classroom teacher before the study was initiated included breathing and imagery techniques taught to the participants to achieve a more relaxed state when they show signs of frustration.

The Freeze-Framer was demonstrated to the participants the day before the intervention phase started for each participant. During intervention phase, the participants completed a 3 to 4 minute computer-assisted biofeedback session immediately before the academic activity. The participant was directed to the computer station assigned for the intervention. The researcher(s) were at the station ready for the student. The intervention implementation checklist was followed by the researcher (Appendix H). The participant completed approximately one minute watching the “Heart Rhythm Display”, which includes the heart rate display, the accumulated coherence “zone” chart, and the coherence ratio bar graph. The challenge level for all three participants was set at the “low” level. Following the session watching the “Heart Rhythm Display”, the participants played the three minute ‘Meadow Game’. The researcher supported the participant as needed. Supports included scripted statements from the Freeze-Framer Implementation Checklist (Appendix H). The supports provided were recorded as researcher anecdotal records (Appendix L). Immediately following the intervention, the participant proceeded to their assigned work area. The teacher then gave directions for the writing activity and placed the assignment in front of the student.

Fidelity of Treatment

A twelve step Freeze-Framer Implementation Checklist was used by the researcher each day. The implementation of the intervention was modeled for the research team by the facilitator. The research team was trained during the modeling sessions to follow the Freeze-Framer Intervention Implementation Checklist (Appendix H). Initial implementation of intervention was observed by a member of the researcher team and the accuracy of the steps were recorded using the Freeze-Framer Intervention Implementation Checklist. Implementation of intervention by researcher was observed by a second member of research team during 20 percent of the sessions. The intervention was implemented with 100 percent fidelity.

Inter-Observer Agreement

Inter-observer agreement was calculated on both dependent variables for 20 percent of the observations. Agreement occurred when the two observers, the research team, independently recorded the same latency of speed to engagement within a range of 1 second, and independently recorded a percentage of time on-task within a range of 10 percent. Prior to training sessions, the facilitator described in detail the dependent and independent measures of the study to the second observer. Three training sessions were conducted for the purpose of training for measuring latency of speed to engagement and duration of time on-task using the 15 second momentary time sampling procedure. The training sessions consisted of case studies on classroom behavior on CD-ROM of students not related to the study. A blank replica of the data collection instrument was used in the training sessions.

One stopwatch was used by both researchers for each participant. Mode 1 was pressed when the academic activity was placed in front of the participant and pressed again when the participant began the activity. Therefore, the latency of speed to engagement was the same for both researchers, establishing a 100 percent inter-observer agreement in training and throughout the study.

The use of momentary time sampling permitted point-to-point, or interval-to-interval reliability checks. An inter-observer agreement for duration of time on-task was calculated by dividing the number of agreements by the total number of agreements plus disagreements multiplied by 100. Reliability checks were conducted on the training sessions and inter observer agreement was 92.8 percent for the first training session, 93.3 percent for the second training sessions, and 100 percent for the third training session. Reliability checks were done during the intervention phase for percentage of time on-task for each participant 20 percent of the time and inter-observer agreement was 91 percent.

Data Analysis

A mixed method approach of data analysis was used. Both quantitative and qualitative data were collected, analyzed, validated, and interpreted. Latency was measured in seconds from the time the teacher placed the individualized writing task in front of the participant to the time the participant began the activity by placing their writing utensil to the paper. Percentage of time on-task was calculated from data collection using a momentary time sampling every 15 seconds for 5 minutes. The percentage of time the participant was on-task is reported. Latency and duration are graphically represented in the results section. After data were collected, data points were plotted for latency of speed to engagement and percentage of time on-task for each participant throughout the study.

Performance level of the individualized writing task was analyzed through a comparison of performance level during the baseline phase versus the performance level during intervention phase. Results are reported individually and cumulatively for all participants along with survey instrument item responses from the educators and parents.

Social Validity

Prior to baseline, the research team and members of the school staff discussed the social validity of the study as a whole. It was important to determine whether the study would be socially valid for the participants and whether they were going to benefit from their participation. Anxiety and frustration were revealed as frequent emotions displayed by the participants, and are common feelings exhibited by individuals with ASD that often lead to maladaptive behavior (Buron, 2003). The school staff expressed interest in trying the intervention. It was also noted that the intervention was practical and cost effective. All agreed that by using computer-assisted biofeedback, the participants would be provided with an opportunity to learn how to self regulate behavior which could ultimately lead to socially important changes for the participants. Hence, the study was socially valid.

CHAPTER FOUR:

RESULTS

The purpose of this study was to investigate the relationship between the use of computer assisted biofeedback and on-task behavior for students with autism spectrum disorders. Two of the research questions were quantitative in nature, focusing on speed to engagement of an academic activity and time on-task during an academic activity. Question One: "Does computer-assisted biofeedback in the classroom increase speed to engagement of an academic activity? (Decreasing the latency between the time the students are presented with a writing activity and the time the students begin their work)". Question Two: "Does computer-assisted biofeedback in the classroom increase time on-task working on an academic activity? (Duration of time on-task was estimated by momentary time sampling.)"

Two additional questions, more qualitative in nature, included an examination of whether the performance level of an activity improved following computer-assisted biofeedback and whether self-regulation of behavior was generalized to other areas of the classroom or home environment as a result of the intervention. Question Three: "Does computer-assisted biofeedback in the classroom increase the performance of an academic activity?". Question Four: "Does generalization of self-regulation of behavior carryover to other areas of classroom and home environment?".

A single-subject multiple baseline across participants design was used in this study. (Kazdin, 1982) to evaluate the effectiveness of computer-assisted biofeedback for students with ASD in the classroom. Results for each question are presented.

Question One

Question one: "Does computer assisted biofeedback in the classroom increase speed to engagement of an academic activity (decreasing the latency between the time students are presented the writing activity and the time they begin their work)?" Data analysis consisted of examining data that were collected on a daily basis over a period of five weeks. Decision of phase changes were made based on visual analysis. According to Kazdin (1982), a stable rate of performance is evident by the absence of a trend (or slope) in the data including a small variability in performance. After a stable rate of performance was evident for each participant during baseline, the intervention phase was implemented.

Speed to engagement was measured from the time the teacher completed stating the directions of the assignment and placed the writing activity in front of the student to the time the student's writing utensil touched the paper. The latency of speed to engagement was recorded then graphed daily. The trend of the data was analyzed visually during the baseline and intervention phases. According to Kazdin (1982), a stable rate of performance is evident by the absence of a trend (or slope) in the data including a small variability in performance. A stable rate of performance was evident for each participant during baseline.

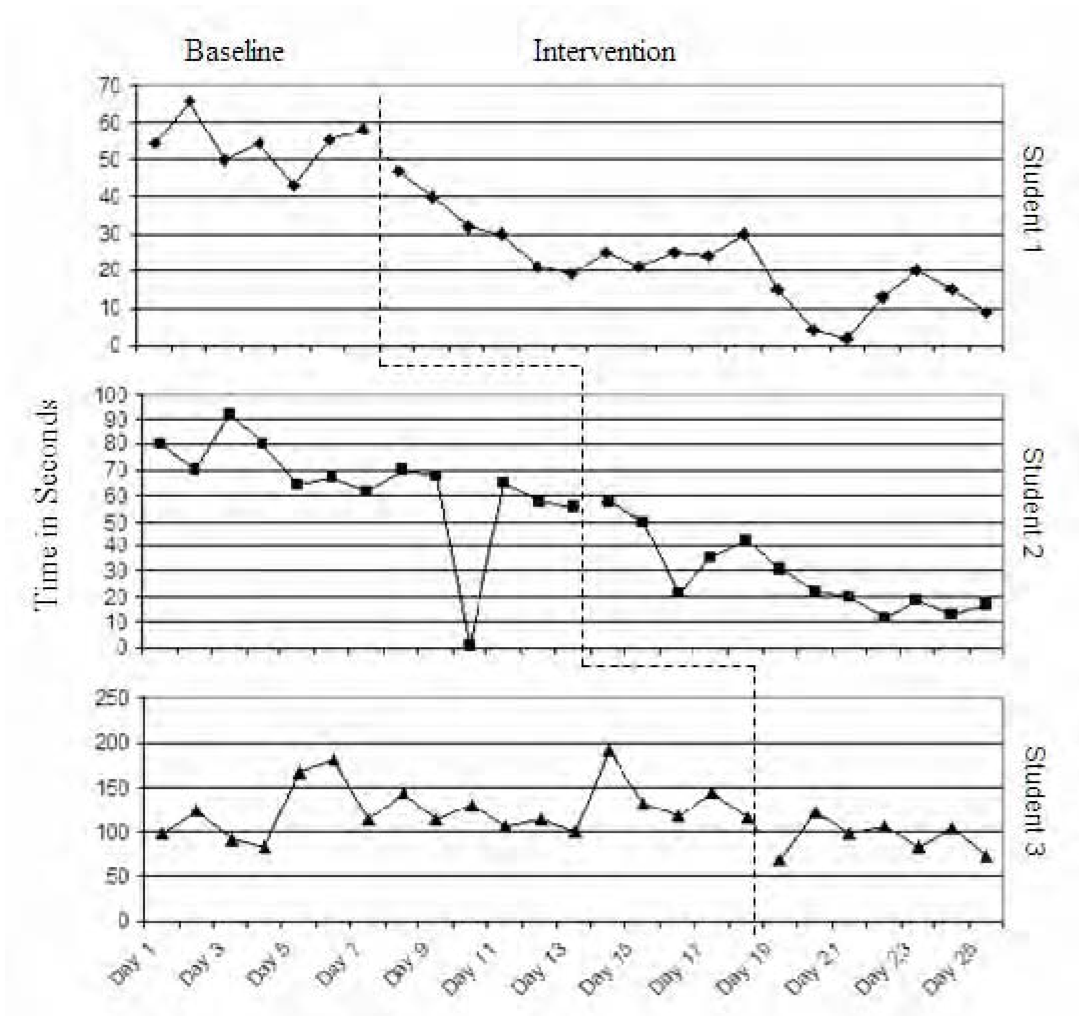

Figure 1. Speed to engagement by participants

Figure 1 represents speed to engagement for each individual participant during baseline and intervention phases. A stable trend was realized during the baseline phase and the intervention phase began with Participant 1 on the eighth day of the study. An immediate increase in speed to engagement occurred and continued for six consecutive days. The data was then stable for six days and sharply decreased again on the twelfth day of intervention. Data for Participant 1 revealed a mean of 54 seconds for speed to engagement during baseline and 22 seconds during the intervention phase.

A stable trend was realized during the baseline phase with the exception of one outlier data point for Participant 2. The intervention phase began with Participant 2 on the fourteenth day of the study. An increase in speed to engagement occurred on the third day of the intervention, then decreased for two days, followed by a steady downward trend, an increase in speed to engagement. Data for Participant 2 revealed a mean of 64 seconds for speed to engagement during baseline and 28 seconds during the intervention phase.

A stable trend was realized during the baseline phase and the intervention phase began with Participant 3 on the nineteenth day of the study. An immediate increase in speed to engagement occurred on the first day of intervention and then decreased to the level similar to baseline. This represented a variable pattern. Data for Participant 3 revealed a mean of 127 seconds for speed to engagement during baseline and 93 seconds during the intervention phase.

During the intervention phase, the overall trend of Participant 1 and Participant 2 visibly increased, fewer seconds to speed to engagement. The graphed data for Participant 3 shows a slight upward trend. Participant 1 demonstrated the largest increase in speed to engagement and was reported by the teacher to be functioning at the 3rd grade level. Participant 2 demonstrated an increase almost equal to Participant 1 and was reported by the teacher to be functioning between the 1st and 2nd grade level. Participant 3 demonstrated an increase in speed to engagement to a lesser degree than the others and was reported by the teacher to be functioning between the Kindergarten and 1st grade level.

The graphed data points in the intervention phase show a visible decrease in the number of seconds to speed to engagement for Participant 1 and Participant 2. Participant 1 and Participant 2 were beginning their tasks quicker during the intervention phase than during the baseline phase. There was an increase of speed to engagement for all three participants. Participant 1 had a 59 percent increase of speed to engagement, Participant 2 a 56 percent increase, and Participant 3 a 27 percent increase in speed to engagement

Question Two

Question two asked: “Does computer-assisted biofeedback in the classroom increase time on-task as measured by a momentary time sampling of the duration of time working on academic activity?” Data analysis consisted of examining data that was collected on a daily basis over a period of five weeks. Decision of phase changes were made based on the analysis of the first behavior investigated, speed to engagement.

Duration was measured from the time the student placed their writing utensil to the paper. Every fifteen seconds from that point on the researcher(s) would record a “checkmark” if the student was attending to the writing activity either by writing appropriately on the paper or by looking at the paper. An “x” was recorded if the student was attending to any other stimuli or writing on the activity inappropriately.

Percentage of time on-task was graphed daily, the trend of the data was visually inspected, and percentage of time on-task was calculated. The formula used for each observation period was the number of time samplings on-task divided by the number of time sampling opportunities during the observation session. Each observation session was for a period of 5 minutes between 9:30 a.m. to 10:30 a.m. each school day.

The trend in data points for Participant 1, Participant 2, and Participant 3 revealed an increase in duration of time on-task. Participant 1 increased time on-task by 50 percent, Participant 2 increased time on-task by 48 percent, and Participant 3 increased time on-task by 19 percent. Data points for Participants 1 and 2 show more substantial increase in duration of time on-task than data points for participant 3. Participants 1 and 2 were reported by the teacher to be functioning at a higher grade level than Participant 3.

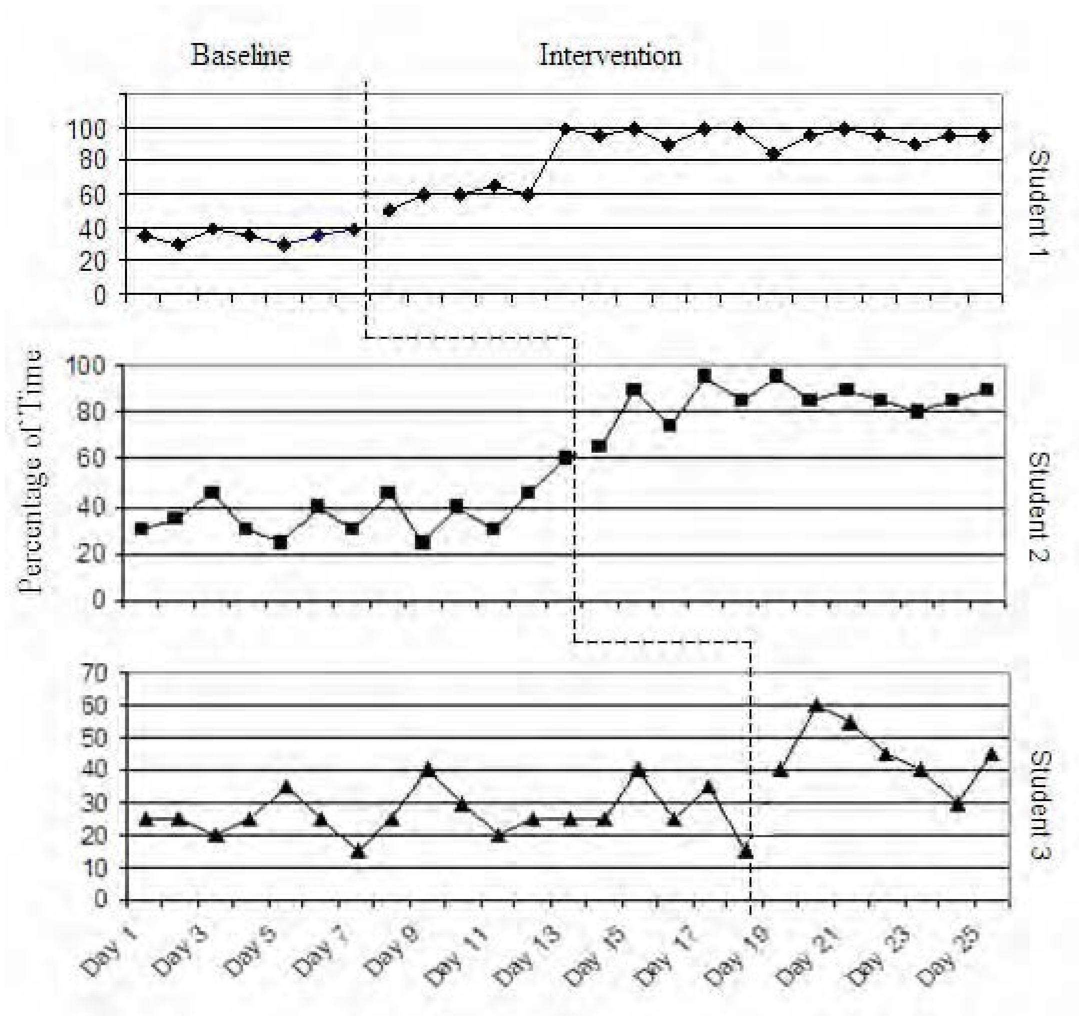

Figure 2. Time on-task by participant

Figure 2 presents the time on-task data for the individual participants. A stable trend was realized during the baseline phase and the intervention phase began with Participant 1 on the eighth day of the study. An immediate increase in percentage of time on-task occurred on the first day of intervention. The data were relatively stable for four days followed by a 40 percent increase in time on-task. This increase occurred on the sixth day of intervention. From the sixth day of intervention throughout the study

Participant 1 remained on-task at or above 80 percent of the time. Data for Participant 1 revealed a mean of 35 percent during baseline for percentage of time on-task and a mean of 85 percent during the intervention phase. These data represent a 50 percent increase in percentage of time on-task.

For participants, a stable trend was realized during the baseline phase and the intervention phase began with Participant 2 on the fourteenth day of the study. A slight increase occurred from baseline on the first day of intervention followed by an upward trend for the next two days. On the fourth day of intervention through the end of the study, Participant 2 remained on-task at or above 80 percent of the time. Data for Participant 2 revealed a mean of 37 percent during baseline for percentage of time on-task and 85 percent during the intervention phase. This data represents a 48 percent increase in percentage of time on-task.

For participants, a variable yet stable trend was realized during the baseline phase and the intervention phase began with Participant 3 on the nineteenth day of the study. An immediate increase in time on-task occurred and lasted for 2 days. On the third day of intervention a decrease of time on-task began and lasted for four days followed by an increase. The variable trend continued and the average time on-task increased following intervention. Data for Participant 3 revealed a mean of 26 percent during baseline for percentage of time on-task and 45 percent during the intervention phase. This data represents a 19 percent increase in percentage of time on-task. An increase in overall time on–task or engagement was evident for all three participants.

Question Three

The third research question, “Does computer assisted biofeedback in the classroom increase the performance of an academic activity?” was answered through the examination of student work samples. Participant work samples were analyzed to determine the impact on performance of an academic activity. All three learners were working on individual goals during the time of the study. Sample work for all participants can be found in Appendices O, P, & Q.

Participant 1 was working on a specific writing task that called for the completion of a sentence by choosing a correct word out of a list of four words. The student was provided verbal directions for the task during both the baseline and intervention phase. During the intervention phase the verbal directions and task immediately followed the intervention. Each work sample in the baseline and intervention phase was evaluated for performance using a teacher made rubric. The rubric for scoring this activity can be found in Appendix M. The percentage of correct word selection was calculated by dividing the number correct over the total number of questions. Results of percentage of correct word selection are represented in Figure 3.

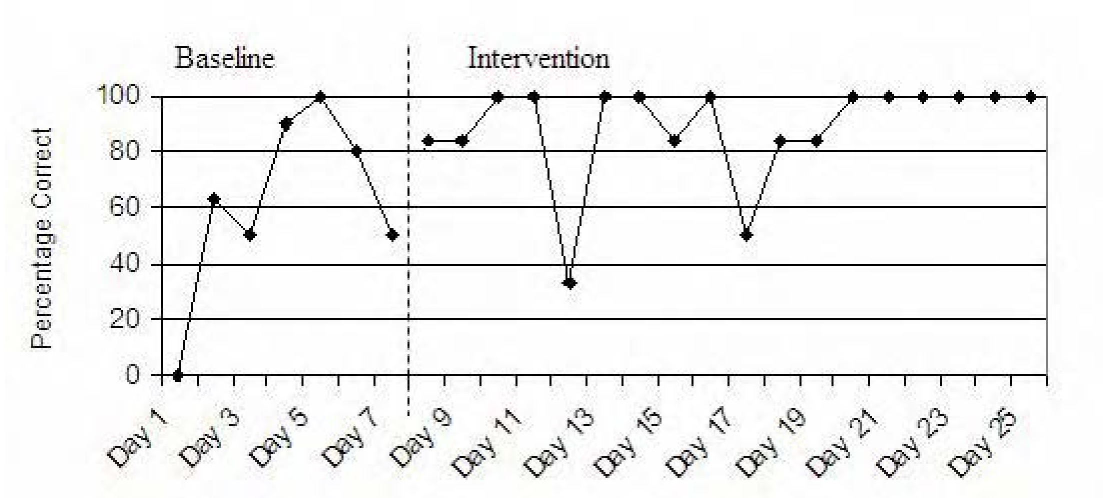

Figure 3. Percentage of correct responses on writing task for Participant 1

A visual inspection of Figure 3 shows that Participant 1 demonstrated the ability to complete work with one hundred percent accuracy during the baseline phase. The scores in the baseline phase ranged from zero to 100 percent with a mean of 43 percent correct. Four of seven data points indicate a percentage below the desired goal written on the student's individualized education plan (IEP) of 80 percent. The performance trend for Participant 1 for days 5 through 7 of the baseline phase represented a decreasing trend line. The three point decreasing trend was considered sufficient to end the baseline phase and introduce the intervention.

During the intervention phase, however, the participant completed the work with 80 percent accuracy (or better) on 16 out of 18 days, or 89 percent of the time. One hundred percent accuracy was achieved on 11 of the 18 days, including six straight "perfect" days in a row to conclude the intervention phase. The intervention appears to have had a positive effect on the student's performance on the assigned academic activity.

Participant 2 was given a writing task that involved copying eight phrases into a worksheet entitled "My Daily Journal". The worksheet was customized to reflect events in the participant's life and identified factors specific to the child. The student was provided verbal directions for the task during both the baseline and intervention phase. During the intervention phase the verbal directions and task immediately followed the intervention. Each work sample in the baseline and intervention phase was evaluated for performance using a teacher made rubric. The rubric for scoring this activity is in Appendix N. Four areas were specified on the scoring rubric: letter formation, spacing, correct number of letters, and task completion. The results for Participant 2 are found in Figure 4.

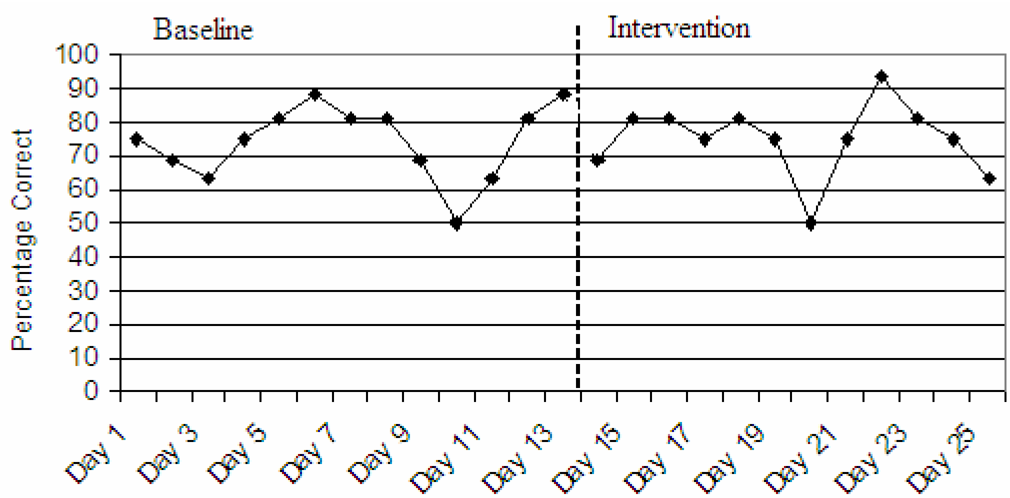

Figure 4. Percentage correct on writing task for Participant 2

A visual inspection of Figure 4 indicates that the intervention had no impact on the performance of Participant 2 on the assigned academic activity. The scores in the baseline phase ranged from 50 percent correct to 88 percent correct with a mean percentage correct of 74 percent. Seven of thirteen data points indicate a percentage below the desired goal written on the student's individualized education plan (IEP) of 80 percent. The repetition of the trend line during the baseline phase was considered sufficient to end the baseline phase and introduce the intervention.

During the intervention phase the scores for Participant 2 ranged from 50 percent correct to 92 percent correct with a mean percentage correct of 75 percent. Participant 2 completed the work with 80 percent accuracy (or better) 5 out of twelve days equal to 42 percent of the time. Overall, the intervention did not impact the student's performance on the assigned academic activity.

Participant 3 was given a writing task that involved copying the same phrase over six times daily into a worksheet entitled, "Who Am I". The student was provided verbal directions for the task during both the baseline and intervention phase. During the intervention phase the verbal directions and task immediately followed the intervention. Each work sample in the baseline and intervention phase was evaluated for performance using a teacher made rubric. The rubric for scoring this activity can be found in Appendix O. Three areas were specified on the scoring rubric: letter formation, correct number of letters, and task completion. The results for Participant 3 are found in Figure 5.

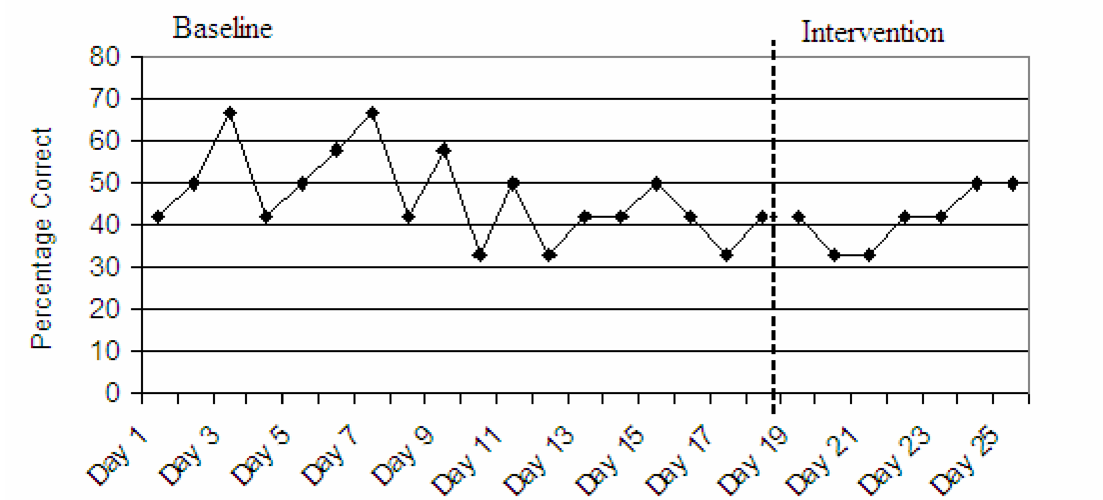

Figure 5. Percent correct on writing task for Participant 3

Figure 5 indicates that the intervention had little effect on the participant's performance on the assigned academic activity despite an increase in trend at the end of the study. The scores in the baseline phase ranged from 32 percent to 68 percent with a mean of 47 percent correct. All eighteen data points indicate a percentage below the desired goal written on the student's individualized education plan (IEP) of 80 percent. The performance trend for Participant 3 for days 16 through 18 of the baseline phase represented a consistent variable trend and was considered sufficient to end the baseline phase and introduce the intervention.

During the intervention phase the scores for Participant 3 ranged from 32 percent correct to 50 percent correct with a mean of 42 percent correct. Participant 3 completed the work with 80 percent accuracy (or better) zero days during the intervention phase. No scores during the intervention phase were as high as highest baseline score. An upward trend at the end of the intervention phase was evident. The intervention appears to have had a negligible impact on the student's performance on the assigned academic activity.

Question Four

Question four asked: "Does generalization of self-regulation of behavior carry over to other areas of the classroom and home environments?" To answer this question, a survey instrument was administered to the teachers and paraprofessionals to determine their perceived effectiveness of the intervention. The purpose of conducting the survey was to investigate if any generalization of self-regulation of behavior was observed at other times during the day. A copy of the survey instrument appears in Appendix F. The results of this survey appear in Table 2.

Table 2.

Educator Perception of Intervention

Item	Yes	No	Not sure
clear presentation of software	3	0	0
clear concept of intervention	3	0	0
research team knowledgeable and helpful	3	0	0
time well spent	3	0	0
observed generalization of self-regulation of behavior	3	0	0
interested in continuing to use in classroom	3	0	0
benefits the students	3	0	0

All educators reported the consistent perception of the intervention being beneficial to the participants. The responses to the survey instrument item asking educators for additional questions and comments indicated that they thought the intervention would be beneficial for the students year round. The educators also reported that the students seemed to enjoy the one on one time with the researcher. The students looked forward to doing the computer-assisted biofeedback activity. The teacher verbalized an interest in establishing a station in the classroom at which the students could use the intervention to “de-stress when they get frustrated or have anxiety”.

The educators also reported observing generalization of self-regulation of behavior of Participant 1 and Participant 2 in transitioning behaviors. The transitions of both students were reported to be completed independently a greater percentage of the time following the use of the intervention.

Parents were also surveyed following the completion of the project to determine whether any benefits from the project generalized to the home environment. Parents did not observe a generalization of self-regulation of behavior nor did they express any interest in using the intervention at home. The parents did not write any additional questions or comments for the survey item asking for additional questions or comments. The complete results of the parent survey are displayed in Table 3.

Table 3.

Parent Perception of Intervention

Item	Yes	No	Not sure
clear presentation of software	3	0	0
clear concept of intervention	3	0	0
research team knowledgeable and helpful	3	0	0
child's time well spent	3	0	0
observed generalization of self-regulation of behavior	0	3	0
interested in using in the home	0	3	0
benefited the child	2	0	1

Responses from educators and parents were consistent regarding the following items; clear presentation of software, clear concept of intervention, knowledgeable and helpful research team, and the participant's time being well spent. The responses were inconsistent concerning generalization, continued use and benefit to the child.

Overall Summary of Findings

Speed to engagement of an academic activity was increased for all three participants. Participant 1 demonstrated a decrease of 59 percent from the baseline to intervention phase. This percentage was derived from the decrease in the mean number of seconds for speed to engagement from the baseline phase to the mean number of seconds for speed to engagement from the intervention phase. Similarly, Participant 2 demonstrated a decrease of 56 percent from baseline to intervention phase. Although not as large, Participant 3 also demonstrated a decrease in speed to engagement of an academic activity of 27 percent from the baseline to intervention phase. Simply stated, on an average, all participants began their respective tasks 27 percent to almost 60 percent quicker.

The mean percentage of time on-task, as estimated by momentary time sampling, increased for all three participants from the baseline to the intervention phase. Participant 1 had a mean of 35 percent of the observations on-task during baseline and 85 percent of the observations on-task during the intervention phase. This represents an increase of 50 percent. Data for Participant 2 revealed an increase of 48 percent. Lastly, data for Participant 3 revealed an increase of 19 percent from baseline to intervention phase. Thus, on average, all students were on-task a greater percentage of the observation opportunities during the intervention phase.

The relationship between computer-assisted biofeedback and the performance level of an individualized writing activity produced mixed results. Data for Participant 1 revealed that for 89 percent of the work samples from the intervention phase a goal of at least 80 percent correct was achieved, while on only 43 percent of the work samples from the baseline phase the goal of 80 percent achievement was reached. For Participant 2, the intervention appears to have had no impact on the participant's performance on the assigned academic activity. During the baseline phase Participant 2 achieved a mean percentage correct of 74 percent and during the intervention phase the student achieved a mean percentage correct of 75 percent. Data for Participant 3 revealed a negative impact on the student's performance on the assigned academic activity. During the baseline phase Participant 3 achieved a mean percentage correct of 47 percent. During the intervention phase the participant achieved a mean percentage correct of 42 percent.

All educators and parents reported the participants' time was well spent using the Freeze-Framer software intervention. However, responses indicate that educators and parents did not agree about the generalization of the impact. Associated with this result is the interest of using the intervention in the classroom or at home. Educators reported interest in continuing its use in the classroom whereas parents reported no interest in using the intervention at home.

CHAPTER FIVE:

CONCLUSION

Major Findings

Results of this study indicate that the computer-assisted biofeedback intervention used in this study was effective with some learners while there were marginal outcomes for others. The study revealed positive results for all students for speed to engagement and time on-task during an academic activity.

In the area defined as "performance level" in the study, positive results were found for Participant 1 on performance level, no impact was found with Participant 2, and a negative impact was found with Participant 3. It should be noted that the tasks of the three individual participants varied and may have impacted the results in this area. Educator and parent responses on the generalization of self-regulation of behavior showed mixed results. The educators reported a positive effect, while parents reported no effect.

Question One – Speed to Engagement

The first research question asked, "Does computer-assisted biofeedback in the classroom increase speed to engagement of an academic activity?" (ultimately decreasing the latency between the time the students are presented with a writing activity and the time the students begin their work).

Results revealed a visibly decreased trend for Participant 1, increasing speed to engagement. Participant 1 demonstrated the largest decrease in time to engagement by 59 percent of the mean time from the baseline to intervention phase. The baseline phase mean was 54 seconds, whereas the intervention phase mean was 22 seconds. Participant 1 was reported by the teacher to be functioning at the highest grade level of the three students. The academic activity completed by Participant 1 each day also consisted of the material that was the most different from day to day.

Results revealed a visibly decreased trend for Participant 2 as well, increasing speed to engagement. Participant 2 also demonstrated a large decrease in time to engagement by 56 percent of the mean time from the baseline to intervention phase. The baseline phase mean was 64 seconds, whereas the intervention phase mean was 28 seconds. Participant 2 was reported by the teacher to be functioning at the second highest grade level of the three students. The academic activity completed by Participant 2 each day consisted of the material that was slightly different from day to day. The activity was not as different as Participant 1 and not as repetitive as Participant 3.

Results for Participant 3 revealed a slightly decreased trend, increasing speed to engagement. Participant 3 demonstrated a decrease in time to engagement by 27 percent of the mean time from the baseline to intervention phase. The Baseline phase mean was 127 seconds, whereas the intervention phase mean was 93 seconds. Participant 3 was reported by the teacher to be functioning at the lowest grade level of the three students. The academic activity completed by Participant 3 each day consisted of the material that was exactly the same each day.

These results indicate that the intervention did have an impact on speed to engagement for all three participants. All participants increased his/her speed to engagement by at least 30 seconds; Participant 1 by 32 seconds, Participant 2 by 36 seconds, and participant 3 by 34 seconds.

It is presumed the quicker one gets on-task the more they would achieve, since studies have demonstrated that increased engagement levels are related to higher levels of student achievement (Berliner & Rosenshine, 1977; Fisher & Berliner, 1985). It also appears that content of the activity could be related to speed to engagement. Hanley, Iwata, & McCord (2003) investigated several studies in attempt to identify best practices and directions for future research in the area of functional analysis. Task difficulty and lack of choice among tasks appeared to promote escape behavior which may have an impact on engagement. In this study, the greatest percentage increase of speed to engagement of a participant (Participant 1) also produced results of greatest increase in achievement among the participants. One would think that familiarity with task would lead to a quicker speed to engagement, however this was not the case.

Heflin & Simpson (1998) found that cognitive behavioral interventions (CBI) may be especially appropriate for students with high-functioning autism due to the need of active participation by students for planning and involvement in their own behavior change. Based on the nature of the intervention, it is possible that students functioning at higher levels benefit more from computer-assisted biofeedback than students functioning at lower levels.

Question Two – Percentage of Time On-Task

The second research question asked, "Does computer-assisted biofeedback in the classroom increase time on-task as measured by a momentary time sampling of the duration of time working on academic activity?"

Results revealed a visibly increased trend for Participant 1, increasing time on-task. Participant 1 also demonstrated the largest increase in time on-task by 50 percent of the mean time from the baseline to intervention phase. The baseline phase mean was 35 percent, whereas the intervention phase mean was 85 percent of time on-task.

Results revealed a visibly increased trend for Participant 2, increasing time on-task. Participant 2 demonstrated an increase of 48 percent of the mean time from the baseline to intervention phase. The baseline phase mean was 37 percent, whereas the intervention phase mean was 85 percent of time on-task.

Results for Participant 3 also revealed an increased trend, increasing time on-task. Participant 3 demonstrated an increase in time on-task 19 percent of the mean time from the baseline to intervention phase. The Baseline phase mean was 26 percent, whereas the intervention phase mean was 45 percent. Data for student 3 revealed the most variability among the three sets of data. A possible reason for this difference could again be the nature of the individualized writing activities. Student 3 appeared disinterested in the academic activity and interested in any other possible stimuli during this activity.

The results indicate that the intervention also had an impact on time on-task for all three participants. Increasing time on-task behavior has been directly correlated to achievement, or learning (Greenwood, et al., 2002; Cancelli, et al., 1993; Nystrand &

Gamoran, 1989). Greenwood et al. (2002) reported learner engagement was predictive of academic achievement. Subsequently, they developed goals for teachers to successfully promote engagement. McWilliam & Bailey (1995) report engagement as being essential to a child's ability to learn. Based on research on engaged time and achievement, it appears the intervention does hold potential for academic achievement gains for individuals with ASD. It also appears that the potential of the intervention may be related to functioning level. An assumption of cognitive behavioral interventions is that individuals have both the capacity and preference for monitoring and managing their own behavior (Heflin & Simpson, 1998). In this study, computer-assisted biofeedback, a CBI, was effective despite an apparent lack of interest in control over behavior. Again, individuals functioning at higher levels appear to benefit more from computer-assisted biofeedback than students functioning at lower levels. However, no firm conclusions can be made solely based on this study due to small sample size. Replications of the study need to be carried out. The type of task is yet another factor that appears to have an impact on engaged time.

Kern & Dunlap (1998) postulate that engagement seems to be enhanced when activities are varied and child choice are options. Task variation, rather than the same activity repeatedly, was found to increase motivation. Allowing task choices was found to increase a child's responsiveness to academic stimuli while decreasing problematic behavior (Koegel, Koegel, Hurley & Frea, 1992). In this study, the participant whose activity was varied the most from day to day showed the biggest gains in speed to engagement, percentage of time on-task and achievement.

Question Three – Academic Performance

The third research question asked, “Does computer-assisted biofeedback in the classroom increase the performance of an academic activity?”

Visual inspection of data points representing performance level of an academic activity show trends for effectiveness for only Participant 1 during the intervention phase.

Participant 1, the highest functioning participant, achieved one hundred percent accuracy on 11 of the 18 days, including six straight “perfect” days in a row to conclude the intervention phase. Prior to the intervention, the student had only 2 days above 80 percent accuracy, with an average of 62 percent accuracy. As discussed earlier for speed to engagement and time on-task, the nature of the activity may have affected performance level.

Visual inspection of data points representing performance level of an academic activity show no effect for Participant 2 during the intervention phase. Participant 2 achieved 90 percent accuracy twice during the baseline phase with a mean average of 74 percent in the intervention phase. Participant 2 achieved 90 percent accuracy once with a mean average of 75 percent. The writing activity for student 2 involved copying eight phrases daily into a worksheet entitled “My Daily Journal”. Some of sentences changed slightly from day to day, but the majority of the assignment was the same each day.

Visual inspection of data points representing performance level of an academic activity revealed an overall negative effect for Participant 3 during the intervention phase. Data for Participant 3 revealed variable results in performance level from just over 30 percent correct to almost 70 percent correct during the baseline phase. In the intervention phase, Participant 3 showed an initial decrease in performance to the 30 percent range followed by a gradual increase to 50 percent correct. One possible explanation of these results is the repetitive nature of the assignment resulting in a complete lack of motivation to attend to the activity. Koegel, et al. (1995), argue that task motivation is influenced by task variation. These findings appear to support this notion. The tasks for Participant 1 and Participant 2 varied, and the task for Participant 3 remained constant. Furthermore, the activity for Participant 3 may not have been appropriate day after day for a five week period, especially with realized negative gains in academic performance.

It appears the intervention had differentiating effects for the three participants. The highest functioning student, Participant 1, demonstrated the largest increase in performance level. The functioning level of the participant also appears to be directly related to engagement and percent correct when using computer-assisted biofeedback as an intervention. The task of Participant 1 was varied the most from day to day. The amount of variability of the task for each participant directly correlates to the gains of the participants. This supports long standing views that when children are provided with developmentally appropriate materials, engagement is promoted (Krantz & Risley, 1974; Montes & Risley, 1975). More recently, Kern & Dunlap (1998) discussed key variables that promote engagement of individuals with ASD. These variables include child choice, task variation, interspersal of maintenance tasks, reinforcement of response attempts, and the use of natural and direct reinforcers. Two areas warranting further exploration include task variation interaction with computer-assisted biofeedback and level of cognitive functioning versus type of task.

Question Four – Generalization of Behavior

The fourth research question asked, “Does generalization of self-regulation of behavior carry over to other areas of classroom and home environments?”

Generalization of self-regulation of behavior was investigated through the implementation of a survey instrument. Findings show some of the responses from educators and parents were different. Responses from educators were positive across the board. Responses from parents were mixed. Educators and parents agreed on the following survey items: (a) clear presentation of software, (b) clear concept of intervention, (c) research team knowledgeable and helpful, (d) time well spent. Educators and parents disagreed on the following survey items: (a) all educators indicated they observed generalization of self-regulation of behavior, all parents indicated they did not observe generalization of self-regulation of behavior, (b) all educators expressed an interest in continuing to use the intervention in the classroom, all parents expressed no interest in using the intervention in the home, (c) all educators reported that the intervention benefited the students, while two of the three parents reported that it benefited their child and the third parent reported that they were not sure if their was a benefit.

These mixed results could be explained by the level of involvement of the individuals completing the survey. All of the educators participated in a demonstration of the intervention and were present in the classroom throughout the baseline and intervention phases. The educators had daily contact and discussions with the researcher(s). The parents did not participate in a demonstration of the intervention and were not present during the intervention. The researcher(s) also did not communicate directly with the parents. Instead, communication between the researcher and parents was done through the teacher. These findings indicate the need to include parents in the training of interventions.

The results of this paper and pencil survey revealed that educators did perceive there to be a generalization of self-regulation of behavior while parents did not have any perception of generalization of self-regulation of behavior following the intervention. Though parents reported they thought their child's time was well spent during the intervention, the parents did not indicate interest in using the program at home. In addition to questions specifically targeted for this study, researcher anecdotal records from educator daily comments and researcher observations revealed achievement of other skills not targeted. In this study, one of these skills included transition. Participant 1, according to teacher report, greatly improved in the area of transitioning from one activity to another without having to be prompted. The teacher reported that prior to the intervention, the student would sit and wait to be told to do something else or engage in a behavior other than what was next on the schedule. During the intervention phase, the student completed the activity he/ she was working on, put it in the finished bin, went directly to the next activity at the computer station, and began the activity. Another observation realized by the teacher was that Participant 1 appeared to be on-task overall more of the time. The teacher also reported that Participant 2 performed a new skill during the intervention phase. Participant 2 was observed reading each line of her academic activity before beginning the task. Prior to the intervention, the student would spin her pencil or a nearby object and begin the activity by writing her name without looking at the entire activity. These findings likely contributed to the educator's report of an interest in using the computer-assisted biofeedback year round as a station where students could access the program individually. The parents did not observe their children during the intervention or any part of the school day following the intervention. Perhaps the difference in responses between educators and parents is due to exposure to the intervention. All of the educators saw a demonstration of the intervention and observed the students immediately following the computer-assisted biofeedback. All parents did not view a demonstration of the intervention, but read a letter and information sheet about the program.

According to Myles & Simpson (1998) a benefit of cognitive behavioral interventions, like computer-assisted biofeedback, is a positive effect of generalization and maintenance of skills. This research indicated generalization of self-regulation of behavior for the two higher functioning participants (Participant 1 & Participant 2) seem to support Myles & Simpson's assertions.

Effectiveness of Computer-assisted Biofeedback

The results indicate a clear relationship between the intervention and speed to engagement as well as between the intervention and percentage of time on-task during an individualized writing activity for two of the three participants. In both areas, two participants (Participant 1 and Participant 2) benefited from the computer-assisted biofeedback to a greater extent than Participant 3.

It is unclear whether or not the students understood the concept of actively participating in facilitating physiological changes through relaxation techniques and imagery. The researcher noted the participants did practice breathing techniques and on occasion verbally described preferred events they were imagining during the intervention. All three participants did achieve medium to high levels of coherence which in turn caused the colors on the meadow game to be displayed. Based on researcher observations and educator comments, the students appeared to benefit from going to the computer station one-on-one with an adult and focusing on relaxing and being calm.

Lazarus (1981) defined stress as the transaction in which demands are seen to exceed coping skills. All three participants participated in taking deep breaths and two of the three verbally described thinking about something they like to do. Thus, it appears this intervention provided an opportunity for the participants to develop coping skills. The findings are of note given that the researcher(s) did not directly observe the participants trying a specific relaxation technique and displaying any understanding of corresponding results. However, the participants were able to focus on the intervention the entire time and it appeared to be motivating to the student. The non-invasive nature of using a computer (Schreibman, 2000) combined with catering to the visual strengths of most individuals with autism spectrum disorder (Peterson, et al., 1995); along with the observations of the participants suggest that the use of computer-assisted biofeedback has promise for increasing speed to engagement and increasing percentage of time on-task as an intervention for students with autism spectrum disorder. Unfortunately, the positive findings for increasing speed to engagement and increasing percentage of time on-task did not always correspond to an increase in performance with expression tasks. Perhaps this was in part due to the tasks.

Results suggest that the use of computer-assisted biofeedback had an overall positive impact on all three participants. Educators shared positive feedback about the intervention and expressed and interest in continuing to use it in the classroom. For students functioning at a sufficient level, prolonged use could provide students the opportunity to develop the skills needed to self regulate behavior, ultimately increasing one's ability to be independent (Koegel, Frea, & Surratt, 1994). Before any major conclusion can be drawn, replications of this study are necessary. Clearly the results show this as a worthy area to continue to investigate.

Implications for Practice

The rate of children being diagnosed with autism spectrum disorders (ASD) and the limited number of effective interventions (Simpson, 2005) remains an area of concern for parents, teachers, and researchers in the field. Results from this study show computer-assisted biofeedback warrants further investigation as an intervention for use with some students with ASD. For educators whose goal is to quicken speed to engagement or increase the percentage of time on-task, this intervention resulted in positive outcomes for all participants. Most research on engagement of individuals with ASD has to do with social engagement (Shearer et al., 1996); however there is a lack of research investigating academic engagement of students with ASD. It is unclear whether or not these students are able to fully comprehend that by making adjustments in breathing or visualization, they can control physiological functions in their body, but it is clear that computer-assisted biofeedback proved to be a practical intervention that demonstrated positive results in the area of increasing engagement and time on-task for students with ASD. Promoting time on-task supports raising achievement as engagement is critical to a child's ability to learn (Buysse & Bailey, 1993).

Interestingly, this study also revealed the importance of using appropriate academic materials. The two students who showed the largest increase in speed to engagement also completed a writing activity that varied slightly from day to day. The writing activity of the third student was exactly the same every day for a five week period. This intervention did not reveal positive results for improving performance level on repetitive tasks. This suggests that validity and variability of academic activity may be linked to engagement and performance (Koegel, et al., 1998).

The results indicate that students functioning at higher levels benefited more from computer-assisted biofeedback than students functioning at lower levels. Rank order highest to lowest functioning student correlated with the greatest to least gains in performance. This implies that students at lower functioning levels may not benefit from this intervention to increase performance. Further research is needed to determine the minimal functioning level of students who could benefit from computer-assisted biofeedback.

Finally, this intervention provided the participants an opportunity to mentally remove oneself from the hectic classroom atmosphere and develop self-management or coping skills. The classroom as a whole was very active. At any given time, eleven different students could have been doing eleven different things at eleven different locations in the classroom. There were three educators/adults in the room. Several of the students in the classroom had spontaneous vocalizations and spontaneous physical movements. The combination of these behaviors helped to create a busy, loud environment. The researchers noted times when the participants had difficulty focusing in the classroom. During specific sessions of the intervention and the academic activity, the participants were physically displaced on occasion by another student or distracted by loud noises made by other students. Using the computer-assisted biofeedback, each participant had the opportunity to focus on being relaxed and calm and develop coping skills.

According to the teachers, the five minutes that the participants focused on being calm and relaxed was something they looked forward to every day. Perhaps a more cognitive behavioral approach to education may provide students with ASD an opportunity to thrive or at the very least be more comfortable in school. A student could have the opportunity to refocus, removing himself mentally from the chaos around him. If all students had the opportunity to try this intervention during the day, it may result in a positive impact.

Limitations

This study is not without its limitations. First, due to the nature of single-subject research design, the investigation included a small sample size of only three participants. Several replications need to be done before results can be generalized (Kazdin, 1982) to other individuals with ASD.

A second limitation of the study is evident in the communication difficulties of the participants. It is unclear if the participants truly understood the principle of the computer-assisted biofeedback program. Nevertheless, all participants did show positive results in engagement following the intervention.

Finally, the participants in this study were reported as functioning at three different academic levels. These levels ranged from the Kindergarten to 3rd grade level. Each participant completed different academic activities. It is unclear as to the impact of the task versus level of achievement. In future research it would be beneficial for each participant to complete similar academic activities.

Recommendations for Future Research

The results of the study indicate a positive relationship between computer-assisted biofeedback and on-task behavior. However these results must be interpreted with caution as the nature of the academic activity in which the student was engaged may have been a contributing factor. The student whose academic activity varied the most from day to day was the most engaged. The student whose academic activity did not vary at all from day to day was the least engaged. This may or may not have impacted the students' engagement, but the trend merits further investigation. If the same material is presented day after day, interest level may be low. If different material is presented, the interest level may be elevated.

One aspect of the study that could be done differently in future replications is to measure the time from when the teacher completed stating the directions of the assignment and placed the writing activity in front of the student to the time the student attended to the activity either by attending to the activity or when the student's writing implement touched the paper. In this study, the time the students spent reading the activity did not count toward speed to engagement when they were actually engaged. However, in this study the operational definition was consistent throughout the baseline and intervention phases, so this should not have impacted the results.

Another beneficial change in the design of future studies is to have the researcher interview the parents rather than a use a pencil and paper survey to measure generalization of behavior. It is likely that more information would be obtained from parents if an interview is conducted allowing for questions to be answered and a practical description of the study to be provided. Perhaps if the parents see the intervention they would connect observations of behavior to the intervention and express interest in using it at home.

Future research must also address the issue of level of functioning. The participants with the teacher reported higher level of functioning engaged in activities quicker and for a greater percentage of time. Future research should specifically investigate the impact at various levels of functioning. This research should focus on all students for whom computer-assisted biofeedback could be used as an intervention to build academic, social, or emotional skills needed to be successful in school and life.

Conclusion

Though results of this study paint a mixed picture, future research in the area of biofeedback, relaxation, and computer-assisted biofeedback for use with students with ASD in the classroom appears warranted. The results indicate that the intervention did have an impact on speed to engagement and on-task behavior for all three participants. The results indicate that students functioning at higher levels appear to benefit more from computer-assisted biofeedback than lower functioning students. Variability of task also appears to impact performance of task. Finally, perception of generalization of self-regulation behavior was observed only by individuals who directly observed the intervention.

Individuals with ASD are often misunderstood and evaluated in a manner that does not truly reflect their aptitude or potential. Anxiety and frustration are often obstacles that isolate individuals with ASD from social and academic opportunities. Therefore, it is important to investigate a variety of interventions to address these obstacles in order to develop research based interventions that work. Furthermore, it is critical that the focus of interventions have the potential to benefit an individual for the rest of his/her life. The findings from this study suggest that computer-assisted biofeedback holds promise in this area. The use of computer-assisted biofeedback should be investigated further as an intervention to assist students with ASD to develop coping skills to alleviate anxiety and frustration.

APPENDIX A:

INTERNAL REVIEW BOARD

University of Central Florida

Office of Research & Commercialization

March 16, 2006

Nancy Aguinaga
429 Finch Drive
Satellite Beach, FL 32937

Dear Ms. Aguinaga:

With reference to your protocol #06-3332 entitled, **"Effects of Computer-assisted Biofeedback in the Classroom on Student Behavior,"** I am enclosing for your records the approved, expedited document of the UCFIRB Form you had submitted to our office. **This study was approved on 3/15/06. The expiration date will be 3/14/07.** Should there be a need to extend this study, a Continuing Review form must be submitted to the IRB Office for review by the Chairman or full IRB at least one month prior to the expiration date. This is the responsibility of the investigator. **Please notify the IRB office when you have completed this research study.**

Please be advised that this approval is given for one year. Should there be any addendums or administrative changes to the already approved protocol, they must also be submitted to the Board through use of the Addendum/Modification Request form. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur.

Should you have any questions, please do not hesitate to call me at 407-823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,

Barbara Ward

Barbara Ward, CIM
UCF IRB Coordinator
(FWA00000351 Exp. 5/13/07, IRB00001138)

Copies: IRB File
Kevin Miller, Ed.D.

BW:jm

12443 Research Parkway • Suite 302 • Orlando, FL 32826-3252 • 407-823-3778 • Fax 407-823-3299

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THE UNIVERSITY OF CENTRAL FLORIDA
INSTITUTIONAL REVIEW BOARD (IRB)

IRB Committee Approval Form

PRINCIPAL INVESTIGATOR(S): Nancy J. Aguinaga **IRB #: 06-3332**
Supervisor: Kevin Miller, Ed.D.

PROJECT TITLE: Effects of Computer-assisted Biofeedback in the Classroom on Student Behavior

[X] New project submission [ ] Resubmission of lapsed project #
[ ] Continuing review of lapsed project #_____ [ ] Continuing review of #
[ ] Study expires: [ ] Initial submission was approved by expedited review
[ ] Initial submission was approved by full board review but continuing review can be expedited
[ ] Suspension of enrollment email sent to PI, entered on spreadsheet, administration notified _____

Chair
[X] Expedited Approval

Dated: 3/15/2006
Cite how qualifies for
expedited review:
minimal risk and #7+#6

[ ] Exempt

Dated: ___________
Cite how qualifies for
exempt status:
minimal risk and _________

[X] Expiration
Date: 3/14/2007

IRB Reviewers:

Signed: ______________________
Dr. Jacqueline Byers, Chair

Signed: Sophia F. Dziegielewski
Dr. Sophia Dziegielewski, Vice-Chair

Signed: ______________________
Dr. Tracy Dietz, Vice-Chair

Complete reverse side of expedited or exempt form
[ ] Waiver of documentation of consent approved
[ ] Waiver of consent approved
[ ] Waiver of HIPAA Authorization approved

NOTES FROM IRB CHAIR (IF APPLICABLE): First review, minor clarifications needed. Parental consent form needs revision.
Sophia F. Dziegielewski.

06-3332

UCF IRB Protocol Submission Form

☒ Initial ☐ Resubmission of IRB #_______

Please type this form using the MicroSoft Word document. Expand as needed. Allow a minimum of 2-3 weeks for the approval process. A letter of approval will be mailed to you once approved. Information on this form must match information on the grant application, dissertation or thesis, consent forms or letters, and flyers for recruitment. **There are no deadlines for submission of minimal risk studies as they are reviewed at least weekly.** If it is deemed by the IRB that the study involves greater than minimal risk or extenuating factors, the complete IRB packet must be submitted by the 1st business day of the month for consideration at that monthly IRB meeting. At title note if investigator is Student, Masters Candidate or Doctoral Candidate.

1. **Title of Protocol:** Effects of computer-assisted biofeedback in the classroom on student behavior

2. **Principal Investigator:** Nancy J. Aguinaga

Signature: *Nancy J. Aguinaga*
Name: Nancy J. Aguinaga
Mr./Ms./Mrs./Dr. (choose one) Ms.
Employee ID or Student PID #: 0257389
Degree:M.A.
Title: Doctoral Candidate

Department:Child,Family&Community Sciences
College: College of Education
E-Mail: aguinaga@mail.ucf.edu
Telephone: 321-794-5943
Facsimile: 321-773-8744
Home Telephone: 321-773-4655

3. **Supervisor:**

Signature: *K. Miller*
Name: Kevin J. Miller
Mr./Ms./Mrs./Dr. (choose one) Dr.
Employee ID or Student PID #:
Degree: Ed. D.
Title: Assistant Professor

Department:Child,Family&Community Sciences
College: College of Education
E-Mail: kjmiller@mail.ucf.edu
Telephone: 407-823-5314
Facsimile: 407-823-3859

4. **Collaborating institution(s) and researcher(s)** None

5. **Dates of proposed project** (cannot be retroactive) From: 3/15/06 To: 3/15/07

6. **Source of funding for the project (project title, agency, account/proposal # or "Unfunded"):** Unfunded

7. **Scientific purpose of the investigation** (dissertation or thesis is not the scientific purpose): To determine the effectiveness of computer-assisted biofeedback for students diagnosed as having Autism Spectrum Disorder on behavior.

8. **Describe the research methodology in non-technical language** Please see attached methodology.

9. **Describe the potential benefits and anticipated risks and the steps that will be taken to minimize risks and protect participants** There are no anticipated risks to the participants in this study.

10. **Describe how participants will be recruited, how many you hope to recruit, the age of participants, and proposed compensation** (if any). Please see attached methodology and informed consent forms.

11. **Describe the informed consent process** Please see attached child assent script and informed consent

12. Describe any protected health information (PHI) you plan to obtain from a HIPAA-covered medical facility or UCF disignated HIPAA component No PHI will be obtained from participants in this study.

I approve this protocol for submission to the UCF IRB. Signature: ____________ / 02.23.16

Department Chair/Director Date

Cooperating Department (if more than one Dept. involved) Signature: ____________ / ______

Department Chair/Director Date

Note: If required signatures are missing, the form will be returned to the PI unprocessed.

APPENDIX B:

O.C.P.S. RESEARCH APPROVAL

Submit this form and a copy of your proposal to:
Program Services
P.O. Box 271
Orlando, FL 32802-0271

Orange County Public Schools

RESEARCH REQUEST FORM

Your research proposal should include: Project Title; Purpose and Research Problem; Instruments; Procedures and Proposed Data Analysis

Requester's Name: Nancy J. Aguinaga — Date: February 24, 2006

Address — Home: 429 Finch Drive, Satellite Beach, FL 32937 — Phone: 321-794-5943

Business: Department of Child, Family, & Community Sciences
College of Education, UCF, Orlando 32816 — Phone: 407 – 823 - 2598

Project Director or Advisor: Kevin J. Miller, Ed.D. — Phone: 407 – 823 - 5314

Address: Department of Child, Family, & Community Sciences, College of Education, UCF,4000 Central Florida Blvd., Orlando 32816-1250

Degree Sought (check one): ☐ Associate   X Doctorate   ☐ Bachelor's   ☐ Master's   ☐ Specialist

Project Title: Computer-assisted Biofeedback in the Classroom and Student Behavior

ESTIMATED INVOLVEMENT

PERSONNEL/CENTERS	NUMBER	AMOUNT OF TIME (DAYS, HOURS, ETC.)	SPECIFY/DESCRIBE GRADES, SCHOOLS, SPECIAL NEEDS, ETC.
Students	3-6	10 minutes a day, 5 days a week for 6-8 weeks	Elementary / Grades 2-6
Teachers	2-3	10 minutes a day, 5 days a week for 6-8 weeks	Elementary / Grades 2-6
Administrators	N/A		
Schools/Centers	1	Same as teachers and students	Bonneville Elementary School
Others (specify)			

Specify possible benefits to students/school system: Students will be able to better manage their behavior. Teachers will get to keep the Freeze Framer Emotional Management Enhancer Computer Based Learning System.

ASSURANCE

Using the proposed procedures and instrument, I hereby agree to conduct research in accordance with the policies of the Orange County Public Schools. Deviations from the approved procedures shall be cleared through the Senior Director of Program Services. Reports and materials shall be supplied as specified.

Requester's Signature: Nancy J. Aguinaga

Approval Granted: ☒ Yes   ☐ No   Date: 3-7-06

Signature of the Senior Director for Program Services: [illegible]

NOTE TO REQUESTER: When seeking approval at the school level, a copy of this form, signed by the Senior Director, Program Services, should be shown to the school principal.
Reference School Board Policy GCS, p. 249

APPENDIX C:

PARENTAL CONSENT

REVISED 3/15/06

March , 2006

Dear Parent/Guardian:

I am a graduate student at the University of Central Florida. I am currently working on my Ph. D. and am under the supervision of a faculty member, Dr. Kevin Miller. I am conducting research on computer-assisted biofeedback and the relationship with behavior change. The purpose if this study is to examine the implementation of a software program based on the principles of biofeedback and its effectiveness in increasing on-task behavior for students with Autism Spectrum Disorders. Participating children will receive instruction on the impact of stress on the body, learn to recognize stressful feelings and learn to use calming or relaxation strategies when faced with challenging situations. A description of the Freeze Frame Technique we are using is attached.

The results of this study may assist and support students, parents, teachers and districts in designing and implementing an effective strategy for students with Autism Spectrum Disorders. It is anticipated that your child will benefit from this intervention by learning how to self-regulate their behavior, ultimately increasing on-task behavior. The study will possibly benefit your child now and in the future to improve adaptive functioning across multiple areas of your child's life.

Your child, if you choose to allow him/her to participate in this study, will be individually instructed in the classroom by his/her teaching staff using the software program directly prior to an academic activity. The session will be approximately five minutes per day for approximately six weeks. This five minute activity on the software extends beyond regular classroom expectations. The completion of a Stress survey each day which includes just checking one statement explaining how the child feels also extends beyond regular classroom expectations. Your child will be observed during the academic activity to determine the speed to engagement of activity and the time on-task completing the activity during baseline and intervention phases of the study by the research team consisting of myself and another doctoral student at the University of Central Florida. The academic activity is part of the class requirement and does not

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REVISED 3/15/06

extend beyond regular classroom expectations. The use of the software program and the Stress survey are part of the study and is optional for participation.

Your child will not be identified by name or singled out in any manner. When reporting results from the study your child will be identified by numbers only. Your child will be told that he/she will not be identified by name in the study.

Results of this study will be reported in the form of a manuscript, which will be reviewed by my faculty advisor and my Dissertation Committee. Further, I intend to publish the results of this study. In the manuscript for my committee, and any subsequent manuscript sent out for publication, your child's identity will remain confidential.

You and your child have the right to withdraw consent for participation at any time without consequence. Participation or nonparticipation in this study will not affect your child's grades or placement in any programs. There are no known risks or immediate benefits to the participants, and no compensation is offered for participation in this study. However, it is anticipated that your child will experience direct benefits from participation in this program including helping students to develop strategies to reduce anxiety and frustration in the face of school-related challenges including increasing student on-task behavior and academic performance.

With your permission, your child and his/her teacher will complete questionnaires and participate in discussions regarding classroom behavior and the impact of the Freeze Frame Program. Your child will complete a 5-point scale stress survey each day prior to the academic activity. The 5-point scale survey is a self report of stress level which can be completed within a few seconds. You will be asked to complete a short survey regarding your experience with your child at the end of the Freeze Frame study. This survey is solely based on your typical observation of your child over the time period of the study and should not take more than 5 minutes to complete. The purpose of gathering this information is to investigate any possible generalization of on-task behavior outside of the classroom.

Results of this study will be available by contacting Nancy Aguinaga. If you have any questions about this research project, please contact Nancy Aguinaga at (321)794-5943 or Dr. Kevin Miller at (407) 823-5314. Research at the University of Central Florida involving participants is carried out under the oversight of the Institutional

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Review Board (IRB). Questions or concerns about research participants' rights may be directed at UCF IRB Office at University of Central Florida, Office of Research and Commercialization, 12443 Research Parkway, Suite 302, Orlando, FL 32826-3252. The phone number is (407) 823-2901.

The consent form below must be completed and returned to the researcher in order for your child to participate in this study.

Sincerely,

Nancy J. Aguinaga

Project title: **Effects of Computer-assisted Biofeedback in the Classroom on Student Behavior**

Parent/Guardian Consent

_______ I have read the procedure described above.

_______ I voluntarily give permission for my child, ____________________________, to participate in the study of the Freeze Frame Learning Program conducted by Nancy Aguinaga from the University of Central Florida.

_______ I voluntarily give my consent to participate in the study of the Freeze Frame Learning Program conducted by Nancy Aguinaga from the University of Central Florida.

______________________________________ / ____________________

Parent/ Guardian Date

______________________________________ / ____________________

Principal Investigator Date

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3/15/2006
CHAIRMAN

Biofeedback & Behavior Change in the Classroom Using the Freeze-Framer Computer-Based Learning System

What is Biofeedback?

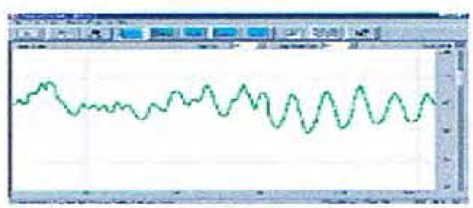
- Essentially, biofeedback is information – or feedback - about an individual's biological functions
- The basic idea of biofeedback training is to provide individuals with increased information about what is going on inside their bodies and their brains
- Students can learn to alter their heart rate and ultimately learn to control their physiological reactions which control problematic impulsive behaviors

What is the Freeze-Framer?

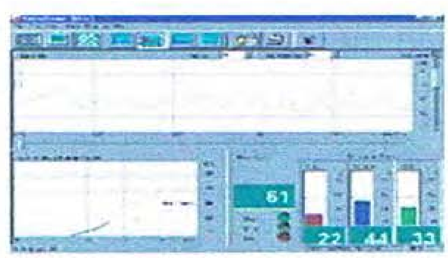
- The Freeze-Framer is research-based educational technology that helps students experience rapid and profound improvements in comprehension, memory, attitude and behavior. Its interactive games make learning to manage emotions fun and fulfilling.

- The Freeze-Framer hardware is a rugged and reliable finger sensor which continuously monitors your pulse and sends your heart rhythm information to the computer.

- The information is then interpreted and displayed on screen as a real-time graph of changing heart rhythms. Students learn how their attitudes affect their heart rhythms and performance.



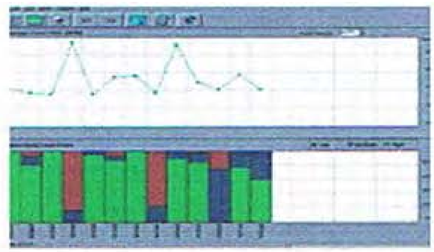
- Freeze-Framer Output is useful as students make internal shifts and learn to stabilize their emotions and balance their nervous systems.



Primary Source: www.heartmath.org

- Play the games—Three interactive games engage the students as they learn to master their own physiology and reach the zone of effective learning and performance.

- Review Sessions—Part of the fun of learning is to see individual progress. In this mode, students track their progress over time as they learn to access their higher thinking skills at the times they need them most.



- Freeze-Framer can be an asset at almost any level improving:
  - Focus and Attention
  - Emotional Stability
  - Impulse Control
  - Anger Management
  - Motivation to Succeed
  - Comprehension
  - Problem Solving
  - Test Scores

Student Responsibilities

- Learn information about stress and emotions
- Learn to use software and demonstrate its effectiveness within the classroom
- Try to transfer knowledge about iofeedback to other situations

Primary Source: www.heartmath.org

Contact : Nancy J. Aguinaga or Kevin J. Miller, Ed.D., Dept. of Child, Family and Community Sciences, University of Central Florida, 407-823-5314 (aguinaga@mail.ucf.edu or kjmiller@mail.ucf.edu)

APPENDIX D:

TEACHER CONSENT

REVISED 3/15/06

March, 2006

Dear Educators,

I am a graduate student at the University of Central Florida. I am currently working on my Ph. D. and am under the supervision of a faculty member, Dr. Kevin Miller. I am conducting research on computer-assisted biofeedback and the relationship with behavior change. The purpose if this study is to examine the implementation of a software program based on the principles of biofeedback and its effective in increasing on-task behavior for students with Autism Spectrum Disorders. Participating children will receive instruction on the impact of stress on the body, learn to recognize stressful feelings and learn to use calming or relaxation strategies when faced with challenging situations. A description of the Freeze Frame Technique we are using is attached.

I am asking you to support the proposed research project by allowing the selected students in your class to participate in a five minute session per day using the Freeze Framer software for approximately six weeks. The results of this study may assist and support students, parents, teachers and districts in designing and implementing an effective strategy for students with Autism Spectrum Disorders. It is anticipated that the children in the study will benefit from this intervention by learning how to self-regulate their behavior, ultimately increasing on-task behavior. The study will possibly benefit the children now and in the future to improve adaptive functioning across multiple areas of the child's life.

You will be asked to participate in a brief training session to learn how to implement the in Freeze Framer program, and complete a survey on the overall experience at the end of the study.

Your identity will be kept confidential, and will not be revealed in any presentations or manuscripts that report the results of this research or within the final manuscript of my Ph. D. dissertation. You have the right to withdraw consent for your participation at any time without consequence. There are no known risks or immediate benefits to you, and no compensation is offered for participation in this study.

I hope you find the Freeze Framer to be a useful tool in your classroom, to help students self manage anxiety and frustration. Attached is an information sheet describing

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the Freeze Framer along with surveys and other measurement instruments to be used in the study.

The purpose of the Freeze Framer Computer-Based Learning System is:

1. To provide workable solutions for challenging behavior, reducing stress and conflict, and creating a coherent learning environment.
2. To help students develop strategies to reduce anxiety and frustration in the face of school-related challenges.
3. To supply new skills and strategies to increase student on-task behavior and academic performance.

Children will be involved in five procedures:

1. Each child will be taught a lesson on the impact of stress and how it affects the body.
2. Each child will be taught the Freeze Frame Technique to manage stress.
3. Each child will learn to use the Freeze Frame Learning Program software to practice the Freeze Frame Technique.
4. Each child will complete a survey regarding their experience with the Freeze Frame Learning Program.

Results of this study will be available by contacting Nancy Aguinaga. If you have any questions about this research project, please contact Nancy Aguinaga at (321)794-5943 or Dr. Kevin Miller at (407) 823-5314. Research at the University of Central Florida involving participants is carried out under the oversight of the Institutional Review Board (IRB). Questions or concerns about research participants' rights may be directed at UCF IRB Office at University of Central Florida, Office of Research and Commercialization, 12443 Research Parkway, Suite 302, Orlando, FL 32826-3252. The phone number is (407) 823-2901.

Sincerely,

Nancy J. Aguinaga

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REVISED 3/15/06

Project title: **Effects of Computer-assisted Biofeedback in the Classroom on Student Behavior**

Teacher Consent

_______ I have read the procedure described above.

_______ I voluntarily agree to participate in the procedure.

_____________________________________ / _______________
Participant Date

_____________________________________ / _______________
Principal Investigator Date

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APPENDIX E:

CHILD ASSENT SCRIPT

CHILD ASSENT SCRIPT

Child in Elementary School

Hello, my name is Nancy Aguinaga. How are you? I am a student at the University of Central Florida and I once was a teacher in a class just like this. I am working on an assignment for school and I would like for you to work with me on this assignment.

I would like to introduce you to the Freeze Framer Learning Program. You will learn how to use a computer program that will show you a picture of your heart rhythms. All you have to do is place a sensor on your finger or ear that will measure you heart rate. The computer program also has some games that you can play to practice the Freeze Frame Technique. I will also be asking you to complete a worksheet about how you are feeling. This information is to help me find out how well this program works. You may stop at any time and you will not have to answer any questions you do not want to answer. Would you like to do this?

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APPENDIX F:

TEACHER SURVEY

Nancy Aguinaga

Appendix F

Teacher Survey of Intervention

Please circle "yes" or "no"

1. Was the presentation of the software clear?

   Yes No

2. Was the presentation of Freeze-Frame concept clear?

   Yes No

3. Was the research team knowledgeable and helpful?

   Yes No

4. Did you feel your time was well spent?

   Yes No

5. Did you observe any generalization of self regulation of behavior?

   Yes No

6. Are you interested in using the Freeze-Framer with your students?

   Yes No

7. Do you think using the Freeze-Framer in the classroom will benefit the students?

   Yes No

Additional questions and comments: ______________________________________

____

____

____

Thank You !!!

APPENDIX G:

PARENT SURVEY

Nancy Aguinaga

Appendix G

Parent Survey of Intervention

Please circle "yes" or "no"

1. Was the presentation of the study clear?

    Yes   No

2. Was the presentation of Freeze-Frame concept clear?

    Yes   No

3. Was the researcher knowledgeable and helpful?

    Yes   No

4. Did you feel your child's time was well spent?

    Yes   No

5. Did you observe any generalization of self regulation of behavior?

    Yes   No

6. Are you interested in using the Freeze-Framer with your child in the home?

    Yes   No

7. Do you think using the Freeze-Framer benefited your child?

    Yes   No

Additional questions and comments:

Thank You !!!

APPENDIX H:

INTEVENTION IMPLEMENTATION CHECKLIST

Freeze-Framer Intervention Implementation Checklist

1. Same time every day – 5 times per week, the student will go to the Freeze-framer computer station with the researcher. __________
2. The challenge level will be set to low. __________
3. The student will secure pulse sensor to their finger or ear. The researcher will assist if necessary. __________
4. The researcher will bring up the Heart Rate Variability (HRV) screen with the bar graph and "zone" chart. The researcher will say "ready _(name)_, here we go" and press start. The researcher will say "remember you are trying to make the waves be smooth and short". __________
5. The researcher will remind the student to: "Remember to think about being calm" wait 5 seconds, then say "Remember to take slow, deep breaths" wait 5 seconds, then say "Remember to think about something that makes you feel good" __________
6. The researcher will model slow deep breaths while watching the screen. __________
7. After 30 seconds watching the HRV screen, the researcher will press stop and say "Okay(name), now you can color the picture on the screen by being relaxed" __________
8. The researcher will start the 3-minute meadow game. Here comes the waterfall. What else will we see? __________
9. The researcher will remind the student to: "Remember to think about being calm" wait 10 seconds, then say "Remember to take slow, deep breaths" wait 10 seconds, then say "Remember to think about something that makes you feel good" __________
10. A message will come on the screen that reads "your session has ended" __________
11. The researcher will then save the student's data and direct the student to the teacher. __________
12. The teacher will then give the student their writing activity. __________

APPENDIX I:

DEMOGRAPHIC INFORMATION SHEET

Appendix I

Freeze Frame Study at Bonneville

Student Demographic Data

Student Number	Age	Ethnicity	Gender	Exceptionality	Medication	Grade level functioning	Teacher certification	Experience	Position	Age	Ethnicity
1											
2											
3											

APPENDIX J:

DATA COLLECTION INSTRUMENT

Researcher ____________________ Date ____________ Time ____________

MIN 1	Latency	1st 15 sec interval	2nd 15 sec interval	3rd 15 sec interval	4th 15 sec interval
		:15	:30	:45	:00
Amber (1)					
Robert (2)					
Allison (3)					

MIN 2					
		1:15	1:30	1:45	2:00
Amber (1)					
Robert (2)					
Allison (3)					

MIN 3					
		2:15	2:30	2:45	3:00
Amber (1)					
Robert (2)					
Allison (3)					

MIN 4					
		3:15	3:30	3:45	4:00
Amber (1)					
Robert (2)					
Allison (3)					

MIN 5					
		4:15	4:30	4:45	5:00
Amber (1)					
Robert (2)					
Allison (3)					

ON-TASK – includes writing answers, completing activity by writing, or looking at paper

OFF-TASK – includes attending to stimuli other than activity or writing on activity inappropriately

√ = ON-TASK

X = OFF-TASK

APPENDIX K:

PRINCIPAL LETTER OF SUPPORT

Orange County Public Schools

Bonneville Elementary School

14700 Sussex Drive • Orlando, FL 32826
(407) 249-6290 • Fax (407) 249-4420

Dr. Kimberly V. Bias, Principal *Mr. Sean D. Maguire, Assistant Principal*

February 9, 2006

Nancy J. Aguinaga
Ph. D. Candidate
Exceptional Education Program
Dept. of Child, Family and Community Sciences
College of Education
University of Central Florida
Orlando, FL 32816-1250

Ms. Aguinaga,

Thank you for the opportunity to participate in the study investigating the effectiveness of the Freeze-Frame program. We are always looking for innovative ways to better serve our students to maximize their success in the classroom. Many of our students could benefit from a tool that helps them learn how to self-manage their behavior. We look forward to participating in this partnership activity with parental consent. Thank you for your interest in assisting the students at Bonneville.

Sincerely,

Dr. Kimberly V. Bias

Dr. Kimberly V. Bias

Orange County Public Schools is an equal opportunity employer

APPENDIX L:

RESEARCHER ANECDOTAL RECORDS

Nancy Aguinaga

Appendix L

Researcher Anecdotal records

Date	***Student***	***During writing assignment***	***During Freeze-Framer***	***Extenuating circumstances***

APPENDIX M:

WRITING ACTIVITY RUBRIC FOR PARTICIPANT 1

Name: __Student 1

Date Submitted: ____________

	Criteria				Points
	4	3	2	1	
Letter Formation	Each letter is formed correctly.	All but 1 letter are formed correctly.	80% of the letters are formed correctly.	50% of the letters are formed correctly.	
Letter Slant	All letters have a uniform slant.	All letters have a uniform slant with 1-3 exceptions.	All letters have a uniform slant with 4-6 exceptions.	Slant of letters vary from letter to letter.	
Neatness	There are no extra visible marks or smudges on the paper.	There are 1-2 visible marks or smudges on the paper.	There are 3-5 visible marks or smudges on the paper.	There are more than 5 visible marks or smudges on the paper.	
Relationship To Line	All letters are located correctly in relationship to the lines.	The size of 1-3 letters are slightly larger or smaller than the space allowed by the line.	The size of 4-6 letters are slightly larger or smaller than the space allowed by the line.	The size of more than 6 letters are slightly larger or smaller than the space allowed by the line.	
Correct	Worksheet is 100% correct.	Worksheet is 90-99% correct.	Worksheet is 80-89% correct.	Worksheet is 70-79% correct.	
Complete	Worksheet is 100% complete.	Worksheet is 90-99% complete.	Worksheet is 80-89% complete.	Worksheet is 70-79% complete.	
				Total---->	____ 24

________%

APPENDIX N:

WRITING ACTIVITY RUBRIC FOR PARTICIPANT 2

Name: Student 2

Date Submitted: ____________

	Criteria				Points
	4	**3**	**2**	**1**	
Letter Formation	Each letter is formed correctly.	All but 1-3 letters are formed correctly.	All but 4-6 letters are formed correctly.	All letters are formed correctly with no more than 6 exceptions.	___
Spacing	All words have a uniform space between them.	All words have a uniform space between them with 1-3 exceptions.	All words have a uniform space between them with 4-6 exceptions.	All words have a uniform space between them with no more than 6 exceptions.	___
Correct number of letters	Worksheet has 100% correct number of letters.	Worksheet has all but 1 correct number of letters..	Worksheet has correct number of letters with 2-3 exceptions.	Worksheet has correct number of letters with more than 3 exceptions..	___
Complete	Worksheet is 100% complete.	Worksheet is 90-99% complete.	Worksheet is 80-89% complete.	Worksheet is 70-79% complete.	___
				Total---->	___ 16

__________%

APPENDIX O:

WRITING ACTIVITY RUBRIC FOR PARTICIPANT 3

Name: Student 3

Date Submitted: ____________

	Criteria				Points
	4	3	2	1	
Letter Formation	Each letter is formed correctly.	All but 1-3 letters are formed correctly.	All but 4-6 letters are formed correctly.	All letters are formed correctly with no more than 6 exceptions.	___
Correct number of letters	Worksheet has 100% correct number of letters.	Worksheet has all but 1 correct number of letters..	Worksheet has correct number of letters with 2-3 exceptions.	Worksheet has correct number of letters with more than 3 exceptions..	___
Complete	Worksheet is 100% complete.	Worksheet is 90-99% complete.	Worksheet is 80-89% complete.	Worksheet is 70-79% complete.	___
				Total---->	___ 12

________%

APPENDIX P:

PARTICIPANT 1 WRITING ACTIVITY WORK SAMPLE

Participant 1

6/6 = 100%

Name ______________________ Date 4-28-2006

/k/ Sound

(Answer ID # 0243169)

Write the word that best completes each sentence.

1. We can use these feathers to make a **(mask, coat, clean, shark)**.

   mask

2. I hope the new **(shake, coat, kite, mask)** will fit me.

   coat

3. Amy has to **(clean, shark, cow, kite)** her room before she can play.

   Clean

4. **(Shark, Mask, Clean, Shake)** hands with Mr. Jackson.

   shake

5. My **(shark, kite, cow, shake)** went high in the sky.

kite

6. The **(coat, clean, mask, cow)** jumped over the moon.

cow

APPENDIX Q:

PARTICIPANT 2 WRITING ACTIVITY WORK SAMPLE

Participant 2

Name ____________ Date 4/28/0

My Daily Journal 4-27-2006

Today is Friday.

TodayisFriday.

Yesterday was Thursday.

YesterdaywasThursday.

Tomorrow will be Saturday.

TomorrowWillbe Saturday.

The month is April.

ThemonthisApril.

Next month is May.

NextmonthisMay.

We are going to Sea World.

we aregoingtosea world.

We will see dolphins.

We Willsee dolphins.

We will have a great time!

We Willhave a great time.

4
1
2
4 11 =69%

APPENDIX R:

PARTICIPANT 3 WRITING ACTIVITY WORK SAMPLE

Participant 3 4-28-06

Name ____ Date ____

Who Am I?

I am Robert ______________.

I am Robert ______________.

I am Robert ______________.

I am Robert ______________.

I am Robert ______________.

I am Robert ______________.

1
1
3/5 42%

REFERENCES

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., text rev.). Washington, DC:Author.

Attwood, T. (2000). Strategies for improving the social integration of children with asperger syndrome. Autism: *The International Journal of Research and Practice, 4*(1), 85-100.

Autism Society of America. (2005). *What is autism?* Retrieved December 2, 2005, from http://autism-society.org

Ayers, A. J. (1979). *Sensory Integration and the child*. Los Angeles: Western Psychological Services.

Baker, B.L., Blacher, J., Crnic, K.A., & Edelbrock, C. (2002). Behavior problems and parenting stress in families of three-year-old children with and without developmental delays. *American Journal on Mental Retardation, 107*(6), 433-444.

Berliner, D. C., & Rosenshine, B. (1977). The acquisition of knowledge in the classroom. In R. Spiro & W. Montague (Eds.), *Schooling and the acquisition pf knowledge*. Hillsdale, NJ: Lawrence Eribaum.

Bledsoe, R., Myles, B. S., & Simpson, R. (2003). Use of social story intervention to improve mealtime skills of an adolescent with Asperger Syndrome. *Autism, 7*(3), 289 – 295.

Bloch-Rosen, S., (1999). *Asperger's Syndrome and the Autistic Spectrum*. Retrieved April 25, 2006, from http://www.aspergersyndrome.com

Bodfish, J. W. (2004). Treating the core features of autism: Are we there yet? *Mental Retardation & Developmental Disabilities Research Reviews, 10* (4), 318-326.

Bondy, A. S., & Frost, L. A. (1994). The picture exchange communication system. *Focus on Autistic Behavior, 9*(3), 1-19.

Borthwick-Duffy, S. A. (1996). Evaluation and quality of life: Special considerations for persons with mental retardation. In R. L. Schalock & G. N. Siperstein (Eds.), *Quality of life. Vol. I: Conceptualization and measurement* (pp. 105–120). Washington, DC: American Association on Mental Retardation.

Buron K. D. (2003). *When my autism gets too big!* Shawnee Mission, KS: Autism Asperger Publishing Company.

Butnik, S. M. (2005). Neurofeedback in adolescents and adults with attention deficit hyperactivity disorder. *Journal of Clinical Psychology, 6*(5), 621-625.

Buysse, V., & Bailey, D. B. (1993). Behavioral and developmental outcomes in young children with disabilities in integrated and segregated settings: A review of comparative studies. *Journal of Special Education, 26*, 434-461.

Cancelli, A. S., Harris, A. M., Friedman, D. L., & Yoshida, R. K. (1993). Type of instruction and the relationship of classroom behavior to achievement among learning disabled children. *Journal of Classroom Interaction, 8*(1), 13–21.

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

Carr, S. C., & Punzo, R. P. (1993). The effects of self-monitoring of academic accuracy and productivity on the performance of students with behavioral disorders. *Behavior Disorders, 18,* 241–250.

Church, C., Alisanski, S., & Amunullah, S. (2000). The social, behavioral, and academic experiences of children with Asperger syndrome. *Focus on Autism and Other Developmental Disabilities, 15*, 12-20.

Cook, B. G., Landrum, T. G., Tankersley, M., & Kauffman, J. M. (2003). Bringing research to bear on practice: Effecting evidence-based instruction for students with emotional or behavioral disorders. *Education & Treatment of Children*, *26*(4), 345-361.

Cook, B. G., & Schirmer, B. R. (2003). What is special about special education?: Introduction to the special series. *Journal of Special Education, 37,* 139.

Cooper, J. O., Heron, T. E., & Heward, W. L. (1987). *Applied Behavior Analysis*. Upper Saddle River, NJ:Merril.

Costenbader, V., & Reading-Brown, M. (1995). Isolation timeout used with students with emotional disturbance. *Exceptional Children*, *61*, 353-363.

Critchley, H. D., Melmed, R. N.Featherstone, E., Mathias, C. J. & Dolan, R. J. (2001). Brain activity during biofeedback relaxation: A functional neuroimaging investigation. *Brain*, *124*(5), 1003-1012.

Curry, L. (1984). Student commitment and school organization in relation to on-task behavior and achievement. *Contemporary Educational Psychology, 9*, 171–184.

D'Zurilla, T. J. (1986). *Problem solving therapy: A social competence approach to clinical intervention.* New York: Springer Publishing Company.

deBeus, R., Ball, J. D., & deBeus, M.E. (2004). Attention training with ADHD children: Preliminary findings in a double-blind placebo-controlled study. *Journal of Neurotherapy, 8*(2), 145-147.

Delandshere, G. (2004).The moral, social and political responsibility of educational researchers: Resisting the current quest for certainty. *International Journal of Educational Research, 41*(3) 237-256.

DeMartini-Scully, D.,Bray, M. A., & Kehle, T. J. (2000). A packaged intervention to reduce disruptive behaviors in general education students. *Psychology in the Schools, 37*, 149-155.

Delquadri, J., Greenwood, C. R., Whorton, D., Carta, J. J., & Hall, R. V. (1986). Classwide peer tutoring. *Exceptional Child, 52*(6), 535-542.

Dossey, B., Keegan, L., Kolkmeier, L., & Guzzetta, C. (1989). *Holistic Health Promotion: A Guide for Practice.* Rockville, MD: Aspen Publishers.

Duchnowski, A. J., Kutash, K., & Frieman, R. M. (2002). Community-based interventions in a systems of care and outcomes framework. In B. Burns & K. Hoagwood (Eds.), *Community-based treatment for youth: Evidence-based interventions for severe emotional and behavioral disorders*. New York: Oxford University Press.

Dunlap, G., Clarke, S., Jackson, M., Wright, S., Ramos, E., & Brinson, S. (1995). Self-monitoring of classroom behaviors with students exhibiting emotional and behavioral challenges. *School Psychology Quarterly, 10*(2), 165–177.

Dybvik, A. C. (2004). Autism and the inclusion mandate. *Education Next*, *4*(1), 42-49.

EEG Spectrum International Incorporated (2005). *Introduction to nuerofeedback*. Retrieved December 28, 2005, from http://www.eegspectrum.com

Feinberg, E., & Vacca, J. (2000). The drama and trauma of creating policies on autism: Critical issues to consider in the new millennium. *Focus on Autism and Other Developmental Disabilities, 15*, 130-137.

Fisher, C. W., & Berliner, D. C. (1985). *Perspectives on instructional time*. New York: Longman.

Frederick,W. C. (1977). The use of classroom time in high schools above or below the median reading score. *Urban Education, 21*(4), 459–465.

Frost, L.A., & Bondy, A. S. (1994). *The Picture Exchange Communication System training manual.* Cherry Hill, NJ: Pyramid Educational Consultants, Inc.

Fuller, G. (1977). *Biofeedback: Methods and Procedures in Clinical Practice*. San Francisco, CA: The Biofeedback Institute of San Francisco.

Gilberts, G. H., Agran, M., Hughes, C. & Wehmeyer, M. (2001). The effects of peer delivered self-monitoring strategies on the participation of students with severe disabilities in general education classrooms. *Journal for the Association for Persons with Severe Handicaps, 26*, 25-36.

Glasser, W. (1996). Then and now. The Theory of Choice. Learning, 25(3) 20-22.

Gray, C. A., & Garand, J. D. (1993). Social stories: Improving responses of students with autism with accurate social information. *Focus on Autistic Behavior*, *8*(1), 1-10.

Greenspan, S. I., Wieder, S., & Simons, R. (1998). *The child with special needs: Encouraging intellectual and emotional growth*. Reading, MA: Addison Wesley.

Greenwood, C. R. (1991). Longitudinal analysis of time, engagement, and achievement in at-risk versus non-risk students. *Exceptional Children, 57*(6), 521-535.

Greenwood, C. R., Horton, B. T., Utley, C. A. (2002). Academic engagement: Current perspectives in research and practice. *School Psychology Review, 31*(3), 328-349.

Gresham F. M. (1996). Learning disabilities, low achievement, and mild mental retardation: More alike than different? *Journal of Learning Disabilities, 29* (6), 570-581.

Gresham, F. M., Beebe-Frankenberger, M. E, & MacMillan, D.L. (1999) A selective review of treatments for children with autism: Description and methodological considerations. *School Psychology Review, 28*(4), 559-575.

Hanley, G. P., Iwata, B. A., & McCord, B. E. (2003). Functional analysis of problem behavior: A review. *Journal of Applied Behavior Analysis, 36*, 147-185.

Haas-Warner, S. (1992). The utility of self-monitoring for preschool on-task behavior. *Topics in Early Childhood Special Education*, *12*(4), 478–495.

Hagiwara, T., & Myles, B. S. (1999). A multimedia social story intervention: Teaching skills to children with autism. *Focus on Autism and Other Developmental Disabilities, 14*(2), 82-95.

Hammond, D. C., (2005). Neurofeedback with anxiety and affective disorders. *Child and adolescent psychiatric clinics of North America*, *14*(1), 105-23.

Heflin, L. J., & Simpson, R. L. (1998). Interventions for children and youth with autism: Prudent choices in a world of exaggerated claims and empty promises. Part I: Intervention and treatment option review. *Focus on Autism and Other Developmental Disabilities, 13*(4), 194-211.

Higgins, K., & Boone, R. (1996). Creating individualized computer-assisted instruction for students with autism using multimedia-authoring software. *Focus on Autism and Other Developmental Disabilities, 11*, 69-78.

Horner, R. H., Carr, E. G., Halle, J., McGee, G., Odom, S., & Wolery, M. (2005).The use of single-subject research to identify evidence-based practice in special education. *Exceptional Children, 71*(2), 165-179.

Horner, R. H., Carr E. G., Strain, P. S., Todd A. W., & Red H. K. (2002). Problem behavior interventions for young children with autism: A research synthesis. *Journal of Autism and Developmental Disorders. 32*(5), 423-446.

Howlin, P., Baron-Cohen, S., & Hadwin, J. (1999). *Teaching children with autism to mind-read: A practical guide for teachers and parents*. West Sussex, England: Wiley.

Individuals with Disabilities Education Improvement Act of 2004, (2004) *U.S.C. 1400 et seq.* Retrieved February 20, 2006, from http://www.ideapractices.org/law/downloads

Institute of HeartMath (2005). *Special Education*. Retrieved December 12, 2005, From http://www.heartmath.org/

Iovannone, R., Dunlap, G., Huber, H., & Kincaid, D. (2003). Effective educational practices for students with Autism Spectrum Disorders. *Focus on Autism & Other Developmental Disabilities*, *18*(3), 150-165.

Janney, R., & Snell, M. E. (2000). *Behavioral Support*. Baltimore: Brookes.

Jarusiewicz, B. (2002). Efficacy of neurofeedback for children in the Autistic Spectrum: A pilot study. *Journal of Neurotherapy, 6*(4), 39-49.

Kagan, J, & Pozen, R. (2005). Autism inflation. *Forbes, 175,* (12), p. 44.

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2,* 217-250.

Kauffman, J. M. (2001). *Characteristics of emotional and behavioral disorders of children and youth* (7th ed.). Upper Saddle River, NJ: Merrill/ Prentice Hall.

Kazdin, A. E. (1982). *Single-case experimental designs: Methods for clinical and applied settings.* New York: Oxford University Press.

Kelley, J.B., & Samuels, M. (1977).A new look at childhood autism: School-Parent collaboration. *Journal of School Health, 47*(9), 538-40.

Kendall, P. C. (1991). *Child and adolescent therapy: Cognitive-behavioral procedures.* New York, NY, US: Guilford Press.

Kern, L., & Dunlap, G. (1998) Circular modifications to promote desirable classroom behavior. In J. K. Luiselli & M. J. Cameron (Eds.), *Antecedent control: Innovative approaches to behavioral support* (p. 289-307). Baltimore: Brookes.

Klin, A., & Volkmar, F. R. (1997).The pervasive developmental disorders: Nosology and profiles of development, 208-226.; In: *Developmental psychopathology: Perspectives on adjustment, risk, and disorder*. Luthar, S. S., Burack, J. A., Cicchetti, D., & Weisz, J. R.; New York, NY, US: Cambridge University Press.

Koegel, L. K, Koegel, R. L., Hurley, C., & Frea, W. D. (1992). Improving social skills and disruptive behavior in children with autism through self-management. *Journal of Applied Behavior Analysis, 25*, 341-353.

Koegel, R. L., Carter, C. M., & Koegel, L. K. (1998). Setting events to improve parent teacher coordination and motivation for children with autism. In J. Luiselli & M. Cameron (Eds.), *Antecedent control: Innovative approached to behavioral support*. (p. 167-186). Baltimore: Brookes.

Koegel, R. L., Frea, W. D., & Surratt, A. V. (1994). Self-management of problematic social behavior. In W. Schopler & G. B. Mesibov (Eds.), *Behavioral issues in autism*. (p. 81-97). New York: Plenum.

Koegel, R. L. & Koegel, L. K. (2000). *Teaching children with autism: Strategies for initiating positive interactions and improving learning opportunities* (rev. ed). Baltimore, MD: Paul H. Brookes Publishing Co., Inc.

Koegel, R. L., Koegel, L. K., Frea, W. D., & Smith, A. E. (1995). Emerging interventions for children with autism. In R. L. Koegel & L. K. Koegel (Eds.), *Teaching children with autism: Strategies for initiating positive interactions and improving learning opportunities (p. 1-15).* York, PA: The Maple Press Company.

Knitzer, J., Steinberg, Z., & Flesch, B. (1990). *At the school house door: An Examination of programs and policies for children with behavioral and emotional problems.* New York: Bank Street College of Education.

Krantz, P. J., & Risley, T. R. (1974). Behavioral ecology in the classroom. In K. D. O'Leary & O. L. S. G. (Eds.), Classroom management: The successful use of behavior modification (2nd ed). New York: Pergamon.

Kuehn, B. M. (2006). Studies Probe Autism Anatomy, Genetics. *Journal of the American Medical Association, 295*(1), 19-20.

Larson, J. & Lochman, J.E. (2002). *Helping School Children Cope with Anger: A Cognitive-Behavioral Intervention*. New York: Guilford.

Larsson H. J., Eaton W.W., Madsen K. M., Vestergaard M., Olesen A. V., Agerbo E., Schendel D., Thorsen P., & Mortensen P. B. (2005). Risk factors for autism: Perinatal factors, parental psychiatric history, and socioeconomic status. *American Journal of Epidemiology, 161*(10), 916-925.

Lawton, G. (2005). The autism myth. *New Scientist*, *187* (2512), 36-40.

Lazarus, R. S. (1981). The stress and coping paradigm. In C. Eisdorfer, D. Cohen, A. Kleinman, & P. Maxim (Eds.), *Theoretic bases for psychopathology*. New York: Spectrum.

Lloyd, J. W., Bateman, D. F., Landrum, T. J., & Hallahan, D. P. (1989) Self recording of attention versus productivity. *Journal of Applied Behavior Analysis, 22*(3), 315-323.

Lovaas, O. I. (1987). Behavioral treatment and normal and educational and intellectual functioning in young autistic children. *Journal of Consulting and Clinical Psychology, 55*(1), 3-9.

Lubar, J. (1995). Neurofeedback for the management of attention deficit Hyperactivity disorders. In Schwartz, M. S. (Ed.), *Biofeedback: A Practitioner's Guide*. New York: Guilford Publications.

Lubar, J. (1997). Neurobiological foundation for neurofeedback treatment of attention deficit hyperactivity disorder (ADD/ADHD). *Biofeedback, 25* (1), 1-4.

Lunt, J. & Kang, K. (1997). EEG biofeedback and autism. *Latitudes, 3*(2).

Mandell, D. S., Novak, Maytali M.& Zubritsky, C. D. (2005). Factors associated with age of diagnosis among children with Autism Spectrum Disorders. *Pediatrics, 116* (6), 1480-1486

Mayer, M., Lochman, J., & Van Acker, R. (2005). Introduction to the special issue: Cognitive-behavioral interventions with students with EBD. *Behavioral Disorders, 30*(3), 197-212.

McCraty, R. (1999). *The Freeze-Framer: A stress management training and heart rhythm education system for increasing physiological coherence*. Proceedings of the Tenth International Montreux Congress on Stress, Montreux, Switzerland.

McCraty, R., Atkinson, M., Tomasino, D., Goelitz, J., & Mayrovitz, H. N. (1999) The impact of an emotional self-management skills course on psychosocial functioning and autonomic recovery to stress in middle school children. *Integrative Physiological & Behavioral Science, 34*(4), 246-268.

McWilliam, R. A., & Bailey, D. B. (1995). Effects of classroom social structure and disability on engagement. *Topics in Early Childhood Special Education, 15*, 123-147.

Mesibov, G. (1997). Formal and Informal measures on the effectiveness of the TEACCH program. Autism: *The International Journal of Research and Practice, 1*, 25-35.

Miller, C. A., Fitch, T., Marshall, J. L. (2003). Locus of control and at-risk youth: A comparison of regular education high school students and students in alternative schools. *Education, 123*(3), 548-551.

Montes, F., & Risley, T. R. (1975). Evaluating traditional day care practices: An empirical approach. *Child Care Quarterly, 4*(3), 208-215.

Moore, D., Yufang, C., McGrath, P., & Powell, N. J. (2005). Collaborative virtual environment technology for people with autism. *Focus on Autism & Other Developmental Disabilities, 20*(4), 231-243.

Moore, D. J., & Taylor, J. (2000). Interactive multimedia systems for people with autism. *Journal of Educational Media, 25*,169-177.

Monastra, V. J., Lynn, S., & Linden, M. (2005). Electroencephalographic biofeedback in the treatment of Attention-Deficit/Hyperactivity Disorder. *Applied Psychophysiology and Biofeedback, 30*(2), 95-114.

Mullins, J. L., & Christian, L. (2001). The effects of progressive relaxation training on the disruptive behavior of a boy with autism. *Research in Developmental Disabilities, 22*(6), 449 – 462.

Myles, B. S., Cook, K. T., Miller, N. E., Rinner, L., & Robbins, L. A. (2000). *Asperger syndrome and sensory issues*. Shawnee Mission, KS: Autism Asperger.

National Institute of Mental Health (2005). *Autism Spectrum Disorders* (Pervasive Developmental Disorders). Retrieved December 2, 2005, from http://www.nimh.nih.gov/publicat/autism.cfm

National Research Council. (2001). *Educating children with autism*. Committee On Educational Interventions for Children with Autism. Division of Behavioral and Social Sciences and Autism. Washington, DC: National Academy Press.

No Child Left Behind Act of 2002. (2002). *Public Law 107-220*. 107th Congress. Full text: http://www.ed.gov/legislation/ESEA02/

Norris, C., & Dattilo, J. (1999). Evaluating effects of a social story intervention on a young girl with autism. *Focus on Autism and Other Developmental Disabilities, 14*(3), 180-186.

Neel, R. S., & Billingsley, F. F. (1989). *Impact: A functional curriculum handbook for students with moderate to severe disabilities*. Baltimore, MD: Paul H. Brookes Publishing.

Nelson, M. (2004). Intervention and treatment research. In R. Rutherford, M. Quinn, & S. Mather (Eds.), *Handbook of research in emotional and behavioral disorders*. New York: Guilford Press.

Nemours (2006). *Biofeedback with children: Frequently asked questions*. Retrieved May 27, 2006, from http://www.nemours.org/internet?url=no/faq/faq1753.html

Nystrand, M., & Gamoran, A. (1989). *Instructional discourse and student engagement.* (ERIC Document Reproduction Service No. ED 319 780)

Odom, S., Gersten, R., Horner, R., Thompson, B., & Brantlinger, E. (2003). *Validating evidence based practices in special education: Multiple methodologies*. Presentation at the OSEP Research Project Directors' Conference, Washington, DC.

Odom, S. L., & McEvoy, M. A. (1988). Integration of young children with handicaps and normally developing children. In S. L. & M. B. Karnes (Eds.) *Early intervention for infants and children with handicaps: An empirical base.* Baltimore: Paul H. Brookes Publishing Co.

Olley, J. G. (1999). Curriculum for students with autism. *School Psychology Review, 2*(4), 595-607.

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

Othmer, S. (2003).The emerging frontier of neurofeedback. *Latitudes, 6*(1), 13-16.

Peterson S. L., Bondy A. S., Vincent Y., & Finnegan C. S. (1995). Effects of Altering communicative input for students with autism and no speech: two case studies. *Augmentative & Alternative Communication, 11*(2), 93-100.

Polatajko, H. J., Kaplan, B. J., Wilson, B. N. (1992). Sensory integration treatment for Children with learning disabilities: It's status 20 years later. *Occupational Therapy Journal of Research, 12,* 323-341.

Porter, S., Omizo, M., (1984). The effects of group relaxation training/large muscle exercise, and parental involvement on Attention to task, impulsivity, and locus of control among hyperactive boys. *Exceptional Child, 31*(1) 54-64.

Porter, S. (2003). Training the brain. Alive: *Canadian Journal of Health & Nutrition, 251*, 90-92.

Prizant, B., & Rubin, E. (1999). Contemporary issues in interventions for autism spectrum disorders: A commentary. *The Journal of the Association for Persons with Severe Handicaps, 24,* 199-208.

Raposa, J. (2003). *Biofeedback in educational entertainment*. Retrieved March 25, 2006 from http://www.interaction-ivrea.it

Rock, M. L. (2005). Use of strategic self-monitoring to enhance academic engagement, productivity, and accuracy of students with and without exceptionalities. *Journal of Positive Behavior Interventions, 7*(1), 3-17.

Rogers, J. (1993). The inclusion revolution. Research Bulletin, *Phi Delta Kappa, 11*, 1-6.

Rojas, N. L., & Chan, E. (2005). Old and new controversies in the alternative treatment of attention-deficit hyperactivity disorder. *Mental Retardation & Developmental Disabilities Research Reviews*, *11* (2), 116-130.

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*(1), 48-59.

Sarafino, E. P. (1997). *Behavioral treatments for asthma: Biofeedback, respondent, and relaxation based approaches*. Wales, UK: The Edwin Mellen Press.

Sasso, G. M., Conroy, M. A., Peck Stichter, J. & Fox, J. (2001). Slowing down the bandwagon: The misapplication of functional assessment for students with emotional and behavioral disorders. *Behavioral Disorders, 26*, 282-296.

Schopler, E., Mesibov, G., & Hearsey, K. (1995). Structures teaching in the TEACCH system. In Schopler & G. B. Mesibov (Eds.), *Learning and cognition in autism* (p. 243-267). New York: Plenum.

Schreibman, L. (2000). Intensive behavioral/psychoeducational treatments for autism: Research needs and future directions. *Journal of Autism and Developmental Disorders, 30*(5), 373-378.

Schwartz, M. S. (1982). *Biofeedback: A Practioner's Guide*. The Guilford Press, New York.

Schwartz, I. S., Garfinkle, A. n., & Bauer, J. (1998). The picture exchange communication system: Communicative outcomes for young children with disabilities. *Topics in Early Childhood Special Education, 18*(3), 144-159.

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

Shearer, D. D., Kohler, F. W., Buchan, K. A., & McCullough, K. M. (1996). Promoting independent interactions between preschoolers with autism and their nondisabled peers: An analysis of self-monitoring. *Early education and Development, 7*(3), 205-220.

Sichel, A. G., Fehmi, L. G., & Goldstein, D. M. (1995). Positive outcome with neurofeedback treatment in a case of mild autism. *Journal of Neurotherapy, 1*(1), 60-64.

Simpson R. L. (2005). *Autism Spectrum Disorders: Interventions and Treatments for Children and Youth*; Thousand Oaks CA: Corwin Press

Simpson, R. L., de Boer-Ott, S. R., & Smith-Myles, B. (2003). Inclusion of learners with Autism Spectrum Disorders in general education settings. *Topics in Language Disorders, 23*(2)116-33.

Simpson, R. L., & Myles, B. S. (1998). *Educating children and youth with autism: Strategies for effective practice.* Austin, TX: PRO-ED.

Smith, S. W., & Farrell, D.T. (1993). Level system use in special education: Classroom intervention with prima facie appeal. *Behavioral Disorders, 18*(4), 251-264.

Spencer, J. (1996).EEG biofeedback. *Latitudes, 2*(5), 8-11.

Sprague, J. R., & Rian, V. (1993). *Support systems for students with severe problem behaviors in Indiana: A descriptive analysis of school structure and student demographics:* Unpublished manuscript, Indiana University Institute for the Study of Developmental Disabilities, Bloomington, IN.

Strain, P.S. (1983). Generalization of autistic children's social behavior change: Effects of developmentally integrated and segregated settings. *Analysis and Intervention in Developmental Disabilities, 3*(1) 23-34.

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*(1), 33-44.

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

Tsai, L. (2000). Children with autism spectrum disorder: Medicine today and in the new millennium. *Focus on Autism and Other Developmental Disabilities, 15*(3), 138-145.

U.S. Department of Education, Office of Special Education Programs. (2003). *Annual report to Congress on the implementation of the Individuals with Disabilities Education Act*. Washington, DC: Author.

U.S. Department of Education, Office of Special Education Programs. (2003). *Remarks Prepared for Secretary Rod Paige at the Autism Summit*. Retreived April 21, 2006, from http://www.ed.gov/news/speeches/2003/11/11192003.html

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Wang, M., & Baker, E. (1986). Mainstreaming program: Design features and effects. *Journal of Special Education, 19*(4), 503-521.

Wehman, P., & Kregel, J. (1995). At the crossroads: Supported employment a Decade later. *Journal of the Association for Persons with Severe Handicaps, 20*(4) 286-299.

Wehmeyer, M. L., Field, S., Doren, B., Jones, B., & Mason, C. (2004). Self-determination and student involvement in standards-based reform. *Exceptional Children, 70*(4), 413-425.

Wing, L. (1996). *The autistic spectrum. A guide for parents and professionals*. London: Constable.

World Health Organization. (1993). *International classification of diseases*-Tenth revision. Geneva, Switzerland: Author.

Yamamoto, J., & Maya, T. (1999). Acquisition and transfer of sentence construction in autistic students: Analysis by computer-based teaching. *Research in Developmental Disabilities, 20*, 355-377.