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STUDENTS WITH AUTISM:
A LIGHT/SOUND TECHNOLOGY INTERVENTION

A Dissertation

Presented to

The Faculty of the School of Education
The College of William and Mary in Virginia

In Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

By

Patricia Powell Woodbury

December 1996

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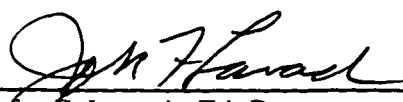
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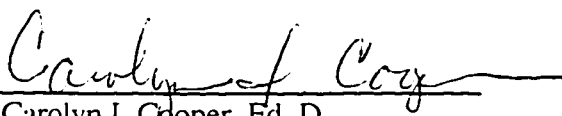
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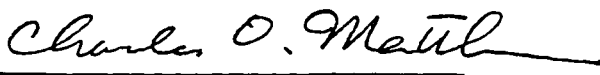
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DEDICATION

This dissertation is dedicated to my husband, Gerard, without whose support, love and patience it would not have been possible; my mother, who taught me about love; my son, daughter and granddaughter who helped me live it; and to my grandfather, who "was a bear."

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STUDENTS WITH AUTISM: A LIGHT/SOUND TECHNOLOGY INTERVENTION

ABSTRACT

The purpose of the study was to investigate the effectiveness of light/sound technology to promote sensory integration which facilitates the learning capacity of children with autism by reducing their high state of arousal, increasing time on task and decreasing acting-out behaviors. This research extended the work of A. Jean Ayres and Lorna King who theorized that the autistic individual's brain does not register, modulate or integrate sensations that most people notice; auditory and visual inputs are ignored more than other types of sensory stimuli. This study utilized light/sound technology to stimulate and desensitize these sensory channels to facilitate processing of incoming stimuli. The technology was furnished by Dr. Harold Russell and was programmed with a microchip to control the frequency patterns. Twelve subjects were selected to participate in this eight week study; only five subjects completed. They represented schools in the Tidewater region of Virginia and Illinois. Inattention, Impulsivity, and Hyperactivity were assessed with The Attention Deficit Disorder Evaluation Scale-Home and School Versions. Comparison of the results of these measures and qualitative data were incorporated into case studies. There was improvement noted in social skills, attention and on-task behavior. The results are supportive of research conducted with learning disabled and AH/HD students conducted by Drs. Carter and Russell.

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STUDENTS WITH AUTISM: A LIGHT/SOUND TECHNOLOGY INTERVENTION

Chapter I

Introduction

Statement of the Problem

This study investigated the effectiveness of light/sound technology to promote sensory integration which theoretically increases the learning capacity of students with autism by decreasing their high state of arousal, increasing time on task and decreasing acting-out behaviors.

The Justification for the Study

Because of federal mandates, special educators are now making a more concerted and consistent effort to correctly identify and serve the educational needs of students with autism. The population identified as autistic continues to increase and the issue of best practice techniques to meet their educational needs is presently being addressed.

In 1990, the Individuals with Disabilities Act (IDEA) was enacted into law. One of the amendments, PL 101-476, indicates under Part A; General Provisions, that autism and traumatic brain injury were added to the list of disabilities that qualifies students for special education. In addition, a directive (IDEA amendments, 1991) has been mandated to solicit comments to determine if children with attention deficit disorder (ADD) should also be eligible for special education services. Under Public Law 94-142 these conditions were served under "Other Health Impaired" by educational systems.

Autism is a rare developmental disability affecting only 5 to 9 children in 10,000 and is manifested through unique deficits (Blackman, 1990). These deficits require

remediation in the areas of sensory integration, behavioral difficulties, social skills, self-help abilities as well as language and communication skills.

Many school districts presently do not have the facilities for this population and have formed cooperatives with other schools systems to provide services. In Tidewater, Virginia, students with autism are primarily served by two area cooperative systems: New Horizons Children's Center that serves six school divisions and SECEP (Southeastern Cooperative Educational Program) which serves eight school districts.

Autism was considered a "low incidence" handicapping condition at one time and Blackman (1990) still considers it a low incidence disability. One text states that children with severe and profound behavior disorders (psychoses) fall into two categories: autism and childhood schizophrenia which are conditions found in less than 1/10 of 1% of children (Haring, McCormick, 1990). Yet, the population of SECEP includes 22 classrooms for students with autism - the same number of classrooms provided for the seriously emotionally disturbed. New Horizons has eight classrooms at the present time. One reason for these numbers may be the broader definition of autism in the Diagnostic and Statistical Manual, Third Edition-Revised (DSM III-R) and Diagnostic and Statistical Manual-Fourth Edition (DSM-IV). It is now classified as a severe form of Pervasive Developmental Disorder with more criteria from which to choose.

Many techniques and theories have been espoused to address the disabling characteristics of individuals with autism: pharmacological interventions (Handen, 1993), functional skills curriculum (Donnellan & Neel, 1986), behaviorism (Skinner), Billingsley & Lambert, 1983), immune globulin therapy (Gupta, 1996), megavitamin therapy (Rimland, 1986), Dimethylglycine (Rimland, 1992), auditory training (Edelson & Waddell,

1992), facilitated communication (Biklen, 1992), and sensory integration (Ayres, 1979; King, 1987).

Although all of the theories and techniques listed above have been shown to have some impact, an extension of sensory integration was investigated (use of light/sound technology) to research the merits of this approach to the education and remediation of the learning problems of individuals with autism.

Theoretical Rationale

The definitions of a majority of researchers today agree that the condition of autism is neurologically based. Among them are Ornitz, Ritvo and the UCLA group of psychiatrists and pediatric neurologists who describe autism as a neurological disorder or sensory integrative disorder (King, 1987). This theory is in contrast to the earlier description by Kanner in 1943, that autism was a psychiatric condition caused by unloving and cold parents ("refrigerator Moms"). Two current definitions of autism support the former theory:

The best evidence to date links autism to severe brain disorders that interfere with the individual's social and cognitive development (Prior & Werry, 1986; Rutter & Schopler, 1978). They (autistic persons) show activity disorders that seem to be linked to attention and perception disturbances....Children with autism often show reactions resembling extreme anxiety when they detect minor changes in their surroundings and routines. Typically, children with autism exhibit serious learning disorders (Haring & McCormick, 1990, pp. 171-2).

and

Autism is a rare syndrome (4 to 5 in 10,000 births), but it is a devastating disability characterized by severe language and communication deficits, lack of normal relatedness, bizarre movement and self stimulating patterns, lack of normal handling of toys and other objects and lack of most normal functional skills. Inability to learn in usual ways results in apparent retardation in many cases, though IQ (to the degree it can be measured) can range from genius to severe or profound retardation (King, 1987, p. 78).

Classifying this research as sensory integration is an extension of the present definition of the term and the techniques. Sensory integration experiences include movement, body awareness, sight, sound, touch and the pull of gravity. The techniques provide a foundation for complex learning and behavior. It is a concept that comes from a body of work developed by A. Jean Ayres, Ph.D., OTR. This work has been expanded by Lorna Jean King, OTR, FAOTA, in her research and work as Director Emeritus of The Center for Neurodevelopmental Studies, Inc. and The Developmental Day School, the only known state certified school for children with autism in the United States.

Ayres (1979) lists three aspects of poor sensory processing observed in children with autism:

1. Sensory input does not register correctly in the child's brain which may cause him to overreact at times and other times pay very little attention to things.
2. The child with autism may not modulate sensory input well, especially tactile and vestibular sensation, so he may be tactilely defensive and gravitationally insecure.

3. The child with autism may have little or no interest in doing things that are constructive or purposeful because the part of the brain that controls the motivation to experience new or different things is not operating normally.

According to Ayres (1979), the limbic system of the brain registers and processes sensory input. The brain of the individual with autism does not register many things that normal people notice: in particular, auditory and visual inputs are ignored more than other types of sensory stimuli. These individuals may over-register or under-register sounds and seemingly ignore their visual environment, avoiding or staring through people or objects. Not only does the autistic brain fail to register sensory input but it fails to modulate or integrate those sensations to form a clear perception of space.

Sensory integration is the organization of sensory input so that an individual can interact with his environment effectively. This integration results in the individual's appropriate perception of his/her body, the world in general, the ability to make an adaptive response, or internalize a learning process. It may result from neural systems working together. Sensory integration is the development of neural activity coordinated together and utilized by the brain in response to sensations (Ayres, 1972, 1974, 1979; de Quiros & Schragar, 1978). A child is born with the capacity for sensory integration but must develop it by interacting with many objects in the environment. Action upon the environment demands that the individual adapt brain and body to physical challenges. The greatest development of sensory integration and organization happens as a result of an adaptive response to sensations (Ayres, 1972, 1979).

Dr. Lorna King has conducted research on sensory integration techniques and expanded Ayres' theory of sensory integration. Most of the research is clinical in nature

and her documented research consists of in-depth case studies which may be the most appropriate way to conduct research with this limited and unique population: however, her findings are hopeful and consistent with recent brain research. Dr. King contends that, in the last twenty years, growing evidence in neurophysiological research indicates the central nervous system evolves throughout life. She acknowledges "education takes place within the limits of a dysfunctional nervous system, BUT the nervous system, whether normal or damaged, is NOT cast in cement" (King, 1987, p. 18). The response to demands of changing situations can cause dendrites to grow and branch to form new connections. If a connection between hemispheres is damaged, dendrites can assume part of the connective function and activation of new synapses is possible when a set is missing. This information is built on animal research, sensory deprivation and recovery research, as well as rehabilitation work with head trauma and stroke victims. "It is true that the damage can never be undone, the nervous system can never be 'normal', but some progress can be made in almost every case—not just by training, but also by facilitating the use of, and stimulating the development of, the remaining nervous system capacities" (King, 1987, p. 18).

Research shows that the child is neurologically immature at birth. Thus, innate within the child are drives to receive, organize, and integrate incoming sensory stimuli. This is a natural, maturational process within the child for the developing nervous system (Hartman, 1986). After birth, the nervous system develops in response to incoming stimulation. The child with autism seems unable to process and organize these sensations or coordinate them with hearing and vision. The ability to learn any task depends on predictable and stable perceptions. The two approaches that help the person with autism

make sense of the sensory world are facilitating their ability to process sensory input into meaningful information and keeping the environment as stable as possible.

Other research indicates that typically the child with autism is in a state of over-arousal due to extreme sensitivity to sensory stimulation: in response, they find methods of calming themselves such as rocking, biting, chewing, pressure touch, humming to shut out stimuli which can't be handled, spinning, and head banging to erase overwhelming sensations (King, 1987). Physiological research also indicates many children with autism operate routinely with this high state of arousal, also described as a stress reaction. This state of arousal is believed to be due to extreme sensitivity to and modulation of sensory stimulation (King, 1987).

The theory of the use of sensory integration techniques pioneered by Ayres and further developed and utilized by King was extended by this research to investigate the use of light/sound machines to increase the learning capacity of children with autism. This was accomplished by attempting to decrease the high state of arousal, increase time on-task, and decrease the acting-out behaviors of this population.

Definition of Terms

The following definitions of terms should be beneficial in clarifying the major constructs of this proposal:

Autism: A severely incapacitating lifelong developmental disability usually manifested during the first three years of life. It is believed to be the result of a neurological disorder which affects the way the brain processes information received through the senses. It is four times more common in boys than girls. Symptoms include: abnormal responses to sensations; delayed or absence of speech and language even though thinking capabilities

may be present; disturbance in rate of appearance of physical, social and language skills; and abnormal ways of relating to people, objects and events (Sposato, 1991-1992).

Adaptive response: A successful response to environmental demands.

Auditory awareness: Pertaining to the sense of hearing; identifying and interpreting sounds.

Body Precept: Perception of one's own body consisting of sensory pictures or "maps" of the body stored in the brain.

Brain stem: The lowest and innermost portion of the brain containing nuclei that regulate internal organic functions, arousal of the whole nervous system and elementary sensory-motor processing.

Central nervous system: The system directly concerned with the brain, brain stem, and spinal cord.

Central programming: Neural functions innate within the central nervous system that do not have to be learned, i. e., crawling or walking.

Facilitation: A neural process promoting the connection of impulses or a response to them; opposite of inhibition.

Intersensory integration: The convergence and interplay of all sensory modalities in the brain.

Learning: A change in neural function as a consequence of experience.

Learning disorder: Difficulty learning to read, write, compute or perform other schoolwork that cannot be attributed to sensory impairments or mental retardation.

Limbic system: Parts of the cerebral hemispheres concerned with emotional response to sensory input and emotionally based behavior.

Magnetic Resonance Imaging (MRI): An imaging procedure in which a computer draws a map from the measured changes in the magnetic resonance of atoms in the brain. Also known as Nuclear Magnetic Resonance (NMR).

Modulation: The brain's regulation of its own activity involving facilitating some neural messages to produce more of a perception or response while inhibiting other messages in order to reduce extraneous or excess activity.

Neuron: A structural and functional unit consisting of a cell body with terminals for receiving and sending nerve impulses.

Percept or perception: The meaning given by the brain to sensory input. Perceptions are subjective.

Sensory deprivation: The lack of sensory input received by the brain or the inability of the nervous system to process sensory input.

Sensory input: Streams of electrical impulses flowing from the sense receptors in the body to the spinal cord and brain.

Sensory integration: The organization of sensory input for use which may be a perception of the world or body, an adaptive response, a learning process or the development of some neural function. Sensory integration allows the many parts of the nervous system to work together so that one can interact with the environment effectively and experience appropriate satisfaction.

Sensory integrative dysfunction: A disorder or irregularity in brain function that makes it difficult to integrate sensory input and may be the basis for many learning disorders.

Sensory integration therapy: Therapy based on the neurodevelopmental theory of A. Jean Ayres that involves treatment using prescribed sensory stimulating activities to improve cerebral organization and the processing of sensations.

Synapse: The place where two neurons make electrochemical contact and transmit a nerve impulse from one neuron to the next.

Research Questions

The primary research questions guiding this study were:

1. Will the use of light/sound technology reduce the hypersensitivity to sensory stimulation that results in the high state of arousal characteristic of students with autism?
2. Will the use of light/sound technology increase the on-task behavior (attentiveness) of students with autism?
3. Will the use of light/sound technology decrease acting-out behaviors (associated with hyperactivity) in students with autism?

In addition to the above questions, parent and teacher interviews, observations, background information, developmental milestones, medical history, educational history, pre-intervention history, anecdotal records, and post-treatment data were compiled and reported on all of the subjects.

Sample Description and Data Gathering Procedures

The investigator obtained a mailing list of the local autism chapter and sent out a letter of invitation (see Appendix A) to the September 12, 1995 meeting at which a demonstration and relevant research were presented. A Parent Information Sheet and Consent Form (see Appendix A) were also included.

The research design used was a combination or mixed design utilizing a case study approach that included repeated measures (ABABA design) to gather data at intervals during the research. This mixture of qualitative and quantitative data was necessary and advantageous due to the limited number of available subjects as well as machines (six) that

had been programmed to prevent possible seizure activity. It was more appropriate in that the intervention with the light/sound technology was instituted twice and the variables measured multiple times during the length of the research. The Attention Deficit Disorders Evaluation Scale (ADDES)-Home and School Version (Hawthorne), was utilized before the treatment and after each two week session to determine if significant changes in behavior had occurred. In addition, it was requested that anecdotal records be kept by the parent and teacher.

Limitations of the Study

The limitations of the study included the limits of access to the sample and population chosen for the study . For example, the sample of this study was small and the volunteer status created a biased sample that might constrain the type of data collected and exclude possible valuable data from those who did not volunteer. The small sample size was also a threat to the validity and generalizability of the results. However, autism is a low incidence disability accounting for only 2 to 11% of the special education population and less than 1% of the general population.

Another concern was that the continuum of levels of functioning varies greatly in this population ranging from those with profound retardation and non-verbal to those higher functioning that are mainstreamed in regular classrooms, i.e., Asperger's Syndrome.

Another limitation was that the data was collected with an instrument calling for a judgment of the number of times a certain behavior occurs and again may have been biased and distorted in the views of the subject (rater reliability threat). The data collected from records was also a threat to validity since records and documents and background

information was not consistent across school systems or parents, leading to inconsistency in the types of data available on each subject.

The research of the light/sound technology has been inconsistent and non-conclusive. There have been few controlled or long term studies published in refereed journals and those have not been with students with autism. There is a great deal of money being spent on these machines and the claims of benefits have increased expectations and possibly produced false hopes. Responsible research needs to be conducted by educators on the light/sound technology. If the claims of the technology are validated, it could be beneficial to the field of education, particularly for children with autism.

In order to combat as many of these limitations as possible, the development of descriptive case reports, coding all data collected, and triangulation of the data was attempted. The students were volunteered by their parents which made their compliance and cooperation a concern. In addition, the aversion some of these students have to anyone or anything new as well as wearing the technology was problematic. Therefore, an introduction by the researcher and/or parent to try the technology with each subject was instituted to determine compliance. Generalizability of the results is restricted due to the volunteer nature of the sample and the uniqueness of the disorder.

The ADDES describes its subscales as measuring inattentiveness, impulsivity and hyperactivity which represent the constructs that are described in the research questions.

Overview of the Remaining Chapters

Chapter two provides a review of the literature that includes the background and history of the subject and the rationale for the study. Chapter three describes the methods and procedures for the collection of data. Chapter four contains the complete case study of each subject and the graphic illustrations of the characteristics and patterns found. Chapter

five summarizes the findings of the study, discusses the implications for the disability, states conclusions, and offers suggestions for further research.

Chapter 2

Review of the Literature

Historical and Theoretical Development

The current (1994) revision of the Diagnostic and Statistical Manual of the American Psychiatric Association, Fourth Edition (DSM-IV), classifies autism as a disorder under the category of pervasive developmental disorders, Axis II. The definition recognizes the profound impairment in development that is characteristic of autistic disorders and their lifelong manifestation.

Research has taken many avenues over the years to solve the complex puzzle of the etiology and treatment for individuals with autism. One of the pioneers in that endeavor is A. Jean Ayres, who in her work as an occupational therapist with severely neurologically disabled children and adults, realized that the weak muscles and poor coordination were not the most severe handicaps experienced by these individuals. In addition, they had learning problems that affected putting puzzles together, dressing themselves, paying attention to any task longer than a few minutes and attending to or performing school work. Dr. Ayres suspected these problems were due to a visual perception disorder. In 1972 she began documenting her approach to these children with learning, behavior and perceptual problems; the approach differed significantly from other professionals at that time. She sought to find the answers in understanding how the brain processes sensations from the ears, eyes and other parts of the body.

Ayres (1979) postulated that poor behavior and slow learning in children are often caused by inadequate sensory integration within the brain of the child. It is likely that such

a hypothesis is generally overlooked because it is assumed by most people that integrative processes are intact unless they are so severely dysfunctional as to be readily observable by the untrained (Ayres, 1979).

Delacato (1959) introduced the concept of "neurological organization" which theorizes that the development and organization of the human nervous system was the most important factor in learning. He observed blind and deaf children demonstrating some of the same behaviors as individuals with autism. He felt the "blindisms" and "deafisms" represented sensory problems and proposed that the alien behaviors of children with autism may be attempts to open up and normalize one or more of the five channels from the world to their brains.

In 1964, Rimland theorized in his book, Infantile Autism, that the symptoms of autism could result from difficulty in giving meaning to incoming sensory stimuli and the inability to relate that stimuli to stored information. He felt the problem was due to damage to the reticular formation of the brain stem in genetically predisposed infants. Two recent studies (Hashimoto et al. & McClelland et al.) reported in the Autism Research Review International (1992 Vol. 6, No. 4) revealed Magnetic Resonance Imaging (MRI) evidence to corroborate this theory of linking autism to abnormalities in the brainstem. Schopler (1965) concurred with Rimland and further theorized that children with autism did not move from using near receptors (smell, feel, taste) to the distance receptors of hearing and seeing. He felt that this inability was the result of sensory deprivation. Further research on sensory integration in the literature showed that difficulties in integration are inevitable without proper environments and sensorimotor opportunities. Without these, there are resulting distorted perceptions and delayed sensorimotor abilities. An emphasis on quality sensorimotor experiences is vital for the development of all sensory modalities.

"Sensory integration is the organization of sensation for use" (Ayres, 1979, p. 5) and is the most important type of sensory processing. Sensations are likened by Dr. Ayres to be "food for the brain" (p. 5) in that they provide energy and knowledge necessary for directing the mind and body. Just as food for the body must be digested to provide nourishment, so sensory processes must be well-organized in order for sensations to be digested and provide nourishment to the brain. The act of peeling and eating an orange will serve to illustrate how sensory integration "puts it all together." The orange is sensed through the nose, mouth, eyes, skin of the fingers and hands as well as the muscles and joints inside the arms, mouth, fingers and hands. How do two hands and 10 fingers work together? The sensations from the hands, fingers, and orange come together in one place in the brain; the resulting integration allows the brain to experience the orange as a whole and use fingers and hands to work together to peel and eat it (Ayres, 1979). Sensory integration is necessary in order for the individual to utilize and use the information collected from the interaction of an individual and the physical forces, objects, and people in their environment. The functions of sensory integration develop in a natural order for most children and the basic principle that drives that process is organization of the sensations in the nervous system (Ayres, 1979). The key to sensory motor organization occurs during an adaptive response to sensation in which an individual deals with his body and environment in a useful and creative way; i.e., hearing a sound and turning to see what happened, or someone bumping into us and we shift our weight to regain balance. Older children make adaptive responses when they play with toys, put on clothes or ride a bicycle. "Watch a child ride a bicycle and you will see how sensory stimulation leads to adaptive responses and adaptive responses lead to sensory integration" (Ayres, 1979, p.14).

Ayres (1972, 1974, 1979) further defines sensory integration as the organization of internal and external sensory stimuli for functional use in order for the child to interact with the environment effectively. Sensory integration experiences include movement, body awareness, sight, sound, touch and the pull of gravity. The techniques provide a foundation for complex learning and behavior.

Research on sensory integration techniques has been conducted by Dr. Lorna Jean King, OTR, FAOTA, whose work and credentials were referenced earlier. A summary of her recent research has been included in Chapter 1 of this document. Dr. King states, "Education and therapy can be bridged by the concept of facilitating neurodevelopment. Skill training and behavior training are cost-effective only when the individual's nervous system is optimally prepared to learn" (King, 1987, p. 3).

Other research is found in the work of Temple Grandin, a person with autism who was diagnosed at age two. She has earned a doctoral degree in Animal Science and teaches at a midwestern university. She feels the sensory problems of the population with autism have been overlooked for years. Grandin describes autism as a developmental disorder with a defect in the systems which process incoming sensory information causing the individual to over-react to some stimuli and under-react to others. She states that sensory deprivation in individuals with autism and animals create similar symptoms in that "restriction of sensory input causes the central nervous system to become overly sensitive to stimulation" (Grandin, 1989, p. 77). As a high functioning person with autism, she has written her autobiography (Grandin, 1986) documenting her dedication to understanding and treating the disorder. She credits a loving and supportive family for her ability to attain her high level of achievement and adaptive functioning.

Donna Williams, another high functioning individual with autism, has reported in her autobiography, Nobody Nowhere, that she experienced both verbal and physical abuse by her alcoholic mother. She would tune out a world that she described as overwhelming her with sensory information she was unable to process or prioritize. She described life as a constant battle to avoid painful sensory overload and the associated confusing emotions that resulted in her desire for isolation. In an interview by USA Today, Donna says, "Autism is a life as the only person in the world or watching the world without a 'you' in it....It is an icy frosty world where love, attachment and closeness are terrifying."...."The only warmth is the colors, patterns, sounds, textures and smells of the things which stay the same" (USA Today, pp. 1 & 2). She describes the fascination with objects as well as the hypersensitivity to sound and light that is often reported by other individuals with autism in the literature.

Lotter (1966, 1967) discovered a greater incidence of neurological and other abnormalities in a group of children with marked autistic behavior. Ornitz and Ritvo (1974) propose a model of autism based on a central nervous system dysfunction which causes perceptual inconstancy that affected developmental rate, cognition and language, social development and sensorimotor integration. Similarly, Fein, Humes, Lucci, and Waterhouse (1984) espoused a type of central nervous system damage in autism in which the form and severity of the major autistic symptoms are dependent on the locus, severity and timing of the damage. Ritvo, Freeman, Mason-Brothers, Mo, and Ritvo (1985) report an extremely high concordance for autism in monozygotic twins thus further supporting a biological/neurological basis for autism.

A review of the available research on sensory integration indicates that it is primarily clinical in nature with the added threat of small sample sizes. Most of the

documented research using sensory integration techniques consists of in-depth case studies. Although the sample for this research was through necessity small, there were repeated measurements taken in addition to the in-depth qualitative data collected for the case studies in the hope of making the results more valid and generalizable to the discreet population.

Sensory integrative techniques have been utilized by occupational therapists or specially trained teachers in a one to one situation. The training is expensive and technical, precluding its use in many public school settings. In addition, the use of these techniques is harder to quantify and although the results may be immediate, like behavior modification techniques, they are not always long lasting.

Use of the light/sound technology can be conducted by the teacher or assistant and eventually by the student him/herself. The specific combination of lights, patterns, and sound can be calming to children with autism and, in addition, allows them to "tune out" the world while becoming desensitized to a variety of light patterns and sounds.

A pilot study was conducted with three students with autism in December, 1992 for 10 days to assess the response of the students to the machine. Although there was not a significant carryover of calming behavior after use of the technology, while on the machine the children were quiet and tolerated longer periods of treatment at each session. They sometimes requested to be allowed to use the machine more than the original 15 minutes allocated.

It is generally accepted that autism is primarily a neurological disorder; therefore, those affected should respond positively to the altering of brain wave activity in order to facilitate learning and social growth. There is a need for this research in order to either validate this treatment or expose the technology as "useless" for one of the several

purposes espoused by its developers. Educational researchers have an obligation to conduct such research so that parents and educators are not offered false hopes.

Use of the light/sound technology seems a natural expansion of the use of sensory integration techniques. The emphasis on the need to reduce the stress and anxiety in individuals with autism is an important goal. There seems enough evidence to suggest the technology may facilitate relaxation, promote neural pathways, reduce pulse rate, etc. One of the important benefits of using calming inputs with the population with autism is that tactile, vestibular, tendon, muscle and joint inputs are effective in dampening oversensitivity as well as facilitating the organization of sensory input into meaningful concepts (Woodbury, 1989).

Dr. King summarizes by stating "One of the most important goals of therapy and education of the autistic individual is the reduction of hypersensitivity to sensory stimulation. If the child is to be able to attend to the activities that adults think are important, he must not be stressed or anxiety ridden by sensory stimuli. As the child becomes less sensitive, he develops the ability to inhibit reactions and to attend. The use of calming inputs such as pressure touch, rhythmic vestibular stimulation, and calming music can contribute much to the adaptive capacities of the autistic individual" (King, 1990, p. 5).

Descriptive Topics

Arousal/Anxiety/Hypersensitivity

Some theorists suggest that an underlying state of hyper-arousal in the person with autism leads to their constricted behavioral repertoire and preoccupation with repetitive stimuli (Hutt & Hutt, 1968). These tensions may be compensated for with stereotypical movements to displace the arousal.

According to Haring and McCormick (1990), individuals with autism react with extreme anxiety when there are even minor changes in their surroundings and routines. As stated previously, they routinely operate in a state of over-arousal due to extreme sensitivity to sensory stimulation. Dr. King states:

There is physiological research to verify that many children with autism operate routinely with a high level of arousal which can also be described as stress reaction (p. 1).

A summary of her findings follows:

1. One can expect these behaviors to increase when the individual is under stress and the need for calming is great.
2. If one provides the individual with the kind of input he finds calming and organizing in socially acceptable ways, the need for unacceptable forms of behavior will diminish and/or disappear.
3. If one can anticipate what will be stressful and can provide calming and organizing input ahead of time, panic and anger can usually be avoided, as well as inappropriate behaviors.
4. Unnecessary stress can be avoided—for example, loud or negative admonitions or directions. Education and therapy can be bridged by the concept of facilitating neurodevelopment. Skill training and behavior training are cost-effective only when the individual's nervous system is optimally prepared to learn (King, 1987 p. 2).

B. J. Freeman, Ph.D., is Professor of Medical Psychology in the Department of Psychiatry and Biobehavioral Sciences at UCLA, and a member of the Autism Society of America's Advisory Board. She has followed the progress of a group of 65 children with

autism for 20 years. In a recent interview, Dr. Freeman states "Anxiety is part of the syndrome" (Advocate, Fall, 1993, p.9.). She explains that the internal experience of autism may create a great deal of anxiety and draws an analogy to those with autism perceiving the world like an FM radio that is not exactly on the station. At times the station may come in loud and clear but mostly it does not. This experience is frustrating for normal people but a person with autism needs things to be the same and this unpredictability of the senses is extremely anxiety provoking. They can be in sensory overload or underload—sometimes switching back and forth.

Delacato (1974) describes three groups of children with autism:

1. Hyper—those whose sensory systems allowed too much of the sensory messages into the brain.
2. Hypo—those whose sensory systems were sluggish and too little of the sensory message got to the brain.
3. White Noise Group—those whose sensory system operated so inefficiently that it created interference or noise in the system.

Williams (1992) relates the constant battle the person with autism fights to avoid painful sensory overload. She states "The anxiety of my inner battle was becoming unbearable. I could say words but I wanted to communicate. I wanted to express something. I wanted to let something out. The anxiety would have been so easy to give in to; whereby I would again lose all awareness of self and my surroundings" (Williams, 1992, p. 19).

Grandin (1986) describes her "nerve attacks" (p. 75) as making her feel like she was clinging to a greased rope that was suspended over an abyss. She later called these attacks "panic anxiety" (p. 75) caused by the oversensitivity of input to the nervous system

from auditory and tactile senses. She was not bothered by intense visual input. An ordinary itch to Grandin caused a reaction similar to being chased by a mugger. The nerve attacks created symptoms similar to stage fright, such as dry mouth, sweaty palms, pounding heart and twitching legs. She describes them as being more like hypersensitivity than anxiety. In her 1991 update, Grandin cites new brain studies that indicate more abnormalities of the cerebellum and an over-active metabolism in the frontal cortex of the brain as a possible explanation of the nervousness and over-arousal problems in individuals with autism.

The research on arousal/anxiety/hypersensitivity is again found in clinical studies and first hand reports. More responsible, controlled research is needed to discover ways that will calm these individuals and allow them to function in a world that is not always the same.

Research literature reports the tendency of individuals with autism to relate to objects rather than people. In fact, they describe perceiving others as objects rather than individuals which is helpful in distancing themselves and coping with sensory overload. Williams (1992) speaks of being unable to comprehend "whole people" (p. 35) and being hugged was like being burned. She created two alter egos to deal with the overwhelming world (although she was never officially diagnosed as having a multiple personality disorder). It is therefore difficult to determine or tease out whether all of her behavior was due to autism or the abuse she suffered from her family of origin.

The light/sound technology should be appealing to individuals with autism in that it is an object that employs repetitious sounds and light frequencies and as previously noted, individuals with autism tend to seek sameness and repetition to calm themselves. It also gives the comfort of shutting out the rest of the world and allowing the autistic individual

the necessary aloneness they desire while lowering their arousal and anxiety by helping to desensitize them to the lights/sounds.

C. Hutt, S. Hutt, Lee, & Ounsted (1964); Margolies (1977); Schechter, Shurley, Toussieng, and Maier (1969); Suedfeld & Schwartz (1983), have attributed the problems of social, behavioral, and language symptoms of autism to the fact that average levels of stimulation are too high. This research with the light/sound technology may be able to increase the amount of sensory input that can be tolerated in a non-threatening and safe way.

Ditson-Sommer (1990, unpublished) conducted a pilot study on ten students with autism at the Chileda Habilitation Institute in Wisconsin. Dr. Sommer noted the elevated arousal of these individuals by watching extensive videotapes of their behaviors. She describes their stressful state and hypothesized that having these subjects use the technology would lower their pulse rate (associated with a state of stress or arousal) and result in a state of calmness. Although it was reported that the pulse rates were lowered, no follow up study was conducted. The data was analyzed by non-parametric techniques but the reports were never published.

There is a need for more studies in this area to determine if the technology can indeed produce calmness and lower the state of arousal that is so very painful and debilitating to the autistic individual.

Attention/On-task Behaviors

Observation in a classroom of students with autism creates an awareness of the attentional deficits evidenced by these individuals. It has been noted by Garretson, Fein, & Waterhouse (1990) that many children with autism cannot maintain attention to tasks that are externally imposed but can continue a repetitive behavior of their choice for extended

periods of time. Their research on children with autism on the Continuous Performance Test (CPT) of sustained attention suggests that a primary impairment in the ability to sustain attention may be attributed to a developmental delay, motivational contingencies, or the demands of the task. The three hypotheses that the researchers formulated were:

1. The usual externally imposed tasks are too complex and changing for children with autism who tend to prefer simple, repetitive pursuits.
2. Children with autism's motivation for mastery or for social reward is insufficient to maintain performance.
3. Children with autism have a deficit in maintaining attention on externally imposed stimuli over and above their motivational state and their preference for simple stimuli (pp. 102-103).

According to research, children with autism have an inability to manage complex tasks. A group of children with autism were asked to reproduce the Rey-Osterrieth Complex Figure Design Copying Test (Rey, 1959). Even though visuospatial processing (copying the Rey figure) is an area of strength for many children with autism (Hoffmann & Prior, 1982; Shah & Frith, 1983), they performed significantly less well on producing the figure from memory and their approach to copying was disorganized: they often selected minor aspects rather than the whole model to copy.

Kinsbourne (1983) has theorized that cognitive or attentional deficits could be more related to motivational deficits. Reinforcement contingencies of a learning situation may not significantly affect the performance of persons with autism.

The fundamental attentional and perceptual anomalies reported and described in the literature represents a group of related ideas (Cohen & Johnson, 1967; Gold & Gold, 1975;

Ornitz & Ritvo, 1976; Rimland, 1964; Schopler, 1965, 1966) that affect the autistic individual's intake of stimuli from the environment.

In her autobiography, Williams (1992) describes her difficulty in reading. She could read the words but was unable to tell what the book was about, losing the meaning in the jumble of words. She would compensate by reading only the main words in a sentence and try to get the feel of the story. She also indicates that unless the task was one she had chosen, she would "drift off" into her own world. She would ask people to repeat sentences several times because she would hear it in bits, segmenting the sentence into words that made a strange and unintelligible message like when "someone plays around with the volume switch on the TV" (p. 69).

Stimulus overselectivity, according to Connor (1990), is a specific characteristic of autism that has educational implications. These individuals have trouble responding to multiple cues. When they receive input from multiple stimuli, they attend to only a restricted range of that stimuli. If a teacher demonstrates something for a student with autism, the student may cue in on a specific aspect that is unimportant to the execution of the demonstrated movement; for example, focusing on the accent of the teacher instead of the meaning of the verbal directions or visual demonstration. According to Wilhelm & Lovaas, (1976), the lower the cognitive ability and the more severe the autism, the greater the stimulus overselectivity.

Children with autism may also show a strong preference through one sensory modality (Kolko, Anderson, & Campbell, 1980). "Kolko and colleagues (1980) investigated sensory preference and stimulus overselectivity and found that individuals with autism consistently overselected the stimuli presented in their preferred sensory

modality" (Connor, 1990, p. 31). Rincover and Koegel (1975) found that generalization of behavior is limited due to children with autism responding selectively to irrelevant stimuli.

Delacato (1974) describes the children with autism he has worked with as having learned to pay attention to their own strange sensory problems rather than the desired inputs.

Temple Grandin (1991) theorizes that:

"the sensory and attention problems caused by abnormal brain development in the fetus or barely detectable seizures in a young child may cause secondary abnormalities in other parts of the brain after birth. Other areas of the developing brain may not develop and mature properly because they lack inputs required for normal development. These brain areas may not receive needed input because the child either fails to pay attention to stimuli or withdraws to block out an onslaught of painful or confusing stimuli. Research with baby rats indicated that if they receive inadequate stimulation of the whiskers, the brain areas that receive input from the whiskers will become over-sensitive" (p. 175)

Deficits in attention and elevated levels of activity have been described in the literature since the term "minimal brain dysfunction" was used in the early literature. The construct has evolved over time to the present term, Attention Deficit/Hyperactivity Disorder (AD/HD), as defined by the DSM-IV.

Pelham (1993) reports one of the most widely used treatments for AD/HD is use of Central Nervous System stimulants that result in short-term beneficial effects but he has found no evidence that these effects translate into long-term improved prognosis. Fifteen researchers; Swanson, McBurnett, Wigal, Pfiffner, Learner, Williams, Christian Tamm,

Willcutt, Crowley, Clevenger, Khouzam, Woo Crinella, Fisher. (1993) reviewed and synthesized the research on the use of stimulants on children with AD/HD. Quantitative reviews indicated the average effect size for intellectual and achievement benefits (.35) were less than half of that for symptomatic improvement (.83). Divergent conclusions were from goal variations rather than from the selected source variation.

Children with autism often exhibit symptoms of AD/HD and are treated with stimulant drugs. Much concern is reported in a survey of the literature that stimulants should be used in combination with behavioral and educational intervention. Swanson et al., reported few references to empirical studies that support such a common-sense recommendation. Even reviews of this area (Gadow, 1985; Pelham & Murphy, 1986) differ in their conclusions about the relative impact of behavioral and pharmacological components of multi-modality treatment. The "review of reviews" suggests that major methodological weaknesses or shortcomings in research preclude clear answers to questions about the impact of combined (or "multi-modality") treatment on children with AD/HD (p. 160).

Pelham (1993) includes some of the treatment emergent symptoms (TES) that are associated with stimulant drugs; namely, insomnia, loss of appetite, irritability, headaches, dizziness, nausea, stomachaches, tachycardia (irregular heartbeat), skin rashes, and drowsiness. Also described is the "zombie" effect of the medication on the individual that is evidenced in cognitive overfocusing and blunting as well as social withdrawal. Perhaps the most disturbing effect noted was evidence that motor tics of the jaw, mouth and tongue can be precipitated and exacerbated from the use of Ritalin. "The fear has been that the medication will precipitate Tourette's Syndrome in children with a genetic vulnerability" (Pelham, 1993, p. 206).

Alternative methods should be explored to help children with autism be able to attend and increase on-task behavior since many of these individuals have a tendency to develop Tourette's Syndrome even without the stimulant medications. Use of the light/sound machine may be able to achieve this goal without such negative side effects. Ditson-Sommer (1991), in a clinical interview with a gifted AD/HD student in the summer program at Arizona State, asked what the machine did for him. The student thought for a minute and answered, "It helps me to stop and think!" Hopefully, it can help others achieve similar results.

Another feature of the technology is the promotion of whole brain thinking when both sides of the brain are integrated to think in a more holistic way. Much of the research speaks to the need for this in individuals with autism who tend to have fragmented thought patterns and comprehend material in a piecemeal style.

Acting Out Behaviors

The context of acting out behaviors in this study will include stereotyped behaviors, hyperactivity, self-abuse and tantrums. Delacato (1974) describes a unique aspect of autism to be hyperactivity. In his work with these youngsters, he gave them sensory stimulation in the frequency, intensity, and duration that they could handle comfortably so that they could normalize the particular sensory channel by gaining more experience using it.

The "father of autism," Leo Kanner, refers indirectly to the prominence of sensory integration dysfunction in individuals with autism when he began studying the syndrome. In his discussion entitled "Autistic Disturbances of Affective Contact" (1943), he states that noise and direct physical contact are threatening to children with autism and, as a result, they either ignore such stimuli or resent and become distressed by it. Temple Grandin

reaffirms Kanner's observations and feels strongly that those who work with autism consider addressing sensory oversensitivity as an area of such importance that it will determine whether the autistic individual fails or prospers (Grandin, 1990).

Sensory integrative dysfunction is not the absence of function but rather a malfunction. Sensations may be partially or inefficiently processed. This dysfunction can occur in all of the senses or sensation receptors and result in hyperactivity, behavioral problems, distractibility, speech difficulties, speech problems, muscle tone/coordination, and learning difficulties. According to Ayres (1979) and King (1987), the incredible plasticity of the brain facilitates reduction of brain dysfunction by activating alternative sensory processing pathways allowing improvement in the way sensations are organized and processed in the brain. The techniques used to accomplish this are categorized as sensory integration therapy.

Poor sensory organizing and processing affects individuals with autism in many ways. According to King (1987), self-abusive and self-stimulatory behaviors are some of the most obvious. Some of the behaviors associated with self-stimulation are ritualistic behavior and repetitive acts such as finger flicking, rocking, spinning objects, hand flapping, etc. Self-injurious or self-abusive behavior may include such acts as hair pulling, biting, or slapping oneself (Pyles & Bailey, 1990). It is theorized that self-abusive and self-stimulating behavior occurs because of the calming effect it provides the autistic individual when they are in sensory overload such as when a noise is experienced as painful or threatening (Kanner, 1943, King, 1987). In addition, King (1987) posits that these behaviors may indicate which sensory modality is most required by the child to organize their sensory inputs and responses. One example of this phenomenon is a blind individual who explained how his parents would not allow him to rub his eyes because this

type of self-destructive behavior is often practiced by blind individuals who dig at their eyes and permanently disfigure themselves.

Temple Grandin (1986) lists her typical autistic behaviors: destructive behaviors, temper tantrums, sensitivity to sudden noises, fixation on spinning objects, preference to be alone, the appearance of deafness, interest in odors, and darting eyes. She describes spinning as a favorite activity that made her feel powerful and in control. She also notes the autistic person may have an under and over responsiveness to stimuli, sometimes ignoring loud sounds but reacting violently to crinkling cellophane. They have to make a choice between self-stimulating behaviors such as spinning and mutilating themselves, or escaping into their inner world to screen outside stimuli. Otherwise, they become overwhelmed with many simultaneous stimuli and react with temper tantrums, screaming, or other unacceptable behavior. Self-stimulating behaviors help calm an overaroused central nervous system. Some researchers believe that children with autism have a hyperactive nervous system, and some AD/HD children with hyperactive behavior have a slow nervous system. The child with autism may self-stimulate to calm himself or, like the hyperactive child, may be excessively active because he is trying to stimulate an under aroused nervous system (King, 1986, pp. 24, 25).

Deprivation of tactile stimuli, some authorities believe, may result in autistic behavior, aggression, hyperactivity, and violence. For Grandin the need for tactile stimulation was overwhelming, but she withdrew from it. "Babies deprived of cuddling avoid being touched when they get older" (Grandin, 1986, p. 34). The answer she fantasized about was a machine that would apply pressure and warmth to her body. She experienced a carnival ride that used centrifugal force to hold the riders against the side of the barrel. She describes her experience as having her senses so overwhelmed with

stimulation that she did not react with fear or anxiety but rather with the sensations of relaxation and comfort.

Grandin's later work (1991) cites the way to stop stereotyped behavior is to replace it with some type of external stimulation; for example, providing deep pressure stimulation or a vibrator applied to the head or hands to stop self-injurious behavior.

Ayres (1979) states that much of the hyperactivity in today's children is due to poor sensory integration and a minor problem in early childhood becomes a major handicap when they start to school. If that child is easily distracted by extraneous sounds, lights, and other people, his brain becomes overly stimulated and responds with excessive activity. "The hyperactive child 'jumps all over the classroom' not because that is what he wants to do, but because his brain is running out of control. His excess activity is a compulsive reaction to sensations he can neither turn off nor organize" (p.9).

King (1990) cites two paths of research to help understand self-abusive and self-stimulating behavior in children with autism: first, sensory deprivation studies noting the need for a rich diet of sensory input to develop the central nervous system and keep it functional and secondly, the study of individual differences. The latter posits what is sufficient input for one individual's development may be insufficient for another. She looks at all behavior as communication and responds accordingly. The questions need to be what can be done to help the individual become less the victim of sensory stimulation and able to make an adaptive response to the situational demands or how can one dampen the hypersensitivity of sensory pathways and raise the threshold of tolerance for stimulation.

Traditionally, the acting out behaviors and learning difficulties of the populations with autism and mental retardation have been dealt with by behavior modification

techniques and psychotropic medications. The goal has been to improve learning and control behaviors such as hyperactivity, inattention, impulsivity, aggression, and self-injurious behavior (Handen, 1993). Stimulants have been used in studies as treatment for inattention and overactivity in children with autism. The results, however, indicated an actual increase in maladaptive behaviors for many of the children (e.g., Campbell, 1975; Campbell et al., 1976). There were some gains in specific target behaviors in this population according to Birmaher, Quintana, & Greenhill, 1988; Strayhorn, Rapp, Donina, & Strain, 1988.

One of the concerns reported in the literature about the use of stimulants is the lowering of the seizure threshold in those children who are seizure prone. However, one study by Feldman, Crumrine, Handen, Alvin, and Teodori (1989) concluded that use of stimulants may not be a problem for those whose seizures were well-controlled and the dosage of Ritalin very low. Some of the other side effects have been cited in the material covered above.

Since the side effects of the various psychotropic drugs are numerous, it seems advantageous to explore the use of the frequencies of the light/sound machine as a way to help control the various acting-out behaviors characteristic by the individuals with autism. King (1990) proposes the use of activities that produce vibration as another means of achieving a calming effect and cites as an example a ride in a car that produces sleep in a fretful baby. She suggests vibrating mattresses, tables, and hand vibrators as calming agents that are effective. She suggests using these calming techniques to offset tantrums or other unwanted behavior. She states that one has to understand that the child's self abusive and self-stimulating behaviors are an attempt to achieve relief and calmness from overstimulation and painful stress. She recommends helping the child substitute a socially

acceptable calming behavior for an unacceptable one. An example would be having the child who bites his wrist chew on beef jerky instead.

Other sensory integration techniques include:

Holding therapy which is described as an intrusive interaction between parent and child. The child is held forcibly while eye contact is made and the parent talks, tickles and touches them. Researchers Thorwarth and Powers have been cited in the Autism Research Review (Vol. 5, No. 3) as having used holding therapy as a negative reinforcer to help children with autism tolerate physical contact by increasing the amount of holding time required for them to earn free time.

Using firm, sustained pressure for face molding or gently "brushing" the child's body are hints given parents. Ayres (1979) also recommends stroking a child's body with different cloth textures.

Rhythmic rocking, foot swinging, finger tapping, pacing and walking can all be calming activities (King, 1990). Massage, hugs, or having heavy covers/mats applied are other means (much like Grandin's squeeze machine). King (1990) calls these techniques calming physiological effects of pressure-touch. Hypersensitivity to touch is often accompanied by hypersensitivity to auditory stimuli (noise). Ayres (1979) indicates that if the neural damage is to the visual system, visual stimulation is necessary for the recovery of sight; likewise with auditory damage, the brain needs experiences of hearing to organize new auditory functions. It is theorized that the light/sound technology may help in this endeavor to provide gentle stimulation of the visual and auditory channels.

Tactile and vestibular stimulation, according to Ayres (1979) and King (1989), help desensitize the tactile system as well as decrease stereotypical and self-injurious behavior. Activities such as swinging stimulates the vestibular system and defective cerebellum

according to Grandin (1989). She also suggests spinning in a chair to help reduce hyperactivity.

The strategies necessary to help the child with autism become more able to make an adaptive response to the demands of their environment appear to be providing sensory input that research shows to be calming and that dampens the hypersensitivity of sensory pathways or raises the threshold for stimulation (King, 1990). "Decreased sensitivity affects all aspects of the child's behavior, whereas behavior modification techniques for dealing with self abusive behavior often do not generalize (King, 1990, p. 5).

Freeman (1993) has used behavior management techniques, but feels they teach only rote skills; an example would be teaching a parrot to talk instead of to communicate. She feels that the reason individuals with autism have trouble generalizing is the way they are taught. "If you use behavior management to teach a child to put a block in the box, and you use the same block and the same box every time, he will learn it—but all he's learned is to put that particular block inside that particular box. If you change the block or change the box, he's lost. He hasn't learned the concept of inside" (p.8). She emphasizes the absolute necessity of the child with autism being able to overcome their social deficits and gain the ability to function independently in society.

Handen (1993) and Pelham (1993) both agree that medication needs to be combined with appropriate psychosocial and psychoeducational interventions to provide the most effective treatment program. The light/sound technology may prove to be an important part of the total package.

Research on Population

Research that has been conducted on this population considers the areas of deficits that are evidenced by individuals with autism. According to Wallace (1992) these are: behavior management, communication/language, sensory integration, social skills, and self-help skills. These areas are not clearly defined but affect each other and are interactive.

According to Smith (1990) and Sposato, (1991-1992) behavioral techniques and interventions have proven the most effective in improving the overall functioning and development of the child with autism. Operant conditioning methods have been employed that arrange variables in the environment to build the relationship between a behavior and its consequence (Alberto & Troutman, 1982). This method has been the traditional way to deal with the challenging behaviors of persons with autism (Butera & Haywood, 1992). In recent years, other techniques have been employed; namely, compliance training, aversive and nonaversive methods and cognitive strategies (Butera & Haywood 1992; Dunlap, Johnson, & Robbins, 1990; Myles & Simpson, 1990).

For many years the literature has reported the need of the individual with autism for the "maintenance of sameness" (Kanner, 1943, p.45). Coleman (1978) calls this type of behavior compulsive and ritualistic. Parents of children with autism report the necessity of sameness and routine in the life of these children. Temple Grandin (1986, 1991) and Donna Williams (1992) enumerate these behaviors in their life as high functioning individuals with autism. Examples of the behaviors are: eating only one or two foods, talking excessively about one object/subject, wearing the same clothes over and over, lining up blocks or arranging objects in the same pattern repeatedly. The rigidity of these behavior patterns create enormous problems for families, teachers, and the individuals

themselves. Grandin (1986) calls these behaviors fixations and says "they fill the need for reducing arousal in an over-active nervous system" (p. 109).

Ogletree (1992), in his research on best practices in communication services (speech/language) for children with autism, espouses a dynamic framework that includes interaction that is established between the teacher and the child. At the present time these needs are usually met by itinerant related service personnel (speech therapists).

Language and communication are considered a cognitive defect in autism (Alvin, 1978). This syndrome profoundly affects the production of language as well as comprehension and communicative use (Coleman, 1978). Individuals with autism do not generally develop speech or use it as functional language and they don't evidence any communicative intent according to some researchers (Schuler & Donnellan-Walsh, 1976).

Dysphasia, echolalia, and pronoun reversal (DeVilliers & DeVilliers, 1978) as well as elective mutism (Schuler and Donnellan-Walsh, 1976) are some of the disorders displayed by individuals with autism. These individuals do not gain the power of communication because they are unable to understand cause and effect relationships, generalize to other situations and associate words with objects or events (Watson et al., 1989).

All of these cognitive defects and language disorders affect the child with autism's behavior and social functioning. Grandin (1986) describes communication as a one way street in that she could understand but could not respond. Developing communication skills, whatever the form, should be a priority for this population (Schuler & Donnellan-Walsh, 1976).

The third area of reported deficits is that of sensory integration that has been the emphasis of this document. Ayres, (1978) Delacato (1974) Grandin (1986, 1991) and

King, (1987, 1990) have all contributed to the research on these techniques. Summarizing its benefits, sensory integration methods have helped those with autism learn to care for their basic needs (Larrington, 1987), improve their behaviors (King, 1987) learn to speak (Ray, King, & Grandin, 1987) and increase overall functioning in life (Ayres, 1979).

Kanner (1943) describes the difficulty relating to other people and situations that the individual with autism evidences and the extreme aloneness they experience as a result. "Social impairments are central to autism" (Watson et al., 1989, p. 4). According to Watson et al., (1989) individuals with autism display limited emotions, lack social awareness, respond inappropriately to the emotions of others and don't initiate interactions. Grandin, (1990) reports that no matter how smart or accomplished a person with autism is, they do not understand subtle social cues, are unable to read complex social situations and have difficulty responding to the reciprocity of social interaction. They cannot imagine how another feels or thinks.

Freeman (1993) describes the teaching of social skills as a new frontier that the individual with autism does not "learn by osmosis" like normal children but has to be taught. She says children with autism can learn these skills and the importance of acquiring the skills is paramount.

Self-help skills is the last area of need to be addressed. Developmental milestones such as eating, dressing, bathing, and toilet training are usually delayed (Lotter, 1966). These skills for independent and functional living may be absent or delayed due to a lack of motivation and the desire to be alone (Ayres, 1979; Grandin, 1990). Hypersensitivity to stimuli and other sensory integration factors deter brushing the teeth or washing the hair. Many individuals with autism need remedial assistance to develop these skills (Blackman, 1990) if they acquire them at all (Smith, 1990). Safety may also be considered under this

topical need. Because individuals with autism don't respond to environmental stimuli in ways that most individuals do, they may not perceive dangerous situations and even if they learn a safety rule, their inability to generalize to another context is problematic (Fredericks et al., 1983).

Research in each of the deficit areas listed above has been conducted with small samples. In reviewing the literature, the area studied most are the use of behavioral techniques, and even though most of the studies demonstrate the limitations of these methods, they are still employed by many programs almost exclusively. SECEP (The Southeastern Cooperative Education Program) serves eight school districts and employs the behavioral and functional skills curriculum approach. This researcher's supervision of Master's level interns in classrooms for students with autism resulted in some observations that are qualitative in nature. Anecdotal information suggests very little of the curriculum seems to be retained or generalized to other situations and progress is not very apparent. The students repeat the same exercises daily and few make sufficient progress to allow them to later return to the regular classroom.

New Horizons Children's Center, another cooperative program, employs sensory integration techniques as well as some of the newer methods such as Facilitated Communication, a technique that uses a keyboard to allow students to communicate by pointing or typing a message while a "facilitator" supports their arm or hand. The differences in the atmosphere and progress of the students appear significant and many are able to be mainstreamed in regular classrooms.

The Developmental Day School, previously described, has had some significant successes utilizing sensory integration techniques with children with autism. As of Fall, 1991, they had 35 students. One of their students has graduated to a language disorder

program and another to a learning disabilities classroom in a public school. This may not sound impressive to some, but when one observes some of these children staying in the same class for many years, it supports the advantages of the method.

The use of sensory integration with the population with autism can be beneficial. King (1990) criticizes the use of the behavioral techniques of Skinner as being ineffective. She feels the behavioristic approach in education has led to a "training" paradigm through use of operant conditioning, structured environments and repetition whose only goal is to train the individual to respond in socially acceptable ways and carry out at least minimal self-care activities. She thinks the method increases the behaviors it was designed to eliminate and produces a "robot-like" person who lacks spontaneity. She blames this approach on the view of some neurologists who felt that if surgery or medication could not be used, then there was nothing to be done to remedy the basic deficits. This view led to a lack of hope for improved nervous system functioning. Her experiences led her to try sensory integrative remedial activities, the results of which were very encouraging and the gains made were lasting. This is in contrast to the results of the behavioral techniques which seldom generalize.

Relevant research has been conducted by Dr. Harold Russell and Dr. John Carter of Galveston, Texas. These researchers built their theoretical rationale on the work of Diamond (1988) who investigated the increased dendritic growth resulting in improved performance on tasks of memory and maze learning after environmental stimulation and Cunningham (1981) who reported increased self-control as well as increased math and reading scores following EEG biofeedback training. Lubar (1985, 1991) also demonstrated improved academic performance in learning disabled students that was significant. Tansey (1984, 1990) and Carter & Russell (1981, 1992) found that children

made significant gains in IQ scores after EEG biofeedback training. They have subsequently been conducting studies utilizing auditory and visual stimulation (AVS) that produces entrainment of brain wave activity and EEG Biofeedback on learning disabled boys with AD/HD. One of their latest published pilot studies (1993) cites the following results:

This preliminary data suggests that use of AVS entrainment to challenge and stimulate the brain appears to result in improved functioning and significant gains on intelligence tests, achievement tests, and behavior as rated by parents and teachers. The simplicity of use and the low cost of the equipment may make effective treatment for learning disabilities and attention deficit disorders available to many of the children in the schools who need it but who would otherwise never receive it (Carter & Russell, 1993, p.72).

An in-depth study conducted by Drs. Carter & Russell (1994) to confirm the results of the pilot study was conducted with 40 boys equally drawn from an elementary and middle school. There were 20 in the experimental group, 10 in the placebo control and 10 in the control group but it is not as yet published. The unpublished report confirms the 1993 pilot study in which significant positive gains were reported in IQ, achievement and behavior of learning disabled boys. A future study is planned to replicate the research with females.

Relevance to this study was established in the aforementioned study with the reported gains made on the ADDES-School Version that was completed by teachers. The three variables of Inattention, Impulsivity and Hyperactivity were measured and significant trials ($p < .01$) and interaction effects ($p < .01$) were reported on the inattention and

impulsivity scales. No significant difference was reported between the two groups on the hyperactivity scale even though both groups evidenced some improvement (Carter & Russell, 1994).

There are also no statistical differences reported between the elementary and middle school students' progress. Dr. Carter and Dr. Russell concluded:

AVS training appears to be beneficial for school boys of all ages, who have problems in school related to LD/ADD. To summarize, the following results were found:

A significant gain in verbal IQ ($p < .01$).

Increases in the lower IQ (verbal or non-verbal) were very significant ($p < .001$).

No improvement in the academic areas of reading, spelling, and arithmetic.

A significant improvement on the total score on the Attention Deficit Disorders Evaluation Scale. Two of the three subtests of the ADDES yielded significant improvement. Inattention and Impulsivity improved beyond chance ($< .05$). No improvement was observed on the Hyperactivity Scale.

Essentially the same results were obtained when the two control groups were combined and analyzed with the experimental group (Carter & Russell, 1994, p. 13).

The Whittington Hall Snoezelen Project (1991) was a one-year research project that was conducted in conjunction with Nottingham University in England. Snoezelen was developed in Holland to provide individuals with sensory and learning disabilities an

appropriate leisure and relaxation facility. The philosophy behind the theory was that all individuals need stimulation and those with special needs have an even greater need. "Snoezelen consists of pleasurable sensory experiences generated in an atmosphere of trust and relaxation. The sensory experiences are arranged to stimulate the primary senses without the need for intellectual activity. Trust and relaxation are encouraged by a non-directive or enabling approach being adopted by the helper or carer" (Hutcheson, 1992 p. 8). Although originally developed for individuals with sensory disabilities and severe learning difficulties, it has proved a major benefit for people who are self-injurious and those who are exceedingly active. "People with sensory, physical and intellectual disabilities gain from the wide variety of stimulation as do those who have problems related to autism" (Hurxhwaon, 1992, p. 9). Snoezelen rooms act as a library of stimulation that offers choices to the participant. The floors and walls can change color and vibrate when activated by switches. Light and sound equipment can be utilized as well as UV lights, mirror balls, bubble tubes, star panels, spotlights, projectors.

Facilitated Communication (F/C) is a technique that was introduced to the general population of the United States by Douglas Biklen of Syracuse University on the ABC Prime Time show. He had observed and been trained in the method when visiting Australia. Individuals with autism type answers or messages by having their arm supported by a "facilitator". Controversy over whether the individual with autism is influenced by their facilitator has been debated. Dr. Biklen has refused to allow controlled studies of the veracity of the method to determine whether the facilitator is the one that is typing the message. He cites trust as the issue in not allowing controlled studies and uses observational research on the method.

Rimland (1992) reports the results of the O.D. Heck Developmental Center where enthusiastic supporters of the F/C technique set up a rigorous scientific experimental evaluation. The results were shocking but conclusive that the facilitator was directing the responses of the trainee. This and other studies have been videotaped, but ignored by Dr. Biklin.

Another relatively new method of working with individuals with autism is Auditory Training (AT). Stephen M. Edelson, Ph.D. and Lucinda L. Waddell are conducting research on auditory training at the Center for the Study of Autism in Newberg, Oregon. AT was developed by Guy Berard of France to help individuals with auditory processing problems. These problems manifest when one hears some frequencies better than others. Dr. Berard gives an example of someone who is hypersensitive to the frequencies 8,000 and 2,000 Hertz but hears other frequencies at a normal level. These auditory peaks are recorded on an audiogram. AT is done by randomly selecting different frequencies from a music source and the trainee listens to them on headphones with the auditory peaks filtered out. The training is given twice per day for 30 minutes for 10 days. In total, three audio tests are administered. The desired goal is to have no peaks in the audiogram and to hear all frequencies equally well. AT is considered a form of sensory integration that desensitizes or sensitizes one or more of the senses. The authors conducted a pilot study at Portland State University in which there were statistically significant differences in the experimental group of eight people and the control group of nine people. They cite reductions in impulsivity, distractibility, self-stimulatory behaviors, and echolalia; in addition, increases in attention, articulation, auditory memory and comprehension were substantiated. No changes were noted in the subjects' sensitivity to sounds or their ability to hear sounds. The current study draws from all over North America but there was no

control group (Edelson & Waddell, 1990). Three of the subjects in this study had received AT with no apparent significant results.

These theories are unsubstantiated to date according to the research literature but if they can make a difference in the life of an individual with autism, systematic research is needed. Autism is a devastating syndrome with few proven effective treatment options available. Some of these treatment techniques are extremely expensive and not covered by medical insurance, which places many families in financial difficulty if they decide to try the method. Most families will try anything in the hope that improvement will be forthcoming.

The Snoezelen Room was demonstrated at the National Council for Exceptional Children Convention in San Antonio, Texas in April, 1993. Hutchison (1991) published a report on the research gathered after the first year of the Whittington Hall Snoezelen Project. Results are very positive and research is ongoing.

Rimland (1992) states there have been only a few controlled studies on facilitated communication (O.D. Heck, August, 1992; Holmes et al.; Eberlin et al.; Szempruch and Jacobson). Some of these have not yet been published and results have not been encouraging. Many families/teachers are now in court cases defending accusations of physical and sexual abuse that were reported during sessions of F/C. He further reports that when asked, Dr. Biklen lowered the estimate of the percentage of subjects that could communicate by this method from 100% to 90-95%. Rimland (1992) cited the enthusiasm of Carol Berger of Oregon, a teacher who has conducted over 20,000 F/C sessions and reports she has never had any allegations of misconduct. The validity of the method has not been established but those individuals who now type independently or with only a hand on the shoulder have reportedly benefited from the technique. Freeman (1993)

points out that there is no scientific evidence that F/C works, and does not feel it is a universal solution to the language problems of individuals with autism.

Auditory Training research appears to be very positive and a large scale study is currently being conducted with 400 children and adults with autism. Data analysis and a report were promised in 1993 according to the Autism Research Review (1992). At least Dr. Edelson recognizes that AT may not be effective for all autistic persons and states, "We are attempting to determine what type(s) of individuals with autism will benefit from auditory training. There are many different forms of autism, and it is unreasonable to assume that everyone with autism will benefit from auditory training" (Edelson & Waddell, 1990, p. 4).

In the appendix to Grandin's (1986, 1991) autobiography, she cautions against the use of just one type of treatment, suggesting instead a variety of methods used in combination. She describes a good program as one that has "flexible non-aversive behavior modification, sensory treatment, speech therapy, exercise, and music therapy" (p. 184). Perhaps one day the use of the light/sound technology will be included in that list as an important treatment model.

Chapter 3

Collection of Data

Sample Population

A program on the light/sound technology was presented at a regular meeting of the Peninsula Chapter of the Autism Society of America. All parents were fully informed of the purpose and procedures of the study (see Parent Information Form in Appendix A) and they were asked to volunteer their child if they were interested in participating in the study. The right for parents to withdraw their children from the study at any time was guaranteed in the Consent Form (See Appendix A).

Data Gathering

The use of qualitative research methods, i.e., the case study approach, complimented by repeated quantitative measures utilizing the ADDES-Home and School Versions was used to conduct this research. In special education research, and in particular low incidence disabilities (autism), the case study approach has played a significant role as has been noted earlier in the research of Ayres and King. It is the most descriptive way to examine special individuals and groups to clarify patterns (Merriam, 1988; Mertens & McLaughlin, 1995). "Case studies are the preferred strategy when 'how' or 'why' questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context" according to Yin (1994, p.1).

An Informed Consent form and the Parent Information Form were completed, signed and returned by the parents. A case study approach was utilized supplemented by

an ABABA research design to gather data at repeated intervals during the study. Since there were only six light/sound instruments available and the subjects covered a large geographical region, the sample was necessarily small.

The Attention Deficit Disorders Evaluation Scale—Home and School Versions. (McCarney, 1989). (ADDES) were completed by a designated teacher and/or parent on each subject at the beginning and end of each of the two week sessions with the exception of one subject whose young age precluded the use of the ADDES.

All subject's names were held confidential and the results of the study was made available to the parents of those who participated upon request. Permission for possible publication was obtained, and confidentiality of individual subjects is guaranteed.

Instrumentation

The light/sound technology used in this study was produced by the Synetics Company. It is one of many "mind machines" that have gained attention in the popular press (The Wall Street Journal, The New York Times), magazines (National Geographic, Omni, Time), and on television (20-20).

The company describes the benefits as: providing total relaxation in 20 minutes; providing the mental focus of meditation; the power of hypnosis; and the reliability of the computer. Other reported benefits are feelings of overall well-being, an increase in mental and physical energy, improved concentration and attention, mental efficiency, retention of newly taught material, accelerated learning, modification of habits (drug/alcohol) as well as enhanced problem solving and creativity.

The light/sound technology consists of a cassette player, earphones, a brain-wave synchronizer computer, and "eye-stim" glasses fitted with gently flickering light/color patterns which duplicate the patterns and frequencies of the brain (Woodbury, 1990).

The technology duplicates the patterns and frequencies of the brain in its most receptive state, using gentle light and sound to stimulate the production of alpha and theta brain waves. The lights in the eye-stim glasses flicker over closed eyes, in harmony with a variable tone or soft white noise. As the brain mirrors the gentle stimuli, the subject will begin to experience changing colors and patterns, a kaleidoscopic creation of an active mind. As the whole brain responds, left and right hemispheres begin to synchronize in the slower rhythms of the alpha state. Breathing slows, pulse rate is lowered, a euphoric sense of well-being is experienced. Each repeated experience strengthens and reinforces and one internalizes and integrates the new data (i.e. Spanish vocabulary) or desired behavior (i.e. cessation of smoking) that has been introduced on tape (Woodbury, 1990, p. 11).

Use of the technology is contraindicated in individuals prone to migraine headaches or seizures because of their possible hypersensitivity to flashing lights (photosensitivity). To alleviate the possibility of this, the Consent Form required the parents to check their child's EEG to make sure they were not photosensitive. In addition, the machines used were furnished by Dr. Harold Russell who has conducted research with learning disabled, AD/HD, and individuals with mental retardation. The machines are fitted with a microchip that controls the patterns of frequencies so that they do not go below 10 hertz or above 18 hertz, which is considered the safe range for subjects prone to seizures and migraines (see letter in Appendix B). There is, however, research being conducted to investigate the control of both migraine headaches and seizures (Advocate, September, 1993); information on the study was not available at this time.

One model of the technology was developed by a hypnotherapist and biofeedback researcher, Rob Robinson, to help deal with stress. He began his research by observing people changing their behavior, beliefs and habits using hypnosis. By using biofeedback and monitoring EEG activity during therapy sessions, the inventor learned that when the mind was most receptive, certain dominant brain wave frequencies were present. Relationships were then established between brain wave frequency and patterns of rote memory, recall, emotions, relaxation/stress, and creativity. He reports the technology speaks to the brain in its own language—frequencies—and that full understanding of the brain's frequency activity could lead to major breakthroughs in dealing with learning and behavior.

The principle behind the light/sound technology is to provide a change in brain wave patterns to facilitate learning. To accomplish this, "entrainment" (the brain's tendency to mimic the patterns of the stimulus) is used to lock into the frequency of an externally supplied frequency (Leviton, 1990).

According to Hutchison (1986.), the four types of brain wave states and their characteristics are:

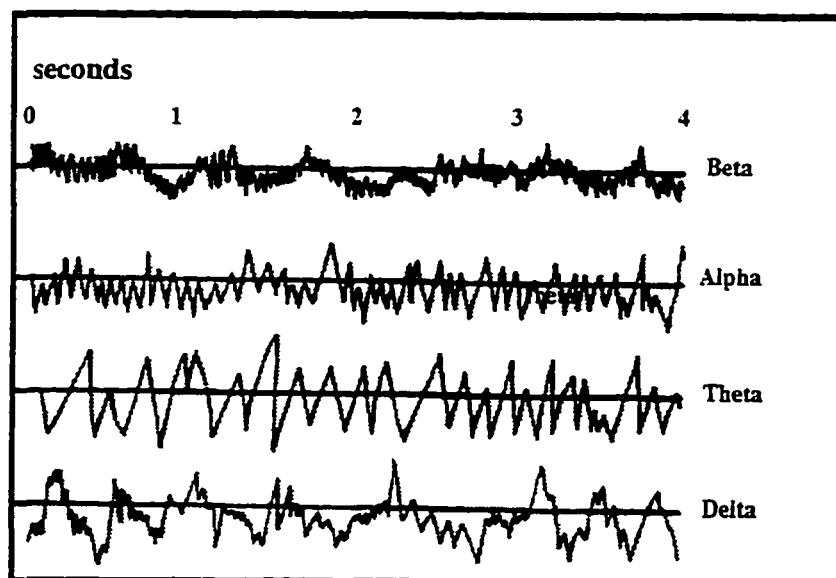
Beta: frequencies of 13-30 Hz (cycles per second); predominant during waking state, periods of mental effort, thinking, concentration, problem solving, focused analysis and periods of stress.

Alpha: frequencies of 8-12 Hz; occurs when calm and relaxed but mentally alert; may be present during daydreaming.

Theta: frequencies of 4-7 Hz; occurs when one is calm and relaxed. Experienced at least twice each day when transitioning from sleep to a waking state and drifting from drowsiness to sleep. This

mental state is accomplished at will only by advanced meditators; it may be characterized by fantasy-like thoughts or vivid images; is thought to be a state in which the mind is hyper-suggestible and is associated with altered perceptions.

Delta: .5-4 Hz: associated primarily with deep sleep. A graphic illustration from that same book, *Megabrain*. (Hutchison. 1986. p. 87) follows:



There are over 20 types of light and sound machines commercially produced according to Hutchison (1990-1992, 1994). He reports that it has been well established that the devices can produce states of relaxation, increase suggestibility, improve receptivity of new information and access subconscious material. New research is under way in the treatment of learning disorders, alleviation of pain, migraine headaches, and enhancement of the immune system. In addition to the published research of Carter and Russell, following is a summary of the most noteworthy research conducted in the last decade on the light/sound technology that has been reported by Hutchinson (1990-1992, 1994).

Budzynski (1980) conducted a preliminary study at the Behavioral Medicine Associates clinic in Denver, Co., and found that the device could be effective for accelerated learning due to the heightened receptivity to new information and suggestibility it produced.

Dr. Gene W. Brockopp, a medical researcher, has suggested the light and sound stimulation could help the brain become passive and un-clutter it, so that new cognitive strategies could be developed. He theorized, "If we can help a person to experience different brain-wave states consciously through driving them with external stimulation, we may facilitate the individual's ability to allow more variations in their functioning through breakup of patterns at the neural level. This may help them develop the ability to shift gears or 'shuttle' and move them away from habitual patterns of behavior to become more flexible and creative, and to develop more elegant strategies of functioning" (Hutchison, 1990-1992, p. 6).

The only empirical study reported by Hutchison was performed by Dr. Norman Thomas and David Siever at the University of Alberta. One group (experimental) was given audio/visual stimulation at 10 Hz. for 15 minutes. Their muscle tension (measured by EMG) and finger temperature were monitored. The control group was asked to relax and visualize a tranquil scene without the stimulation for 15 minutes and were monitored similarly. Both groups were considered resistant or non-hypnotizable subjects. The results showed that although the control group expressed a sense of relaxation, the EMG and temperature monitors indicated they were experiencing increased amounts of muscle tension and decreased finger temperature (associated with stress and tension). The experimental group showed dramatic increases in relaxation that lasted for long periods after the 15 minutes of audio-visual stimulation. The researchers wrote, "It is concluded

that auto-suggestion relaxation is not as effective as audio-visually produced relaxation. Electroencephalography shows that a frequency following cortical response is evoked in the audio-visually stimulated subjects (Hutchison. 1990-92).

Other relevant unpublished research includes that of an anesthesiologist, Robert Cosgrove Jr., Ph.D., M.D., who studied light stimulation using the Alpha-Pacer II device and reported on its ability to induce deep relaxation. He proposed evaluating the device for its sedative properties in patients before, during and following surgery. He reported that they were quantitating the electroencephalograph effects and showing strong EEG entrainment. He planned to use the device to test the hypothesis that the machine was a neuropathway exerciser and had potential for promoting optimal cerebral performance in brain injured patients in which the degree of recovery was related to sensory and cerebral stimulus.

In 1990, Bruce Harrah-Conforth Ph.D., of Indiana University, completed a two-year, controlled study of brain entrainment using a computerized light/sound machine known as the MindsEye Plus. The control group listened to pink noise with their eyes closed. The group using the machine showed dramatic alterations in their EEG patterns responding to the light/sound frequencies as well as evidence of hemispheric synchronization. The researcher reported the device caused hyper- and hypo-arousal which translates as a pleasurable, creative "high" as well as deep relaxation.

"The Other 90 Percent", a private research group in California, is engaged in an on-going study of light/sound devices led by Julian Isaacs, Ph.D. The group is using a 24 electrode color brainmapping EEG with software that gives sensitive and precise measurement as well as statistical analysis of the electrical activity of the brain. They have

determined that the process of entrainment does occur but published reports were not available (Hutchinson, 1990-1992, pp. 5-9).

Research of the use of the technology with students with autism is limited to one case study (not reported in the literature) and a pilot study at the Chileda Institute (not reported in the literature). The need for this study is established by the lack of reported data of the technology with students with autism. The pilot study, *Creating Alternate Learning Modes for Self-Abusing Children with autism (CALM)* was conducted by Dr. Rayma Ditson-Sommer in 1991 at a private institution in Wisconsin. Pulse rates and self-abusive behaviors were decreased. Ditson-Sommer (1991) refers to the technology as "biofeed-in" technology. In addition, she has conducted other types of research: a light/sound lab at Arizona State University for students with learning problems and at the Center for Academic Precocity, a program with the Montessori Day School in Phoenix located at the same university.

Dr. Harold Carter reported in a telephone interview by the investigator (April, 1995) the work he has done utilizing the AVS technology with an adult female with autism. He reported she is very high functioning and benefited from the treatment by being able to reduce medication.

Doug Wilson, Research Associate at the Department of Electronics and Instrumentation of the University of Arkansas at Little Rock, evaluated the visual technology for Threshold Limit Values for light and near-infrared radiation. He determined they were not exceeded and that there was a considerable margin of safety in the eye-stim glasses of the technology. A letter and research report certifying his findings is found in Appendix C.

A ten-day pilot study was conducted by this researcher at New Horizons Children's Center in December, 1992, with three students. Observations in the form of anecdotal records were made before, during and immediately after the sessions on the technology. Some notations were: "You could actually see B (the student) starting to relax; waited calmly while equipment was put away; completed coloring task afterward; stayed with task better than usual and took suggestions; seemed calm afterwards and helped put equipment away; he really enjoys going out to do this; sat calmly and quietly; very quiet. The subjects were very active, disruptive children who quickly adjusted to the glasses and ear phones (something new) and appeared to benefit from the experience. These comments were considered a rationale for further study and a longer trial period which might result in more long-term effects.

The September, 1993, issue of the Advocate, the paper published by the American Mental Health Counselors Association, has an article on "EEG biofeedback: A Wave of the Future." It reports research on brainwave training as treatment for ADD, epilepsy, post-traumatic stress, addictions and learning enhancement. Seizure control is one of the main thrusts of some of the research and is taking place at a Veteran's Hospital in California.

Evaluation Instrument

Attention Deficit Disorders Evaluation Scale-Home and School Versions (ADDES)

The Attention Deficit Disorders Evaluation Scale was developed by Stephen B. McCarney, Ed. D., and published by Hawthorne Education Services in 1989. The school version of the ADDES was used to gather a baseline of behavior and the efficacy of the treatment. The ADDES was developed as an aid in the diagnosis, planning and placement of Attention Deficit Disordered (ADD) children and adolescents (with or without

hyperactivity). It is appropriate for ages 4 years 5 months through 20 years. The school version of the scale contains 60 items: each item is associated with one of the three characteristics of the American Psychological Association's (APA) definition of ADD as outlined in the Diagnostic and Statistical Manual, Third Edition-Revised (III-R). The three characteristics are inattention, impulsiveness (on-task behavior) and hyperactivity (as it relates to acting out) all of which correlate with the research questions being investigated.

The scale was standardized and field tested on 4,876 students evenly distributed across all grade levels (K-12). Demographic characteristics of the standardization sample represent national percentages of race, sex, residence, geographic area, and occupation of parents.

Utilizing the Coefficient Alpha (Cronbach, 1951), McCarney (1989b) reported the internal consistency of the ADDES as .97 for the total test; test-retest reliability correlation coefficients exceeded .89 for each of the three subscales. Interrater reliability coefficients of the subscales ranged from .81 to .90 for all age levels. Content validity was established through the initial development process and criterion-related validity established by a comparison with the Conners (McCarney, 1989). Comparison to the Conners Teachers Rating Scale was used as a measure of concurrent criterion-related validity. Each subscale reached .001 level of confidence when compared to the Conners. Item performance also correlated well with total scale performance, which further substantiates the internal cohesiveness of the scale as a measure of these characteristics.

On the ADDES, each item is rated on a five-point scale from (0)—does not engage in the behavior to (4)—one to several times per hour. Three types of scores may be obtained after administration: (a) raw scores for individual items; (b) subscale standard

scores; and (c) percentile scores. The percentile scores and subscale standard scores allow a profile of the student's behavior across the three subscales to be constructed.

Administration of the ADDES takes about 12 to 15 minutes for the parent, teacher or other school personnel, familiar with the student, to complete.

Koutnik (1992) reviewed the ADDES by comparing it to the Conners' concluding it reflects or exceeds the current criteria of assessment of youngsters with possible AD/HD outlined by the National Association of School Psychologists (1992). Although both the Conners and ADDES have a home and school version, he reports the advantage of the ADDES because it has separate items and norms for attention, impulsiveness and hyperactivity. He also lauds the more objective response alternatives; for example, "One to several times per month"; "per week"; "per day"; that make it more useful as a diagnostic tool. On the negative side is the difficulty reading the norm tables (a computerized quick scoring program is available). The "throwaway" items at the lower levels have raised objections from Kindergarten teachers and it has been suggested that the item, "Does not engage," be rewritten and the scale renormed to exclude any of that type item.

In summary, this measurement instrument appears to be the most appropriate to tease out and measure the variables delineated in this study. It is reported to be technically sound and comprehensive. In addition, researchers at 38 colleges and universities conducted research with the instrument covering the time period October, 1991 through April, 1993, according to a list provided by the company. The publisher invites research on the instruments.

Research Design

The multiple case study design was determined to be the best choice for this research because, according to Yin (1994, p. 45) multiple case studies provide evidence

which "is often considered more compelling, and the overall study is therefore regarded as being more robust." However, as Leedy (1993, p. 139) stated, "The nature of the data dictates the methodology. If the data is verbal, the methodology is qualitative, if it is numerical, the methodology is quantitative." He suggests that the alternative is a hybrid variation designated as triangulation that employs both quantitative and qualitative methods and techniques. Nancy Burns states in *Nursing Science Quarterly*, qualitative methodology should: "be an alternative to the experimental method, consider words as the elements of data, be primarily an inductive approach to data analysis and result in theory development as an outcome of data analysis" (Leedy, 1993, p. 140).

According to Mariano (in Leedy, 1993) qualitative research is both scholarly and creative. It requires creative thinking, intellectual and emotional energy, a great deal of time and a desire to discover meaning, explain phenomena, and develop understanding. Leedy concludes by stating, "Creative scholarship at its very best is the ultimate criteria for the qualitative researcher and to achieve it may well require nothing short of 'sweat, blood, and tears'!" (Leedy, 1993, p. 140). Synthesis and analysis are the tasks of the qualitative researcher. He warns, however, that quantitative and qualitative methodologies are not mutually exclusive. "Qualitative and quantitative data may compatibly live in the same house; the terms refer more to a global atmosphere in which the researcher attempts to solve the basic problem for research, not to any exclusive method of operation" (Leedy, 1993, p 142). There has been an emphasis on combining approaches recently. Goodwin and Goodwin (1984) pointed out that studies may be considerably enhanced if the combined approach were employed.

Yin (1994) recommends case study research as the preferred strategy for “how” or “why” questions. It is effective when the researcher has little control over events and the focus is on contemporary phenomenon within a real-life context.

According to Stake (1995), case study is not considered sampling research and is not conducted to understand other cases. He posits the researcher has an obligation to understand the one case and the unusual case helps illustrate what may be overlooked in typical cases. Even for collective case studies, Stake recommends that the selection by sampling of attributes is not the highest priority; the opportunity to learn is of primary importance. He continues that particularization, not generalization is important and understanding the case itself.

Stake (1995) reports it is not uncommon for case study researchers to make assertions on a relatively small data base, invoking the privilege and responsibility of interpretation. He feels researchers are privileged to assert what they find meaningful in their inquiries. “An ongoing interpretive role of the researcher is prominent in qualitative case study. ‘Thick description,’ ‘Experimental understanding,’ and ‘Multiple realities’ are expected in qualitative case studies” (p. 43). He concludes that qualitative case study seeks greater understanding, appreciates the uniqueness/complexity of the case and the interaction with its contexts. It perceives and represents what is happening through interpretation and uses narratives to optimize the opportunity for the reader to gain experiential understanding of the case. Guba & Lincoln (1982); Eisner & Peshkin (1990) place high priority on direct interpretation of events and lower priority on interpretation of measurement data in their approach to qualitative case study.

Although the literature is becoming more plentiful in the support of combining approaches, or triangulation, to reap the considerable gains of such endeavors, few of them

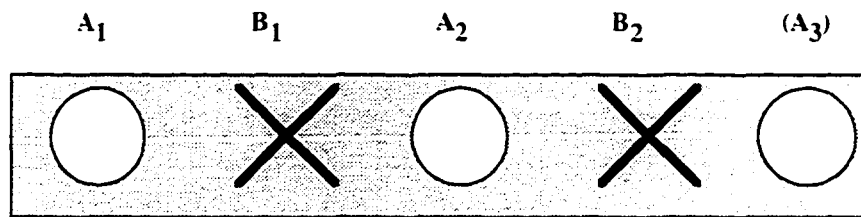
address the issue of how to accomplish this. Duffy has filled this need by outlining the following guidelines:

1. Theoretical triangulation involves the use of several frames of reference or perspectives in the analysis of the same set of data.
2. Data triangulation attempts to gather observations through the use of a variety of sampling strategies to ensure that a theory is tested in more than one way.
3. Investigator triangulation is the use of multiple observers, coders, interviewers, and/or analysts in a particular study.
4. Methodological triangulation is the use of two or more methods of data collection procedures within a single study. (Duffy, 1987, p. 131)

The design of this study utilized an ABABA design with repeated measures and in addition, qualitative data in the form of anecdotal records were gathered on each case. Interviews with principals, teachers, parents, therapists, aides, and other relevant staff were conducted on all subjects. Document analysis of school, educational, psychological, speech/language, neurological, developmental and medical records was also a source of data. The researcher made multiple observations of the subjects when that was possible. E-mail exchange and phone calls were conducted with the parents of subjects who live in Illinois and Ohio.

Random selection and assignment of subjects was impossible due to the constraints and restrictions imposed by the nature of the population, i.e., seizures, voluntary participation by parent, the human subjects committee and the small sample size.

An ABABA design was used and a graphic illustration follows:



Although the focus was on the differences observed on the variables as measured by the ADDES, the value of the document analysis, interviews, anecdotal records and observations recorded by the teachers, parents and the researcher were invaluable to the results.

Validity issues were addressed by repeated measurements of the variables addressed in the research questions, multiple sources of data, and by replication of the study when possible.

Specific Research Questions

1. Will the use of light/sound technology reduce the hypersensitivity to sensory stimulation that results in the high state of arousal characteristic of students with autism?
2. Will the use of light/sound technology increase the on-task behavior (attentiveness) of students with autism?
3. Will the use of light/sound technology decrease acting-out behaviors (associated with hyperactivity) in students with autism?

Data Analysis

The data gathered from the various sources were analyzed and grouped in headings described the subjects in their total environment. The issues explored in the school and home environments included family history; developmental milestones; medical aspects of the case; educational history and issues; pre-intervention history and baseline; light/sound

technology intervention: measurements of the ADDES-School and Home Versions; post-intervention data; and the graphic presentation of the results of the evaluation instrument. In addition, the results recorded by the parents and teachers on the ADDES were analyzed to determine the net effect of applying the treatment to the subject. This was done by assuming each trait within each category had equal weight. Each level of grading scores within each trait also had equal weight. Therefore, the net effect (positive/negative) as depicted in the figures is defined as the difference between the sum of the trait scores measured after each interval (treatment/non-treatment) and the sum of the baseline trait scores. Since the number of traits was different for each category, the results were converted to percentage values. In equation form this was:

Gain, % = $(\text{Sum of baseline scores} - \text{Sum of interval scores}) / \text{Sum of baseline scores} \times 100$.

The individuals were tested and compared on the basis of the results of the ADDES. Although the focus was on the differences observed in the variables (Inattention, Impulsivity and Hyperactivity) as measured on the ADDES, the rich material of all qualitative data was found to be extremely valuable and was reported as individual case studies. The combination of qualitative and quantitative data gives direction to necessary modifications as well as further research efforts.

Ethical Considerations

There is a variety of research in the literature on the population identified as individuals with autism but the literature that was reviewed was based on clinical studies with small samples or individual case studies which is considered the most efficient way to study this population. The interventions are numerous and varied in approach with each discipline (behavioral, pharmacological, sensory, etc.) espousing theirs to be the way to reach and teach this population. In fact, it is important to explore new teaching methods

and use combinations of approaches in both research and interventions in order to help these students function optimally.

Since the Individuals with Disabilities Education Act (1990) has officially made this syndrome a disability to be addressed by educators and the identification criteria have allowed for a greater number with the syndrome to be identified, it is incumbent upon the educational system to utilize recently developed technology and methods that will allow more of this population to become optimally participating members of society. It is therefore important that innovative techniques be tested that produce responsible and publishable research. Much of the review of the literature also includes studies that have not been published. This study adds to the literature additional quantitative and qualitative data on the efficacy of alternative and innovative techniques in dealing with the varied characteristics of autism. There was no foreseen possibility of causing physical harm to subjects associated with the study and the approval of the Human Subjects Committee of the College of William and Mary was solicited. The subjects were carefully screened for possible seizure activity and tendency toward headaches by having parents check their child's EEG for evidence of photosensitivity and by having them check with their neurologists (See Consent Form, Appendix A).

Informed parental consent of all subjects was obtained for all participants with a consent form documenting the purpose, length, and brief description of the research questions to be investigated and explored. The right to decline to participate or withdraw in full or in part at any time was guaranteed (See Consent Form, Appendix A).

The subjects and their parents or guardians have the opportunity to discuss the results with the researcher and all individual results will be kept confidential if the research should be considered for publication.

Chapter 4

Findings and Analysis of Results

The purpose of this study was to investigate the effectiveness of light/sound technology to promote sensory integration in order to increase the learning capacity of children with autism. Data was gathered from multiple sources as previously outlined and presented in a primarily narrative format with tables and figures to graphically represent results. The case studies include results that reflect both quantitative and qualitative methodology. This was accomplished by assessing five subjects on three variables before, during and after the intervention(s). The variables were:

1. Reduction of hypersensitivity to sensory stimulation that results in the high state of arousal characteristic of students with autism.
2. Increasing on-task behavior (attentiveness) of students with autism.
3. Decreasing the acting-out behaviors (associated with hyperactivity) of children with autism.

Even though twelve subjects qualified for the study, complete data was available on only five cases. Eleven were male and one female; they ranged in age from three and one half to seventeen. The attrition of subjects was due to multiple reasons that included refusal of subject to wear the technology on a consistent and long-term basis; disruptive behavior perceived by parent; destruction of the technology and the inability to tolerate the auditory stimulation even at low levels. Due to the small size of the sample, results are reported both quantitatively and qualitatively with analysis that compared each subject's interval results with their baseline data.

The multiple case study and repeated measures research design as represented by ABABA was employed by the investigator to provide better data control. Since it was expected that the intervention would have a lasting effect, the reinstatement of the original baseline rate of inappropriate behaviors was not possible. The ADDES gives both scaled scores and percentile ranks; however, the translation of the raw data to these statistics is so gross (e.g., a raw score ranging from 29-38 would receive the same scaled score) that the results of the raw data will be reported instead. According to Borg and Gall (1989) this method of reporting is in line with most researchers utilizing the multiple baseline design. They indicate that researchers report results as raw data with a few descriptive statistics when interpreting single-subject research. Even though the original design called for only the school version of the ADDES to be used, the home version data was also utilized since the machine was to be used both at home and school when possible; replication studies were conducted in three of the cases in at least one setting (home or school).

Qualitative data is reported that was gathered from document analysis, anecdotal records that were documented each time a subject was on the light/sound technology, interviews, and observations. The form for gathering the anecdotal information is found in Appendix B. Broad categories include the amount of time on the machine and the behaviors before, during and after use.

Subjects were selected from a group of possible applicants who attended a presentation of the technology and relevant research the investigator made to the local chapter of the autism society. In addition, word of mouth from the original parent group led to other parents calling to inquire about the study.

Contact was made with each parent and school upon selection of the subject. The subjects lived in the Hampton Roads area and represented five school systems: York

County, Hampton, Newport News, Norfolk and Virginia Beach. Two of the subjects live in midwestern states (Ohio and Illinois) but only one completed the study.

Teachers and administrators were thoroughly informed about the research and each subject was given two trials on the machine prior to data collection to insure willingness to wear the technology; this did not always result in long-term use of the machine.

1. Baseline measurement was made on the ADDES.
2. Subjects used the technology at least once a day for two weeks.
3. Subjects were re-evaluated on the ADDES.
4. Subjects did not use the technology for two weeks.
5. Subjects re-evaluated on the ADDES.
6. Subjects used the technology at least once a day for a second two weeks.
7. Subjects re-evaluated on the ADDES.

The six light/sound machine were furnished by Dr. Harold Russell. Dr. Russell's research with these machines is previously documented and were chosen because the machines have been programmed with a chip to control the frequencies to prevent the possibility of seizures (See letter in Appendix B).

The data are reported according to the sections delineated above and include triangulated data collected through observations, interviews, intervention results, anecdotal records, and records review and analysis.

Following are the five case studies:

Case Report Number One

Background

Case number one is a seven-year-old male, herein referred to as Cory, who lives with his mother, father and older half-brother. The family is military and live in a middle

class neighborhood near the school where Cory was mainstreamed in a first grade classroom at the time of the initial study. The researcher has followed Cory for a year and the initial study was replicated at the end of his first grade year. Cory is currently in a regular second grade class.

Document analysis was conducted at both school and home. Many of the documents were present at both settings. The following documents, and their interpretations when applicable, were available in the home visit: a portfolio of Cory's daily work and behavior management system since kindergarten; Champus records; Child Study and Eligibility records; the Psychological Evaluation from Clinical Associates of Tidewater; the Neurological report from Children's Neurological Services; the electroencephalogram report from Mary Immaculate Hospital; the Developmental report from Children's Neurological Services; the Speech/Language evaluation from Children's Hospital of the King's Daughters; a series of correspondence from the pediatrician, clinical psychologist, neurologist, the speech/language therapist and the developmental specialist. At the school, the following documents were reviewed: attendance records, report cards, school health forms, birth certificate, immunization record, and reports relevant to the eligibility process for special education. The information gleaned from this document review is interwoven throughout the case report in the appropriate categorical section.

Cory's mother, Mrs. X., is 36 years old. She was a single mother in the Air Force when she met her husband. She stayed in the Air Force for ten years and has been out since 1992. Her husband, Mr. X., is still in the Air Force and plans to retire after 20 years.

When asked about the educational background of the parents, Mrs. X. reported she has a GED and some college courses. Mr. X. has a high school diploma and went to college but Mrs. X. could not remember if he received a degree. She commented that he

probably did not, since he is currently working on an associate's degree through the Air Force. She also could not remember the spelling of Mr. X.'s middle name. Cory's older brother is 12 years old and attends middle school; he has not had any academic problems, according to Mrs. X.

Cory was born in Landstuhl, Germany at an Army hospital. The pregnancy was not planned in that she and her husband had tried to conceive after they were married but had given up and she had started "running and working out." At that time, when she "had gotten down where she wanted to be," she became pregnant and therefore experienced mixed feelings about the pregnancy. She describes her feelings as both happy and sad. Mr. X. was happy about the pregnancy but wanted a girl (and still does), but Mrs. X. is firm about not wanting more children.

Mrs. X. describes her pregnancy with Cory as a difficult one. It was termed a "dual" pregnancy, in that a month after she got pregnant with Cory, she got pregnant again. (The social worker's report indicated Mrs. X. continued to have periods after she was pregnant with Cory, but according to the pediatric neurologist's background information, bleeding around the fourth month was reported by Mrs. X.). The fetuses were not considered twins and Mrs. X. had a miscarriage of the undeveloped fetus at month four; this did not, however, pose a threat to Cory. She said it was explained to her by her doctor that the body was protecting itself by expelling a foreign object.

From the beginning of the pregnancy, Mrs. X. stated she experienced a "lot of emotional problems." During this time Mr. X. left the household because, according to her, he could not deal with her emotional problems. Subsequently, both Mr. and Mrs. X. sought individual counseling and he returned home after about a month. During his absence he attended a leadership school. Mrs. X. said part of their marital problems was

due to her unwillingness to allow Mr. X. to discipline her older son in what she felt was an "abusive way" and that resulted in some verbal abuse toward her. The rest of the pregnancy was described by Mrs. X. as uneventful and she was more emotionally stable. Cory was delivered vaginally and weighed 7 lb. 7 1/2 oz. at birth (the neurologist's report indicated the birth weight to be 7 lb. 5 1/2 oz and the clinical psychologist reported 7 lb. 5 oz.). Mrs. X. described Cory's delivery as normal although she was in labor for 12 hours and the afterbirth was sent to a laboratory to be tested but she could not remember the purpose for this or what the results were. On a follow-up call regarding Cory's APGAR score, Mrs. X. asked, "Would that be the eight they told me about?"; however, she was moved to another room and is not aware of what the second measurement was.

When asked about drugs/alcohol during the pregnancy, Mrs. X. said she had "an occasional beer" but stopped smoking when she found out she was pregnant with both children. She reported she did experience sinus problems (the neurologist's report also indicated migraines) and may have taken antibiotics and decongestants. She also remembered there was an incident at six months into the pregnancy when she was taken to the hospital emergency room with a severe bladder infection and antibiotics were administered.

When Mrs. X. was asked about Cory's temperament as a baby, she commented, "Oh, man, he was a very cranky, unhappy baby!" She did not breastfeed him and she said he was such a difficult baby, they "went through" five baby sitters in the first year. She reported Cory had chronic ear infections during the first year of life which she attributed to her husband's smoking in the house. She said Cory was not "cuddly" and she reported she felt a lot of guilt about him because she really didn't want to be around him after she came home from work. She further commented that she dreaded weekends. She related

to the researcher that she and her husband never took Cory anywhere: one of them would stay home with him so the other could go out. The clinical psychologist's report indicated Cory had experienced a "lifelong irritability and oversensitivity to noise, pain or overstimulation" according to his mother. Sleep disturbances, finicky eating and rituals related to routines were also cited.

His mother reported that if Cory hurt himself or got angry, he didn't like to be comforted and would hit and kick to get away. It has only been in the last year or two that he can be comforted (if it is his idea). However, if he gets angry, Cory will ignore everyone, won't speak, and will go to his room and hide his face in a pillow, shutting himself away for hours. Mrs. X. says she doesn't like it when he is that way and will go to his room, talk to him, (even though he won't answer), and try to get him to laugh or respond. She commented, "I don't like it when he is mean and I try to get him out of it."

Mrs. X. feels that her husband is "aloof" and uninvolved in the children's school and medical problems. She says, "Mac is working on it", but she does not feel they do enough things with the kids as a family. Cory likes to go outside and play with the older kids and she said she and her husband pretty much let him do what he wants to do. She says Cory knows he is "different" but she had never sat down and talked with him about it until she made an appointment to get the EEG and Cory asked if he was dying.

She reported Mr. X. has had a lot of trouble dealing with the situation and she feels that she takes all the responsibility. She finally confronted Mr. X. and he is more involved now than in the beginning. She commented, "Cory is very close to me": she continued by saying she feels she always has to be the "bad guy."

As the interview was being concluded, Mr. X. arrived home and fixed his lunch. He came in and met the researcher but made no response to any of the comments made to

him about Cory. He left and fixed himself a sandwich and began watching TV which had been on during the entire interview.

Developmental Milestones

Developmentally, Mrs. X. reported all milestones were age appropriate as far as she could remember. She reported Cory walked early (eight months) and talked at an early age (Dr. David's report indicated eighteen months). She found a baby sitter after the first year who worked with special needs children and reported this sitter "did wonders with Cory." She said she knew at an early age that there was something different about Cory.

The family was transferred to California when Cory was three years old. At that point, Mrs. X. described day care as a "constant hassle" and since there was incentive money offered to leave the Air Force, she made the decision to get out. When asked about Cory's potty training, Mrs. X. reported it was so traumatic for him and he was three to three and one half years old before he was completely trained. She started the process when he was about two years old. Cory had no problems urinating but refused to have bowel movements. At one point, he had to be taken to the doctor to get suppositories. Her mother-in-law asked, "What's the matter with him"? However, it was reported the mother-in-law kept the children for a month during a transition period from Germany to California and Cory performed more normally there.

When asked about enuresis, Mrs. X. reported, "Although the bed is never wet, I still occasionally find wet underwear." She said she does not know when these accidents happen and hasn't said anything to Cory.

Mrs. X.'s last comment to the interviewer was that she would hate to have a "purely child with autism to deal with" because she feels that Cory has made progress by learning to be spontaneously affectionate and occasionally says, "I love you, Mommy."

Mrs. X. reported the clinical psychologist had told her concerning Cory. "They don't write books about kids like Cory and your life will be a roller coaster."

Medical Factors

As reported earlier, Cory had recurring ear infections as an infant that resulted in tubes being placed in his ears at one year of age. Since that surgery, according to his mother, he has been relatively healthy. He was tested for allergies about a year ago and no shots or medication were prescribed. He is allergic to mold spores. His immunization records are up to date according to the school records. There was a reported difference in the hearing screening: Right - 20-50; Left - 10-50. No significance was attributed to this difference.

The clinical psychologist referred Cory for a neurological examination after reviewing the reason for referral and additional evaluation results. He noted normal development except for social skills, impulse control and attentional focus. In addition, the clinical psychologist's report described Cory as "hyperactive; needs constant attention; disruptive and aggressive; short attention span; can follow only one direction at a time; loud and rambunctious; bullying; doesn't know when to stop."

Cory was reported to have a high need for order, predictability and specificity of routines. Sleep disturbance, finicky eating and rituals related to routines were also reported. The clinical psychologist also noted moments of apparent stop-stare spells and sudden, brief, mute resistance. Cory was reported to behave oddly at times in both social rapport and communication. He told "tall tales" or embellished the truth to increase the drama of a situation or to secure attention. He defended these fabrications and seemed to believe them. He was noted to lash out or snap back at a friendly comment or refuse to cooperate, according to the report. The clinical psychologist's assessment of emotional and

personality factors was that Cory was not “seriously emotionally disturbed, psychotic or autistic.” He did find intermittent, loose association and idiosyncratic responses. His conclusions indicated a social learning disability; poor controls over cognitive distraction and impulsivity and interference with conventional learning due to oversensitivity to excess stimulation.

The pediatric and adolescent neurologist also noted behavioral idiosyncrasies. He reports Cory is perseverative and can talk on subjects of interest to himself for great lengths of time. Cory is not accepted well by others and strikes out at them. He is ritualistic and insists on proscribed routines in the morning and when doing homework. He talks to himself and when speaking with other individuals, appearing to look past or through them.

The neurological examination revealed cranial nerves to be intact. Deep tendon reflexes were equal and symmetrically active with no pathologic reflexes. Tests of cerebella function, gait and coordination were within normal limits. Sensory examination was normal and no pragmatic speech disturbance was noted.

The neurologist concluded that Cory has an attention disorder that was being treated with Ritalin; in addition, he felt there were sufficient symptoms to suggest a disorder involving sociability. Since language skills were normal, Asperger’s Syndrome was considered. A referral was made for a complete developmental assessment, an electroencephalogram (EEG) and CT scan, Fragile X testing as well as a speech and language evaluation.

The developmental assessment was conducted using the following instruments:

Vineland Adaptive Behavior Scales

Learning Accomplishment Profile, Diagnostic Edition (LAP-D)

Wing Autism Checklist

Attention Deficit Disorder Evaluation Scales

On the Vineland, Cory had scores in the Average range for daily living skills and gross motor skills. His scores were moderately low in communication and difficulties in socialization skills were reported. Significant difficulties were noted in coping skills and interpersonal relationships. On the LAP-D, Cory was non-compliant and did not want to participate in the testing session other than playing tic-tac-toe with the examiner and identifying some shapes and some isolated words. No results were reported on the autism or AD/HD checklists.

The other relevant findings were reported by the mother as being a good long-term memory and talent in art. Cory's artistic talent was also reported by the kindergarten teacher. The mother was reported as feeling Cory shows a lack of awareness of psychological barriers and difficulty inhibiting embarrassing remarks in social situations. He refers to all acquaintances as friends and has a poor grasp of the concept of friendship although he wants friends.

In summary, the developmental specialist concurred with the clinical psychologist's findings, indicating the presence of a social learning disability, or what she termed "a non-verbal learning disability," as well as an attention deficit. She recommended possible placement in a special learning environment such as a small, structured classroom with firm limits and social skills training as part of his daily routine.

Cory had a speech/language evaluation by Children's Hospital of The King's Daughters. Tests administered were:

Clinical Evaluation of Language Fundamentals-Revised (CELF-R)

Test of Auditory-Perceptual Skills

Test of Pragmatic Skills

Oral Peripheral Examination

Clinical Observations

The CELF-R assesses receptive and expressive language skills in the areas of syntax, semantics and morphology. Combinations of subtest standard scores resulted in a Receptive Language Score of 93; an Expressive Language Score of 97 and a Total Language Score of 94. All subtest scores with the exception of Oral Directions (Below Average) fell in the Average range.

The Test of Auditory-Perceptual Skills was administered to Cory to assess his ability to comprehend linguistic information presented auditorially on graded tasks. There was considerable scatter in the subtest scores ranging from Slightly Below Average to High Average. His age equivalent scores ranged from below four years to 11 years 6 months compared to his chronological age at that time of 6 years 5 months.

The Test of Pragmatic Skills measures the underlying rules used by a child or adult to communicate. Cory's achieved score fell at the 50th percentile and his pragmatic language skills are considered appropriate for his age.

Articulation, oral peripheral examination, and voice/fluency were all reported as normal.

The neurologist reported Cory's electroencephalogram and CT scan were normal. After reviewing all other relevant data, he concluded that Cory does have Asperger's Syndrome and stated even though Cory appears to have normal motor skills which many Asperger's children do not, he had a discreet social deficit. The neurologist pointed to the measures of language pragmatics that were within normal limits as being the most sensitive for detecting verbal high-functioning students with autism. Concurrent with

Asperger's, the neurologist cited the attention disorder and its effect on socialization as being sufficient reason to continue the stimulant medication.

Educational History

Cory began kindergarten in California at 4 years 11 months. Mrs. X. reported he was constantly picked on by two other children in the class. He never completed his work and with five serious behavior problems in the class, she felt Cory was an "unnoticed problem child." At the end of that school year, the family moved to Hampton. One of the reasons they bought their present house was because of its proximity to Tucker-Capps Elementary School, which is one of the school system's fundamental schools. When Mr. and Mrs. X. went to register the children, they were told they would have to get on a waiting list even though they were zoned for that school. However, they were told if Cory were in kindergarten, he would automatically go to that school and since Mrs. X. felt he was not ready for first grade, she requested that he repeat kindergarten.

After two weeks in school, the teacher called and reported Cory was hitting and pushing other students, was having trouble following directions, and the teacher was concerned that something was wrong. It was suggested that Cory be tested for possible AD/HD. Mrs. X. also met with the school principal and counselor concerning another child (reported to be a "bully" by Mrs. X.) with AD/HD who continually picked on Cory. Mrs. X. said that Cory came home from school crying every day and he got to the point he didn't want to go to school. Mrs. X. accused the school of allowing her son to be abused. She reported she tried to work with the mother of the other child by initiating telephone calls and inviting them over to get to know each other etc., but there was no positive response. She said she was at school almost every day and continues to volunteer there. She was very grateful that the school separated the two boys for the first grade.

According to Mrs. X., Cory was put on a trial dosage of Ritalin by his pediatrician December 7, 1994. She remembered the date because she really did not want to have him on medication. However, the parents and school noticed a big difference and felt the results were helpful in that Cory began to perform better in school. Mrs. X. expressed concern that no specific testing or evaluation was done by the physician to determine if Cory was AD/HD.

There were two Child Study meetings held during Cory's kindergarten year and a referral was made for a full evaluation for consideration of possible special education services. During that year, behavior modification techniques were employed by the teacher; a calendar was kept and a sticker was placed on every day for good self-control. Several parent/teacher conferences were documented in the files during that year. Some of the issues discussed in October, 1994 were concerns of Cory's high level of anxiety, initiating and completing work, inability to follow directions, and efforts to increase self-control. The November conference noted concerns over possible allergies and attention to task. The pediatrician initiated Ritalin on a trial basis and Cory was tested for possible allergies.

At this point, Mr. and Mrs. X. had consulted a clinical psychologist to work with Cory. He recommended a full psychological evaluation as well as a neurological exam. He also worked with Mr. and Mrs. X. on parenting skills and they instituted the 123 Magic techniques for discipline issues with Cory.

After a full evaluation, electroencephalogram, neurological, and developmental testing, Cory was diagnosed as having Asperger's Syndrome and considered by the Eligibility Committee at the end of his kindergarten year. According to the eligibility report, Cory was found ineligible for special education services because he was on or

above grade level in all academic areas. Mrs. X. confirmed this finding in the interview and said Cory was referred to the 504 Committee and put on a 504 Plan because he still needed accommodations made in order to be mainstreamed for his first grade year. Section 504 of the Rehabilitation Act of 1973 is a civil rights law to prohibit discrimination on the basis of disability in programs and activities, public and private, (including education) that receive federal financial assistance. Hampton Public Schools elected to serve Cory under this law rather than IDEA.

In first grade, Cory participated in Project LEAP (Learning Experiences Assessing Potential), a program that provides differentiated learning experiences for primary children in a program of activities designed to assess higher-level thinking skills. The learning experiences are designed to be prescriptive in nature, providing a means of collecting consistent work samples to be used in evaluating a child's ability.

According to the clinical psychologist's report, the WISC III; WIAT; Achenbach Behavior Checklists; CAT; HTP; and Diagnostic Play Interview provided the data base for the results of the psychological testing. Cory's performance on the WISC III resulted in the following profile of scores:

<u>VERBAL SUBTESTS</u>		<u>PERFORMANCE SUBTESTS</u>	
Information	8	Picture Completion	10
Similarities	11	Coding	9
Arithmetic	10	Picture Arrangement	10
Vocabulary	9	Block Design	19
Comprehension	8	Object Assembly	13
Verbal IQ:	95	Performance IQ:	115
		Full Scale IQ:	105

These results revealed average verbal skills, above average nonverbal skills and a composite measure of intelligence in the average range.

Results of the Slosson Intelligence Test-Revised administered by the Hampton Public Schools resulted in a score that was in the Average range as well.

Average scores were noted on the WIAT, an achievement test that correlates with the WISC III.

Following are the standard scores reported:

Basic Reading	102
Reading Comprehension	94
Listening Comprehension	83
Math Reasoning	102
Numerical Operations	96
Oral Expression	91

These results are reported in standard scores (mean = 100) and reflect average scores in achievement with the exception of Listening Comprehension which is slightly below average and is the subtest most sensitive to social context and cues.

Results of the WRAT-R grade equivalent scores were based on Cory being a repeating first grader:

Reading Recognition	Beginning first grade
Arithmetic	Middle first grade

All of the achievement scores were considered consistent with the IQ score, but according to the clinical psychologist's report, probably show some interference from distractibility.

The clinical psychologist indicated in his report that Cory was "not seriously emotionally disturbed, psychotic or autistic." He did, however, exhibit an "intermittent, but pronounced-when-it-happens, loose association or very idiosyncratic response." He acknowledged that this could be attributed to creativity, but if that was so, it was poorly formed, articulated or socially appropriate. He described Cory's behaviors as "coming out of nowhere with an odd perception or a mixed up phrase." He further conjectured that the sometimes "odd communications arose in reference to a social situation, cognitive distraction and impulsivity; and interference with conventional learning due to oversensitivity and excess stimulation." He described a coping style that, when stressed, results in aggressiveness, inaccessibility and social rigidity.

The Woodcock Johnson Psycho-Educational Battery-Revised, Part Two: Tests of Achievement was administered by the Hampton school system and all scores fell in the average range for grade and age:

SUBJECT	GRADE	AGE	STANDARD SCORES	
			GRADE	AGE
Reading	1.1	6-3	107	89
Math	1.2	6-6	109	93
WrittenLanguage	1.1	6-4	106	92
Knowledge	1.5	6-9	109	100

The sociological evaluation conducted by Hampton Public schools included much of the information already reported. In addition, reference was made to Mr. X.'s youngest brother who has had a lot of social and impulsive behavior problems over the years. The social worker also reported that Mr. X. said Cory was a lot like he was as a child.

Pre-Intervention History

The researcher conducted an observation before the study was initiated. This observation lasted for one hour. During both settings, a work session at various stations in the room and on the playground, Cory did not stand out as significantly different from the other first graders. He was on-task, was socially appropriate while working at a learning station with other students, and complied with the teacher's requests. However, he was on his prescribed medication.

During the first weeks of school, the teacher and mother had held conferences by phone and in person (Mrs. X. volunteered at the school regularly) and had concluded that in order for Cory to perform optimally, his medication needed to be increased. Mrs. X. had inquired about the light/sound machine and wanted to try it with Cory. Therefore, she checked with their neurologist and the research was initiated to try to deal with some of the Cory's symptoms and avoid an increase in medication.

Review of school records, parent conference reports, interviews with both the teacher and principal have been incorporated in the pre-treatment baseline data. Records from the kindergarten teacher list some of the following behaviors as being problematic and chronic: restless, fidgets, squirms; has short attention span; talks a lot; makes constant comments; can't wait for his turn to speak; demands must be met immediately; gets angry if his comment can't be heard; unpredictable behavior; overly sensitive to criticism; overly concerned with sense of right and wrong; distractible; makes inappropriate noises

frequently; denies mistakes and blames others (the guidance counselor later confirmed this in her comments about Cory "not owning" his behavior); easily frustrated with certain tasks; needs constant reminders to initiate, follow through and finish tasks; can't concentrate in a group; physical; prone to hit; difficulty with transitions; runs, jumps, yells; fluttering eyes, banging table; turning shirt sleeves around; touching classmates hair; overly concerned about place in line; throwing work papers; jumping up and down on stuffed animals; and very rough behavior. She concludes her remarks by stating that Cory has so much potential and brain power and is very artistic, but she felt there was something getting in the way of his successful performance.

The items addressed on the Home and School versions of the ADDES completed by his first grade teacher and his mother served as the official baseline data. These items included: Does not listen to what other students are saying; Requires eye contact in order to listen successfully (one to one situation); Does not listen to or follow verbal directions; Is disorganized to the point of not having necessary materials, losing materials, being unable to find completed assignments, being unable to follow the steps of the assignment in order, etc.; Blurts out answers without being called on; Bothers other students who are trying to work, listen, etc.; Talks beyond what is expected or at inappropriate times; and Demonstrates inappropriate behavior when moving with a group (e.g., fails to stay in line, runs, pushes, etc.).

On the Home scale, the behavior items that were targeted as occurring most frequently were: Does not listen to what others are saying; Is unsuccessful in activities requiring listening (e.g., games, following oral directions, etc.); Has difficulty concentrating (e.g., staying on task, following a conversation; Is impulsive (e.g., begins talking while others are talking, pulls on parents while they are talking to others, etc.); Is easily frustrated

(e. g., gives up easily, does not put forth his/her best effort, etc.); and Runs in the house, will not sit appropriately on the furniture, yells, etc.

Light/Sound Technology Research Results

During Fall semester of the 1995-96 year, the research was conducted and replicated at school in the Spring before the close of school. His first grade teacher noticed a "significant improvement" when he was on the technology the first six weeks but the results were not as dramatic the second series, which is not unexpected due to the gain factor. She said she felt many of Cory's problems were primarily related to being socially immature.

When the researcher met with the parent in the Fall, 1995, Mrs. X. was going to request an increase in Cory's medication in order to help him focus and complete his work. The investigator subsequently met with Cory, the parent, principal and teacher, in the Principal's office. After discussion and demonstration, the technology was placed on Cory. He immediately became very calm and quiet. This was after school, which according to his mother, is a time that was usually very difficult for Cory to become focused enough to do his homework. The meeting lasted about 30 minutes and Cory was asked at least three times if he wanted to take the technology off. Each time he shook his head "No" and was virtually oblivious to the conversation that the others in the room were having with the investigator. Finally, after about 20 minutes, the researcher took the technology off Cory and asked him how he felt. He replied, "Good, I like that."

A protocol of use of the technology was set up to reflect the mandates proscribed by the Human Subjects Committee and the approved proposal. Thus, for the baseline data, an initial evaluation on the ADDES, both Home and School versions, were completed. Then, the machine was used for two weeks twice per day; at the end of that period, an

evaluation with the ADDES was collected. Then, the subject was off the machine for two weeks and another evaluation was collected. Another two weeks on the technology was initiated and an evaluation at the end on the ADDES. Finally, there were two weeks without the machine with a final evaluation.

The light/sound machine was administered to the subject by the teacher and/or parent in the classroom and by the parent in the home during the initial study. For the replication study, Cory went to the nurse's office and she administered the technology.

In addition to the ADDES evaluations, anecdotal records were kept and brief interviews with the teacher and parent were frequent.

Of the total days on the machine (usually twice per day), all but three resulted in a positive change (according to the anecdotal remarks) of behavior after Cory used the machine. Following is the anecdotal documentation of immediate behavior changes during the two treatment periods of the technology:

First Treatment Intervention Anecdotal Records

Date	Time	Behavior (before and after)	Comments
9/25/95	7:30A	Loud and running around before; calm afterwards; seemed relaxed during:	Seems to enjoy this event
	11:15A	eating lunch before; calm after and during.	Teacher said he had a Great!! day
9/26/95	7:30A	same as above	Another good day at school
	11:10A	same as above	
9/27/95	7:30A	Antsy before: Almost fell asleep during; calm after:	Three days of good behavior at school. This is a 1st.
	11:10A	Same as above	
9/28/95	7:30A	Loud, antsy before: singing during: calm after	Another good day at school. ☺ (smiley face drawn)
	11:10A	Same as above	

First Treatment Intervention Anecdotal Records Cont.

Date	Time	Behavior (before and after)	Comments
9/29/95	7:30A	Noisy. jumping around before: humming during: settled down after	Had a good morning at school. Teacher says She's "impressed with the results."
9/29/95	11:10A	Lunchroom - hiding under table. fidgeting during (wouldn't sit still) Outside recess - happy	Staying on task a lot more often
9/30/95	8:20A	Jumping around room Loud and can't sit still (even to watch cartoons!) Singing and Humming during	Still a little wound up. but not as much as before.
10/1/95	8:30A	Jumping around room. before: Making loud noises Tapping boots together loudly and Singing during	After sat and watching cartoons
10/2/95	7:45A	Very cooperative (new chart for behavior) Talking during	Sat and watched TV after
10/2/95	11:10A	Eating lunch before Talking and wanted to sit up during Recess after	Good day at school
10/3/95	7:30A	Not as active as usual Humming and singing during	No notation
10/3/95	11:15A	Eating lunch before Quiet during and after Talking in class	Talkative at school today
10/4/95	7:30A	Couldn't sit still before Wanted to lay down on floor during	Still a little antsy after
10/4/95	11:10A	Eating lunch (trying to hide from mom) Quiet during Recess after	Good day at school
10/5/95	7:30A	Impatient and fussy before Talked during Anxious after	
10/5/95		Class Field Trip - Va. Living Museum Did not use machine	Very active and excited before, during and after class trip

End of first two-week treatment intervention.

Second Treatment Intervention Anecdotal Records

Date	Time	Behavior (before and after)	Comments
10/6/95	7:30A	Good behavior before Hummed during	Watched TV after
10/21/95	8:45A	Noisy and hyper before Didn't want to use machine Said OK after I said OK	Still noisy but not as hyper

Second Treatment Intervention Anecdotal Records Cont.

Date	Time	Behavior (before and after)	Comments
10/22/95	1:00P	Tired and irritable before Laid down on floor during Sat and colored for <u>1</u> solid hour after!	Church in the morning (unable to use machine until 1 PM.)
10/23/95	7:30A 11:30A	Loud and jumping around room Shaking feet and loud singing during Eating lunch/didn't want to do it. Talked him into it - Recess after	Calmer after. Great day at school Seems to be getting annoyed with this.
10/24/95	7:30A 11:30A	Calm and getting ready for school. Laid down to do, but didn't want ear phones. Same as above.	No notation.
10/25/95	7:30A 11:30A	Quiet and cooperative before, during and after Better afternoon - same as above	Didn't have trouble using machine
10/26/95	7:30A 11:30A	A little fussy but cooperative before, during and after. Playing during lunch	In a good mood before, during, and after.
10/27/95	7:30A 11:30A	Good morning (very cooperative before, during and after. Same as above.	Had a good week. Earned stickers for every day!
10/28/95	8:00A 3:00A	Very noisy, jumping around room before; Didn't want ear phones again Same as above but more cooperative.	Went fishing after.
10/29/95	1:00P	Tired and couldn't sit still before. Laid down and was quiet during.	Watched TV and played games (good mood) afterwards.
10/30/95	7:30A 11:10A	Noisy and hyper before Lunch before/didn't want earphones	Talking too much in school.
10/31/95	7:30A 11:00A	Excited about Holiday; couldn't settle down. Fidgeting during and after. Same as above.	Good day today in school.
11/1/95	7:30A 11:00A	Ate breakfast and was very unruly before; Sat in chair during Eating lunch before/ wore earphones but kept wanting them off before finished.	He does not enjoy getting on the machine much anymore, but I talked him into it. Told him it was his last week. He can't state why, but I believe it was the same thing as with his medicine. In the beginning he kept saying, "I can be good without it (meaning the medicine). He started saying the same thing about the machine.
11/2/95	7:30A 11:00A	A little better this morning than yesterday; won't get ready unless I'm constantly at him. Refused to use machine today. Same as yesterday.	

Second Treatment Intervention Anecdotal Records Cont.

Date	Time	Behavior (before and after)	Comments
11/3/95	7:30A 11:10A	Didn't want to use. Same as yesterday.	
11/4/95	7:30A 11:05A	Didn't want to use. Better this afternoon.	Teacher is pleased with his performance. Stays on task and completes work on his own.

A summary of the anecdotal records include such descriptors as: loud/noisy, antsy, running/jumping around, irritable, can't sit still (even to watch cartoons), followed by: calm after, settled down, happy, three days of good behavior at school ("This is a first!"), quiet, not as hyper, colored for one solid hour after, watched TV, good mood, good week, (earned stickers every day), "Teacher is pleased with his performance. Stays on task and completes work on his own." The only negative comments were that Cory was more talkative, which may or may not be considered negative.

The investigator conducted a follow-up interview and checklist with the teacher after two months. The results of this checklist is found after the school version of the original study. The effects of the technology were not permanent as indicated by the checklist scores. The teacher reported Cory had regressed to initial baseline and she was planning to call the parents. She said there was a "dramatically positive difference" when he was on the machine and she wished the parents would continue to use it. She felt it was a better choice than increasing his medication.

Following is the table of the scores for Cory.

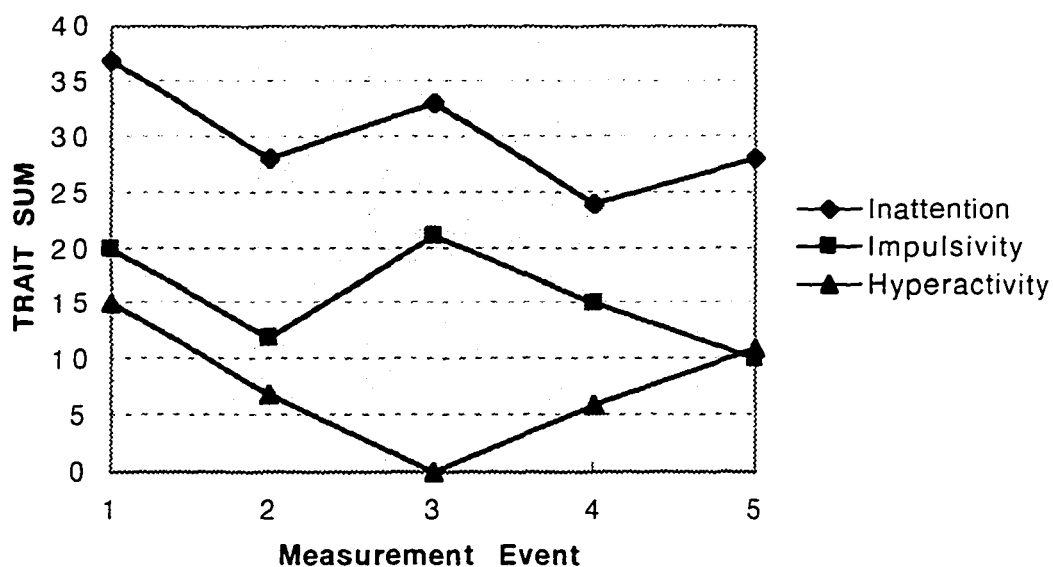
Table 1.1
School Version

Design Phases	Inattention	Impulsivity	Hyperactivity
Baseline	37	20	15
After 1st Two Weeks	28	12	7
After 2 Weeks Off	33	21	0
After 2nd Treatment	24	15	6
After 2 Weeks Off	28	10	11
After 2 Months	38	17	14

These results are graphically represented in the following figure.

Figure 1.1

SCHOOL TREATMENT RESULTS
SUBJECT NO. 1



The results of the net effect of applying the treatment to the subject are presented graphically in Figure 1.1(a). School Version; Figure 1.2(a); Home Version; Figure 1.3(a); Replication. It is assumed each trait within each category has equal weight. Likewise, each level of grading scores within each trait also has equal weight. Therefore, the net effect (positive/negative) depicted is defined as the difference between the sum of the trait scores measured after each interval (treatment/non-treatment) and the sum of the baseline trait scores. Since the number of traits were different for each category, the results were reduced to percentage values. In equation form this becomes:

$$\text{Gain, \%} = (\text{Sum of baseline scores} - \text{Sum of interval scores} / \text{Sum of baseline scores} \times 100.$$

The following figure represents the net effect of gain (positive/negative) expressed in percent.

Figure 1.1 (a)

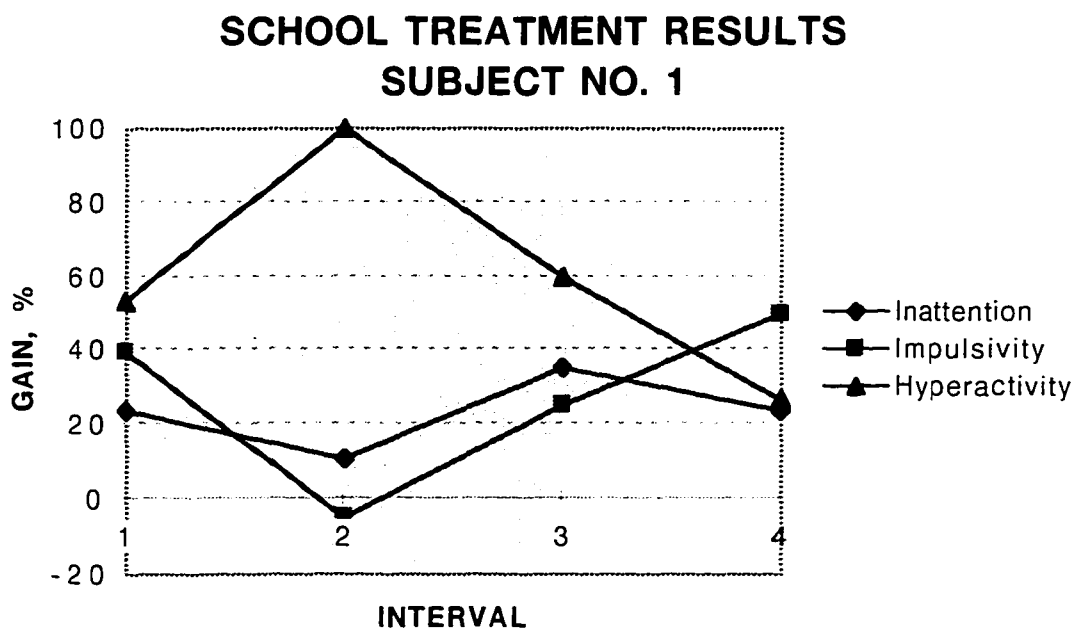


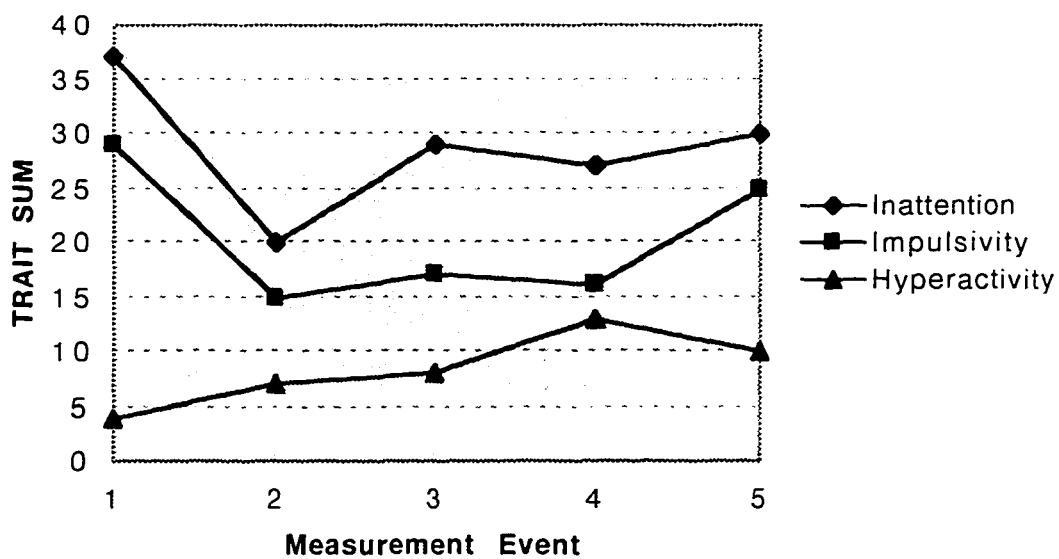
Table 1.2
Home Version

Design Phases	Inattention	Impulsivity	Hyperactivity
Baseline	37	29	4
After 1st Two Weeks	20	16	7
After 2 Weeks Off	29	17	8
After 2nd Treatment	28	16	13
After 2 Weeks Off	30	25	10

These results are graphically represented in the following figure.

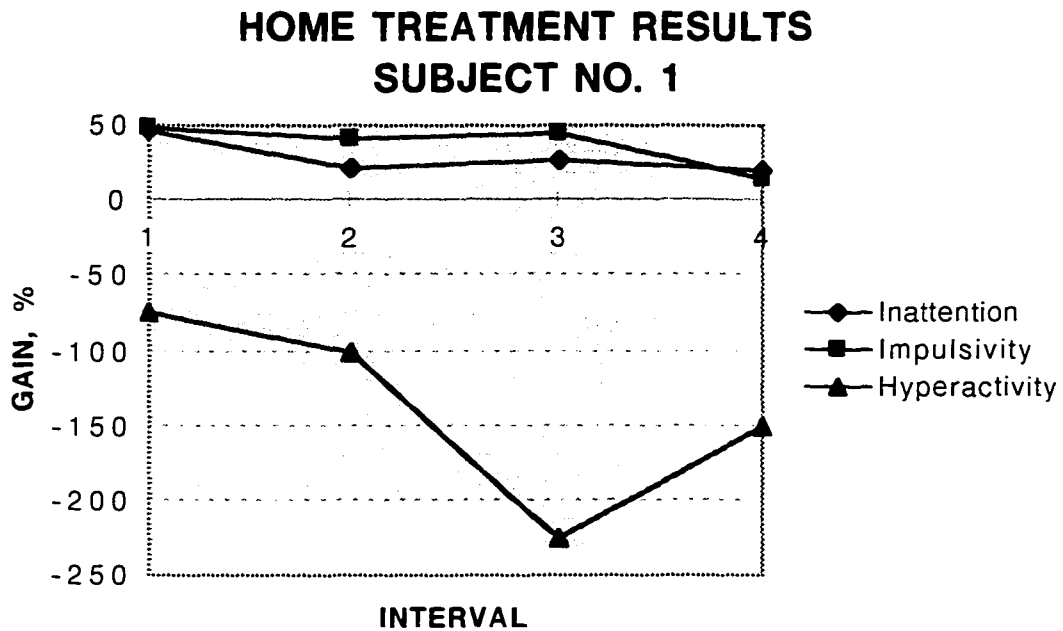
Figure 1.2

HOME TREATMENT RESULTS
SUBJECT NO. 1



The following figure represents the net effect of gain in percent.

Figure 1.2 (a)



After another three months, the researcher requested the teacher to replicate the study at the end of the school year. Cory wore the technology only once per day and went to the nurse's office to have it administered. No anecdotal records were kept. The time periods were half the original since there was only one month of school left.

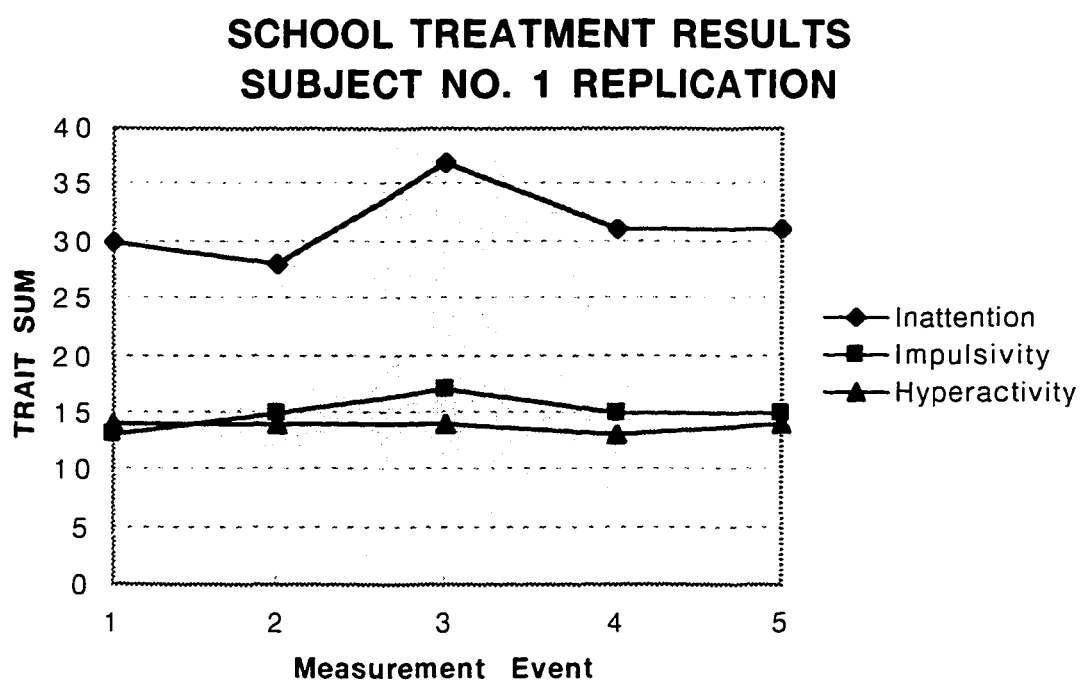
A table of the scores of the replication study follows.

Table 1.3
School Replication

Design Phases	Inattention	Impulsivity	Hyperactivity
Baseline	30	13	14
After 1st Week	28	15	14
After One Week Off	37	17	14
After 2nd Treatment	31	15	13
After One Week Off	31	15	14

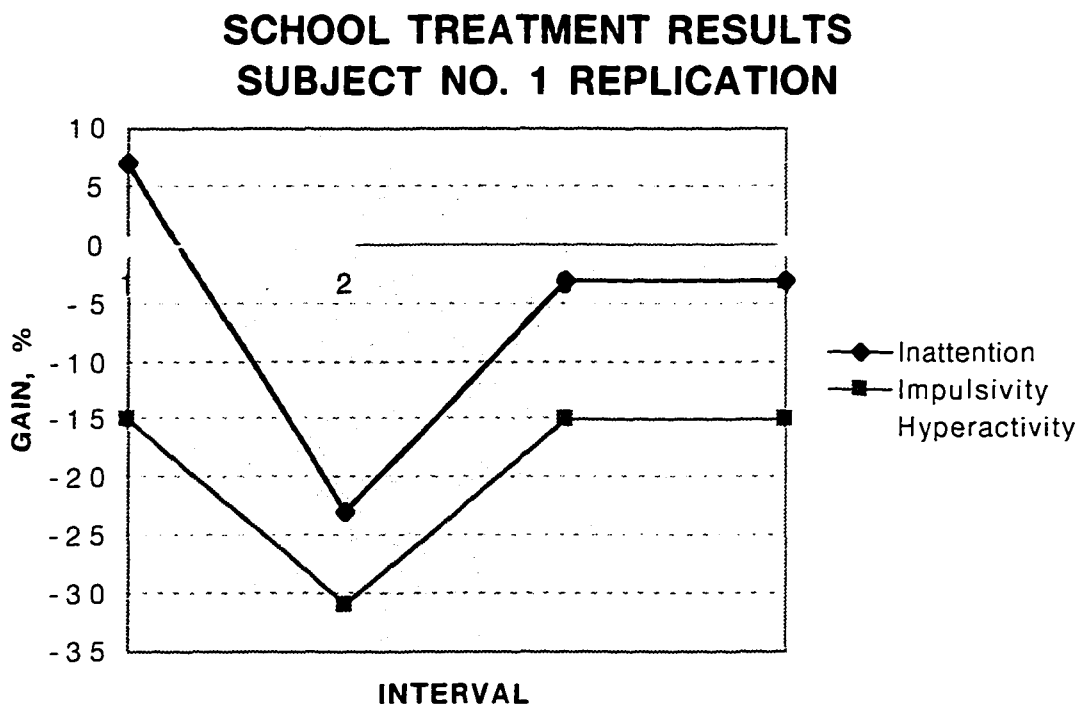
These results are graphically represented in the following figure.

Figure 1.3



The following figure represents the net effect of gain expressed in percent.

Figure 1.3 (a)



Although the results were not as dramatic as before, one important reason could be due to a “gain factor” in that one could assume the starting level of behaviors to be lower due to improvement from the initial intervention and not as much gain is expected to be made in a second application of an intervention. In addition, the technology was only used for half the time and only once per day instead of the twice per day in the original research.

A third factor was the end of the school year is difficult even for normal children.

Post-Treatment Data

An interview was held with the teacher after this replication. She felt that Cory was “definitely helped” in that he was pretty stable during a time when most of the students

were operating at a high level of activity and anticipating the upcoming end of the school year.

Two parent/teacher conference sheets were in the cumulative file and are of note. The first was held in November during the course of the research. The teacher notes Cory had adjusted well to first grade, works hard and does a neat job. She continues that he is a good reader and does well in writing. She reported his listening skills had improved but he still talked out inappropriately at times, but felt that too was improving.

In contrast, the teacher made the following comments on the conference report dated February 28th: "I have seen a decline in the quality of Cory's work since the beginning of the school year. He often rushes through assignments, turns in sloppy and incomplete work." She wrote she felt Cory was capable of so much more and wanted to see him work up to his potential. At this point, the researcher had contacted the teacher for a follow-up report and evaluation on the ADDES. The teacher reported she had observed a "significant difference" when Cory was using the technology and wished the parents would initiate its use again.

During the Fall semester of 1996-97 school year, the researcher conducted follow-up interviews and observations concerning Cory and his present placement. A brief interview was conducted with the elementary guidance counselor concerning Cory. According to the guidance counselor, Cory participated in several groups dealing with his difficulty relating socially during his first grade year. She reported that Cory was reactive and didn't want to take responsibility for his behavior. She has only seen him once this school year and she feels he is much better adjusted.

Another post-treatment observation was made of Cory by the researcher in his second grade classroom. His mother feels this classroom is a good situation for Cory since the teacher has a more structured approach than the previous teachers.

When the researcher entered the room, Cory was standing up at the end of a table of five children. His seat was at the end of the table, giving the impression of being added on. No other table had children sitting at the end. The teacher was questioning Cory about what the directions had been and what he was supposed to be doing (they were drawing body parts; specifically, ears). He quickly drew the ear and then stood up to get his lunch box which he hit with his fist. He was questioned by another child at the table and replied, "I'm pretty good at it" and proceeded to draw the other student's picture of an ear. The teacher stopped him and he showed her his drawing. The class then prepared for lunch, washed up, and each child selected a book to take to the lunchroom. When Cory went for a book, he walked past the researcher and asked if she had worked with his brother. When he was told no, he asked the observer if she was Mrs. White and was again told no. Cory waited for the end of the line (his mother says he is always at the front or end) but ended up in the middle and promptly reported that he had been hit by the girl in front of him. The teacher corrected the girl and Cory said, "She is doing it again!" The teacher moved the girl to the back of the line. The researcher did not observe the girl hitting Cory and the girl seemed very upset that she had been accused. Cory, on the other hand, seemed very pleased he had gotten her in trouble as evidenced by the expression on his face (satisfied smile).

On the way to lunch, a number of the children took a referral form out of a box on a table in the hallway. Cory also took one. During the lunch period, Cory tried to fill the form out but obviously did not know what it said. At one point he jumped up (without

permission) and ran into the hall to obtain another one. The rest of the period he seemed to interact appropriately, raising his hand for a straw from the attendant and talking to the girl next to him. Cory ate all of his sandwich and the other items in his lunch sequentially, without mixing any of them. He drank most of his juice and threw the straw across the table into the trash can when it did not work in his thermos. He yelled at another student in line.

Cory's current teacher reported he will listen but needs redirection often. She still observes problems with his social behavior, in particular, aggressiveness. She reports he is "on task" most of the time. The observation lasted a total of one and one-half hours.

The Principal was interviewed again in September, 1996 and said she and the parents had met and decided to try Cory without any 504 Plan accommodation this year. She felt they should try treating him as a "normal kid" and could reinstate the 504 plan as necessary but she stated, "Why not go for it?" There were notes of encouragement and praise (Fantastic, Cory!) from the Principal in Cory's cumulative file.

Summary

Cory's behaviors appeared to be positively effected by the light/sound technology. Since the behaviors decreased during the treatment phases, if the technology had been worn for a longer period of time with more frequent sessions, the results might have been more positive. Drs. Russell and Carter's (1994, 1995) findings in studies with learning disabled students cite a positive correlation between benefits with frequency and duration of use of the technology.

Mrs. X. was not interested in continuing the use of the machine because she said Cory had lost interest in it and did not want to wear it anymore. She said it was no longer a

novelty to him. He is the same way about his medication and asks to stop taking it from time to time, which the parents allow as long as he can maintain his behavior.

Case Report Number Two

Background

Case number two is a five-year-old, herein referred to as Carl. At the time of the initial study, Carl was mainstreamed in a kindergarten classroom at SECEP, a regional program that serves children and youth with serious emotional disturbance and autism. The researcher has followed Carl for a year and he currently has three classroom placements at school.

Document analysis was conducted at both home and school. The records were very complete and ranged from an initial referral in Michigan when Carl was two years old. The following documents, and their interpretation when applicable, are included in this case study: Birth to Three Developmental Inventory; Speech and Hearing Clinic Audiological Summary (Oakland Schools); Clarkston Community Schools Occupational Therapy Evaluation; Speech and Language evaluation (Clarkston schools); Neurological Consultation (pediatric neurologist) and subsequent follow-up reports spanning three years: EEG report; Fragile X report; Metabolic Laboratory Report; various lab reports from Children's Hospital of the King's Daughters and Sentara; reports of a Speech-Language Evaluation, Psychoeducational Profile-Revised, and a Psychological Evaluation by SECEP; independent Speech and Language Assessment (speech/language therapist); urinalysis report; Radiologists report; Hair Multi-element Analysis Report; and EKG report.

Both Carl and his younger brother are adopted (they do not share the same biological mother). Both adopted parents were interviewed; the researcher spoke with the

father, Dr. Y., on the phone and the background history was given by the mother, Mrs. Y., in an interview conducted at their home.

Dr. Y. is an Obstetrician/Gynecologist who currently practices in Virginia Beach, Virginia. He was a resident in the hospital in Michigan where Carl was born. They had met the birth mother and were there when she went into labor, etc. Dr. Y. requested drug testing and the birth mother tested positive for cocaine during the fifth month of pregnancy. The test was repeated during delivery and the results for both the mother and Carl were negative for cocaine. The biological mother was a heavy smoker and anemic during the pregnancy which could have caused intrauterine retardation, according to Mrs. Y. The baby was delivered by repeat caesarean section when the mother was 27 years old. The biological mother had previously given birth to two female children and their development was described by her as "advanced." None of the children had the same father. The birth mother also suffered an infection, pylo-nephritis (kidney), during the pregnancy for which she was treated with antibiotics. The biological father is AD/HD and there is a history of milk allergies and asthma in the mother's family. Mrs. Y., the adoptive mother, is a registered nurse and was at the hospital for Carl's delivery. She reported his APGAR scores as eight and nine respectively. She was allowed to feed and bathe him in the hospital. Carl weighed 6 lbs. 6 1/2 oz. and was 20 inches long at birth. Mrs. Y. reported Carl was very hungry and gained three pounds in three weeks. She said, "He grew like wildfire!" He always maintained steady gains in weight and height, and is currently in the 95th percentile for height and 50th percentile for weight.

When asked about Carl's temperament as a baby, Mrs. Y. said he was easy going, happy, and affectionate. While they were in Michigan, he would give eye contact and flirt when she took him shopping; however, these behaviors ceased when he was around 15

months old. She described him as "somewhat colicky" as a baby, but she gave him Mylecon (an over-the-counter medication for relief of gas) that helped with the symptoms. Mrs. Y. said he would spend a lot of time in the swing, and in reflection, her first hint at a possible problem was that he would start to scream for no reason. She did not want to spoil him so she did not try to soothe him after checking on obvious reasons for his crying (hunger, wet diaper, etc.). Mrs. Y. reported Carl took two long naps a day. She said he always had loose stools which she questioned the doctor about but he was not alarmed. She said Carl could not have apple juice because it made conditions much worse.

At about eight months old, Mrs. Y. noticed that when Carl was in his high chair, he would grimace and tighten all his muscles ("almost seizure-like"). She described it as being like he was in a "rage" and he would "blow up" for a few seconds and then calm down. She reported an incident on a family vacation to Windsor, Canada, when Carl was about 14 months old. He was up late and woke up screaming during the night. She described him as not being awake or asleep, but he was inconsolable. She called the incident the beginning of "night terrors," which at the time they "blew off," but he continued to experience them.

When Carl was around two years old, he became a real behavior problem. He was not talking like other kids and wouldn't interact with others in his play group. He would cover his ears and scream. On his second birthday he sang "Happy Birthday" but hated his third birthday that was held at Chucky Cheese. She felt it was due to the noise factor. Mrs. Y. reported he would not sing or look at anyone directly. He could not ask for cookies according to Mrs. Y. and would instead throw himself on the floor and have a "major temper tantrum." She reported that Carl was very "bonded with his father" and they still have a good relationship. "Carl adores his father," she said.

When Carl was about two and a half years old, Dr. and Mrs. Y. adopted another male child. Mrs. Y. said Carl never seemed to openly resent the new baby. The family moved to Virginia when Carl was three years, two months old.

Developmental Milestones

Carl began to sit up at about six months of age. He could not sustain the position and would gradually slip over, according to his mother. At nine months of age, Carl began walking with the aid of a baby walker, and two weeks later, he began to crawl. He began walking independently around 12 months and started running at the same time. Mrs. Y. describes him as being "klutzy" in that he continually banged and bruised himself.

Mrs. Y. described Carl as a good eater until he was about two years old. At that point, he stopped drinking milk and eating vegetables. The only things he would eat were macaroni and cheese and oatmeal. He did not like soup because he did not want anything mixed. She said his fine motor skills were poor for his age and he couldn't hold utensils. She reported an aversion to visual/auditory stimuli and exhibited the behaviors she knew to be similar to other children with cocaine exposure (she did not elaborate on what they were).

Toilet training was described as "a horror story" by Mrs. Y. Carl continued to have loose stools (about seven per day) but before the move from Michigan, he could urinate on the toilet. Then they adopted the second child, and Carl started resisting toileting activities, totally refusing to the point of hiding the toilet seat. All efforts at toilet training ceased at that juncture.

After their move to Virginia, the parents waited until Carl was about four years old and was involved in Lovaas sessions before they initiated toilet training again. They would sit in the bathroom with him during the training session. Some progress was reported but

he continued to throw tantrums and would arbitrarily "urinate on the kitchen floor." He would have to be restrained during Lovaas therapy, because according to Mrs. Y., "He became frustrated and couldn't deal with it." In the Spring of 1995, Carl was potty trained for a few weeks and could hold his urine for up to three hours. He would still scream and have temper tantrums on the toilet. It was noted in the neurologist's report that one of Carl's favorite videos was the one on toilet training which he would preferentially get out and watch. During that summer, 1995, he was still having trouble with bowel movements but he was urine trained. This condition persisted throughout the Fall, 1995 and Mrs. Y. gave the example of Carl going to the bathroom and getting some "pull-ups," then going back to the computer and having a bowel movement. At Halloween time that year he became interested in Darth Vader and by the middle of November when he was five and one half, he was fully trained and had control of his bowels. During this time period, efforts were also reinforced in his kindergarten class.

Language development was considered normal by the parents until about the age of 13 months. He said "Mama" and "Dada" at the appropriate time but further language development by Carl was described as atypical. Mrs. Y. had already noticed that Carl was not talking like other kids and she reported he started to stutter.

Mrs. Y. had Carl's hearing tested and a speech/language evaluation was conducted at two and one half that revealed a significant delay in those skills. He had about a 13-15 word vocabulary and scored between nine and fifteen months. He would say, "Oh, no" and "Oh, oh." He relied on babbling, pointing, grunting or screaming to let others know his wants and desires. At that time, Carl did not evidence echolalia; however, echolalic episodes and phases developed later.

Mrs. Y. reported that at two and one half, Carl attended a pre-school Kindercare for three mornings a week in Michigan but refused to interact with the other children. He screamed for the entire time and would go to the adults for comfort. He wanted to be held and it was reported he was extremely anxious and nervous. He would hold his hands over his ears and cry during group time or music if it was loud.

Carl was described as a light sleeper who often woke at night without clear explanation. Night terrors and an inability to be consoled further complicated these sleep patterns.

Medical Factors

Carl experienced one ear infection around eighteen months of age but it was not treated with antibiotics. Loose stools were a constant problem and were not diagnosed until he was five years old. At that point, he was tested for allergies and found to have a gluten and casein intolerance.

Mrs. Y. reported that Carl was assessed by a pediatrician in Michigan who was a developmental specialist. He gave a specific description of Carl that fit the criteria of autism. However, when they moved to Virginia, they had an evaluation by a pediatric neurologist with the Child and Adolescent Neurology practice. The pediatric neurologist's first evaluation was when Carl was three years, three months old and was the result of a referral by his father for significant language and behavior problems. At that time, the neurologist reported a severe language disorder affecting expressive more than receptive skills as well as substantial behavioral issues. The doctor said he preferred to refrain from using more comprehensive labels until follow-up observations were completed. He recommended the SECEP program as being the most appropriate placement for Carl because of its emphasis on language development and behavior modification.

In Michigan. Dexedrine (2.5 mg) had been prescribed for Carl's hyperactivity in his pre-school program. The neurologist continued this dosage and added Imipramine in an effort to decrease Carl's impulsiveness and help stabilize some of his sleep patterns. He planned to increase the drug to 10 mg BID in subsequent weeks. The pediatric neurologist's report indicated Carl was a candidate for a more comprehensive neurometabolic investigation to include fragile-X determination, metabolic screening of the urine, and an EEG.

Physically, the neurologist's placed Carl's height at the 90th percentile and weight in the 85th percentile. His report included references to the following neurological components: Carl had a symmetrical calvarium without bruits, his eent exam was unremarkable and his neck was supple and without significant adenopathy. He reported Carl's chest was clear and the cardiovascular exam was normal. No abdominal organomegaly was noted and genitalia were normal. He reported Carl's back to be straight without congenital abnormalities and there was no evidence of neurocutaneous disease. The main problem on the neurological examination concerned Carl's behavior which was noted as "uncooperative" for the entire examination. This was evidenced by his continually fighting his father during the medical part of the exam and refusing to willingly participate in any of the neurological examination. The neurological report indicated most of the information was obtained through a history provided by the parents.

A subsequent letter of referral to a child psychiatrist by the neurologist reported sessions to that date. He described Carl's sleep and behavior problems as "monumental." In addition to increasing the Imipramine to 10 mg BID, he indicated Carl was a candidate for additional medications such as Mellaril. At the subsequent visit a month later, Clonidine was prescribed. The neurologist describes Carl's hyperactivity as being "out of

control." He reported a brief trial on Ritalin was ineffective but may be reintroduced at a later date. He said the EEG report was in the normal range and Fragile X testing did not confirm carrier status or diagnosis of that syndrome for Carl.

The neurologist reported an improvement in speech and sleep habits on a follow up visit in June, 1994. Spinning activity had lessened as had perservative behaviors. A physical examination indicated general medical and neurological factors to be unchanged. He reported, "Behavior in the office was very stressful with frequent periods of defiance."

The neurologist reported that socialization skills continued to be weak and that when Carl became upset, he would "scream incessantly." It seems to take "very little to trigger these periods of tantruming." The same report noted Carl broke his foot during the summer he was four, continued to be a very picky eater, and an increase in spinning had been observed which the parents were asked to discourage. The neurologist also described an elevated activity level, and frustration over the lack of effective communication skills. At this point, Carl was put on a Clonidine patch which was reported by the parents as not being effective. A visit one month later when Carl was four and one half revealed a head tic indicative of early dyskinesia. Since this condition is associated with the side effects of Imipramine, it was discontinued. Paxil, 10 mg q am was initiated. The neurologist still maintained his diagnosis of pervasive developmental delay with associated hyperactivity and extreme impulsivity. In addition, he enumerated other behavioral characteristics that Carl exhibited: an inability to handle transitions, poor social skills, obsessive compulsive behaviors and uncontrollable temper tantrums that included screaming and aggressiveness even with his father with whom he relates extremely well.

Mrs. Y. started giving Carl DMG in addition to Ritalin and Clonidine. The neurologist did not think the DMG was necessary since there was "no appropriate

scientific evidence that it was of any value to Carl's disorder." He prescribed a trial of Tenex for the hyperactivity but indicated Ritalin had been re-introduced and if the Tenex did not help, a higher dose of Ritalin would be given; Clonidine was continued. Carl had an Adenoidectomy in October, 1994 that appeared to help his sleep patterns according to the parents.

An MRI of the brain was performed in March, 1995. No intracranial abnormality was noted but mucomembranous thickening and sinus disease was noted.

The parents had hair analysis performed by Doctor's Data Laboratory in August, 1995. Results indicated Carl had an excess of copper. Dr. and Mrs. Y. arranged to have Chelation Therapy by a local physician who does not usually treat children. He accepted Carl's case "out of compassion" according to Mrs. Y. He participated in three cycles (one week on, one week off) of Cuprimine prescribed according to weight; the drug is considered experimental. The parents saw instant results. He spilled enormous amounts of copper and they suspected Carl might have Wilson's disease but this was checked and he does not have a copper storage problem. Carl started speaking much better and acting more appropriately. According to Mrs. Y. they also started chiropractic sessions at about the same time.

Correspondence from the pediatric neurologist dated December 13, 1995 is addressed to the family's doctor who is a general practitioner. The neurologist summarizes a long meeting with the family regarding the numerous issues that Carl's neurodevelopmental and behavioral problems have caused. He refers to the difficulty of working out a satisfactory pharmacological regimen and denotes a less than satisfactory label for the difficulties. He notes the parent's being uncomfortable with the PDD label and agrees. He was still considering the possibility of Landau-Kleffner syndrome but

thinks that is an unlikely diagnosis due to the normal EEG. He feels Carl has improved in his language and socialization skills since the initial office visit. He feels this improvement is due to the Lovaas program and notes the parents have been participating in almost every other activity that is available to them, therefore making it difficult to sort out which has had the most benefit. The pediatric neurologist notes Carl's continued "fidgetiness and hyperactivity" and has discussed strategies including SSRI's, Inderal, Wellbutrin, BuSpar, Lithium, neuroleptics, tricyclics, Clonidine and anticonvulsants. He planned at that time to increase the Ritalin to 10 mg TID and then later reducing it and adding Prozac; this was done according to the mother, but she said she has seen no significant results as a result of the Prozac which has been increased to between 4-8 mg. In addition, Carl currently takes Ritalin, Clonidine and Tenex.

There were numerous laboratory reports supporting the evaluations enumerated above in the file that covered a four year period.

The parents are currently pursuing a new treatment that has been pioneered by an immunologist who theorizes that autism is due to an immune system deficiency which is the reason the vast majority of these youngsters have yeast infections, chronic ear infections and many are not immunized to the diseases that they have received shots for as infants. Dr. Y. reported he recently discovered Carl has no immunity to tetanus even though his shot record was up to date.

A recent publication by the immunologist reports findings on a study of 20 children with hyperactivity. The results indicate 18 of them are no longer hyper and all have improved in eye contact and expressive language since the treatment he prescribed. Carl's father, Dr. Y., had just returned from a conference where he heard this physician discuss his results and is more convinced than ever this will help his son. The researcher attended

a parent's meeting where Dr. Y. shared the results with other parents of children with autism. The treatment consists of injections of immune globulins. The parents are trying to find someone in their area who will treat Carl.

Educational History

Carl began attending a pre-school class when he was two. He appeared to enjoy the activities but would not sit down for story time or music. He often would cover his ears and scream when he heard music if it was too loud.

Mrs. Y. referred Carl to the SPICE (she could not remember what the acronym stood for) program in 1992 when he was twenty-eight months old and they were still living in Michigan.

An evaluation was conducted with the Birth to Three Developmental Inventory (BTDI) and the following results reported:

SUBTEST	MONTHS
Language Comprehension	24
Language Expression	24
Motor	26
Problem Solving	28
Social/Personal	24

The examiner qualified these ratings by saying that the majority of the information contained in the evaluation was derived through parental information because Carl was "often non-compliant or not interested in many of the tasks presented." She felt that there were delays in his language development and his social interaction skills. She further noted that even though the BTDI indicated Carl's problem solving skills were within normal limits, based on her observations, there were some delays in that area also. It was also

reported that the inventory indicated a higher level of functioning in the areas of Language Comprehension and Expression than were indicated functionally in Carl's ability to use language in a socially meaningful manner. It was recommended that Carl be "included in a pre-primary impaired program as a severely language impaired candidate."

A speech/language evaluation was also done when Carl was 28 months that reported a receptive language age of 22 months and an expressive language age of 18 months which she indicated was more reflective of Carl's true language functioning level. In addition, delays were noted in adaptive behaviors, social development and attentional behaviors.

The Oakland Schools conducted an evaluation of Carl in January, 1993. Following are the tests and their results:

1. Speech and Hearing Clinic Audiological Summary

This assessment was requested to rule out hearing loss as a contributing factor to Carl's delayed speech and language development. At this point, Carl had been receiving weekly speech and language therapy as part of the Clarkston SPICE Pre-Primary Program. Carl did not adjust well to the sound room even though he was allowed to sit on his father's lap. Closing the door, the reinforcement lights and the auditory stimuli caused him what was described in the audiologist's report as great "discontentment" and he was not able to successfully acclimate to the environment. He screamed and cried (without tears) throughout the evaluation with short breaks when he engaged in play activities. Carl's responses were observed to various auditory stimuli. His responses consisted of eye movements, head turning toward speaker and covering his ears or saying "No" when he heard the sound delivered through the loudspeakers, even those presented at whisper levels.

Normal hearing sensitivity was observed and the report ruled out hearing loss as a contributing factor to Carl's speech and language delay. It further noted that covering his ears in the presence of auditory stimuli at home and school (a behavior reported by parents) may be due to his experiencing "an overload of sensory stimulation" according to the evaluator. The therapist reported that when the family was preparing to leave, Carl smiled and said, "Bye bye."

When Carl was 36 months old, the Clarkston Community Schools conducted an occupational therapy evaluation. The instrument used was the Peabody Developmental Motor Scales, a standardized test for individuals from birth to 83 months. Due to Carl's oppositional behaviors, the test could not be administered according to standards but results "give some idea of what Carl can motorically do with his hands." His raw score placed his performance in the first percentile with a fine motor age of 25 months. The following skill categories with point scores and percentiles were reported:

	Point Score	Percentile
Hand grasp	42	24
Hand use	48	2
Eye/hand coordination	54	4
Manual dexterity	10	2

A sensory motor history, supplied by the parents, revealed Carl dislikes having his hair or face washed. He prefers finger foods and is overly sensitive to sound, and becomes excited when confronted with a variety of visual stimuli. He had no interest in learning to dress himself. Final conclusions by the examiner suggest delayed fine-motor skills and concerns about sensory processing. A limited attention span and difficulty engaging in

typical preschool play were also noted. Occupational therapy was recommended for the next school year.

Carl was re-evaluated at the end of his first year in SPICE Pre-Primary School. The behavioral observations described Carl as enjoying school as evidenced by his eagerly entering the classroom each day. He appeared comfortable in familiar settings but displayed extreme discontent when the setting was varied in any way. He might "shriek, hold his hands over his ears and wiggle in a frantic manner." However, he would easily regain his composure once the setting was again familiar. He was evaluated on the Gesell Preschool Inventory on which he earned the following developmental ages:

Subtest	Developmental Age
Cubes	2 to 2 1/2
Copy Forms	Less than 2 years
Incomplete Man	Refused to attempt
Verbal Items	Unable to respond

In addition, The Early Learning Accomplishment Profile (Early LAP) was administered and resulted in the following profile:

Gross Motor	30 months
Fine Motor	Solid at 22 months, scatter above
Cognitive	Solid at 18 months, scatter above
Language	Solid at 15 months, scatter above
Self Help	30 Months
Social/Emotional	Solid at 16 months, scatter above

The report suggested that Carl was still exhibiting a significant delay in motor, social and language development; his behaviors were rated as "equal to or greater than 1/2

of his expected development for his chronological age.” The examiner concluded Carl continued to meet the criteria for programming as a Pre-Primary Impaired youngster. Speech/language therapy and a consistent behavior plan at home and school were recommended as well as occupational therapy with emphasis on sensory processing.

A speech and language evaluation was also repeated at the end of that school year utilizing the following sources of data:

The Rosetti Infant-Toddler Language Scale

Westby Symbolic Playscale

Informal Assessment Activities

On the Rosetti, the following profile was reported:

Interaction-Attachment	9-12 months (emerging)
Pragmatics	9-12 months
Gestures	12-15 months
Play	9-12 months
Language Comprehension	12-15 months
Language Expression	12-15 months

The examiner stated it was difficult to measure task acquisition due to the qualitative differences with which Carl approached each situation. She reports that Carl has a short attention span but when he was engaged in a favorite activity (computer), it was hard to redirect him.

Conclusions based on formal and informal assessments were that Carl’s receptive and expressive language skills were within the 12 to 15 month old range. He could identify some body parts and common objects, follow one-step directions and comprehend a few simple prepositions. On occasion he would model a single word and imitate some

simple gestures. His play skills were in the 9 to 12 month old range with some skills emerging in the 12 to 18 month old range.

The family moved to Virginia when Carl was three years, two months old. He was evaluated by a pediatric neurologist one month after they arrived. He was placed in the Malibu Elementary Pre-School Handicapped Program. The neurologist thought SECEP would be the best placement for Carl and the parents asked SECEP to evaluate him. They were told Carl was too high functioning but they made suggestions for his program. He started individual speech therapy with a private therapist.

When Carl was four years old the family began Lovaas language and behavioral training. The neurologist encouraged them in this effort. There were weekly meetings and about four hours of in-home training with various teachers.

SECEP initially evaluated Carl when he was four years, 11 months old. He entered their program on January 3, 1995 and was placed in the program for children with autism. He was attending the morning preschool class at Pembroke Elementary School. The Speech/Language Evaluation was conducted from February-April, 1995. At that time, Carl was receiving speech therapy three times per week. The following tests were administered in February:

1. The Preschool Language Scale:

Auditory Comprehension	3 years 5 months
Expressive Communication	3 years to 3 years 5 months

2. The Test of Early Language Development: It was reported Carl achieved an overall level of 3.5 years: he had difficulty processing questions, following directions and maintaining attending skills.

The additional testing completed in April, 1995 included:

3. The Receptive One-Word Picture Vocabulary Test: 3 years 2 months (4th percentile)
4. The Expressive One-Word Picture Vocabulary Test: 3 years, 7 months (12th percentile)

The Psychoeducational Profile-Revised (PEP-R) was administered as a part of the diagnostic component of his placement with SECEP in order to make suggestions for educational programming; additionally, the assessment will serve as one component of his preschool exit eligibility meeting. On this assessment the following levels were achieved:

Overall score	47-51 month level
Imitation	43-48 month level
Perception/Eye-Hand:	55-71 month level
Gross Motor	52-70 month level
Fine Motor	50-67 month level
Cognitive Functioning (performance)	41-43 month level
Cognitive Functioning (verbal)	49-50 month level

Carl was described as a 4 year 11 month old youngster with a history of language and learning delays who exhibits characteristics of PDD and mild autism including language and communication deficits, social deficits, and unusual sensory responses to his environment.

The psychological evaluation conducted by SECEP included the information gleaned from the psychoeducational evaluation. In addition, the following tests were administered:

The Leiter International Performance Scale (Leiter)

The Stanford-Binet Intelligence Scale: Fourth Edition (SB:FE)

The Developmental Test of Visual Motor Integration (VMI)

The Vineland Adaptive Behavior Scales-Interview Edition (Vineland)

The Leiter is a measure of nonverbal intelligence that is heavily weighted with items measuring visual concepts and relationships. Carl's performance on this test was in the average range of intellectual functioning. He received a mental age score of 4 years 9 months which translates into an IQ of 106.

On the SB:FE Carl's received a Test Composite Score of 69 indicating an overall cognitive functioning level within the borderline range. Subtest scores ranged from the borderline to low average levels of functioning. This test is more language based and therefore must be interpreted differently from the Leiter.

Perceptual motor integration skills were measured on the VMI. Carl's results indicate functioning at the 4 year, 3 month old level and this performance was considered a relative strength, possibly due to the visually arranged tasks.

The Vineland measured Carl's functioning within the home and community. The information was supplied by Carl's mother. The scores were:

Adaptive Behavior Composite Score	66	3 years 3 months
Communication Domain	82	3 years 9 months
Daily Living Skills Domain	61	2 years 7 months
Socialization Domain	84	3 years 8 months
Motor Skills Domain	61	3 years 1 months

The school psychologist summarized Carl's performance as being like that of a 4 year 11 month old male who is receiving services in a class for children with autism. She noted the discrepancy between the performance on the Leiter (average range) and the SB:FE (borderline) as being due to a delay in the ability to process information presented to him in a verbal format compared with his nonverbal skills. Perceptual motor integration

skills were at the 4 year 3 month level but his overall adaptive behavior is significantly delayed. The developmental delays Carl exhibits are characterized by a severe communication disorder and deficits in adaptive behavior as well as symptoms of AD/HD that include difficulties in attending to task and controlling his impulses. The report continues to note that Carl is easily distracted and very active for his age. He also displays ritualistic and perseverative patterns of play and interaction and has some sensory irregularities.

The last evaluation in the file was by a private speech/language therapist. Her very thorough report was eight pages, single spaced. The results of her evaluation are summarized in the following points:

1. Carl manifests a moderate to severe receptive and expressive language impairment as measured by the Preschool Language Scale-3.
2. The Bracken Basic Concept Scale revealed average performance on the School Readiness Composite, assessing knowledge of numbers, colors, letters, and shapes.
3. Language sample analysis yields a MLU (mean language unit) of 3.2, which places Carl's performance two standard deviations below peer expectations.
4. Carl uses a wide range of semantic relations and is beginning to develop the early expected bound and grammatical morphemes consistent with Brown's Stage II., beginning Stage III.
5. Pragmatic analysis indicates that Carl uses language for a wide variety of communicative functions but has deficits at the discourse level with conversational skills, topic maintenance, and production of narratives.
6. Speech is characterized by developmental articulation errors on affricates, fricatives, liquids and blends. Speech is approximately 70-75% intelligible. Short utterances are

generally intelligible but longer utterances are frequently partially or totally unintelligible. Unintelligible utterances are also common during self play.

Pre-Intervention History

The behaviors addressed in the items on the School and Home versions of the ADDES, completed by Carl's kindergarten teacher and his mother respectively, served as baseline data. The highest rated items on the school version were: Is easily distracted by other activities in the classroom, other students, the teacher, etc.; Does not listen to what other students are saying; Does not hear all of what is said (e.g., misses word endings, misses key words such as "do not," etc.); Does not remain on task (e.g., is more interested in other activities, sits and does nothing, etc.); Moves about while seated, fidgets, squirms, etc.); Will not wait his/her turn in activities or games; Appears restless (e.g., shifts position in seat, paces about, etc.); Engages in inappropriate behaviors while seated (e.g., tips chair or desk, puts feet on desk, touches others as they walk by, taps and makes noises, etc.); and Becomes overexcited (e.g., loses control in group activities, becomes loud, etc.).

On the home scale, the most frequently observed behaviors were: Is easily distracted by other things happening in the home (e.g., other children, TV, radio, etc.); Does not listen to what others are saying; Does not listen to or follow verbal directions; Has a short attention span (e.g., cannot sit still while a story is being read, cannot keep his/her attention on homework assignments, is easily distracted, etc.); Has difficulty concentrating (e.g., staying on task, following a conversation, etc.); Does not follow directions from parents or other home authority figures (e.g., refuses to do what he/she is told, goes on doing what he/she was doing, does the opposite of what he/she is told, etc.); Is impulsive (e.g., reacts immediately to situations without thinking, is impatient, is unable to wait for a turn or for assistance, etc.); Is easily frustrated (e.g., gives up easily, does not

put forth his/her best effort, etc.); Has accidents which are the result of impulsive or careless behavior; Moves about while seated, fidgets, squirms, etc.; Appears restless (e.g., shifts position in seat, paces about, etc.); and Moves about unnecessarily (walks around, rocks, shakes head, etc.).

In the behavioral observations of the assessment reports, Carl's behavior is described as "out of control" and "incredibly exacting" for those who were working with him. He would refuse to execute the assigned tasks, run from the room, sit with his hands over his ears and scream, become upset at any change in the environment such as going to the library from the classroom, not participating in group activities such as Circle Time and Music, and yelling if other students attempted to play with toys he was playing with until the other students were redirected to other activities. There were numerous reports of a short attention span, rapid shifts in attention, yet limited interest in the people in the environment. Three reports cited his interest in and positive interaction with animals. The pediatric neurologist's reports all give very colorful descriptions of Carl's behaviors and his having to leave the door open to the examination room so Carl could move in and out freely in order to conduct the consultation. He described him as a "very loud young man." He continued by saying Carl "hates being placed in any new situation and hates being cooped up. When the door to the examination room was closed today, he went wild and screamed incessantly for 20 minutes. As soon as the door was opened he calmed and ran out. There is very little ability to self-inhibit his behavior. In the past he used to cover his ears and scream with any unusual auditory stimulation." A later visit described Carl being able to listen and follow directions. However, "At times he refused to cooperate and ran out of the room. Before I got to the room the whole staff had become quite frustrated at his incessant screaming at being placed in a room and the door closed." The neurologist

describes Carl as having "monumental behavioral problems" in one report and in another "profound behavioral problems." He later reports Carl's frustration tolerance to be extremely limited and "he tends to be very perseverative and impulsive." He further reports Carl is very resistant to change and has difficulty with transitional periods. He also indicates Carl's biggest handicap as "his marked fidgetiness and hyperactivity." In addition, he notes temper tantrums that are manipulative and describes a "one of the original nightmare visits with Carl, his mother and father. His behavior got out of control a few seconds after entering the office and his decibel level didn't get below 100 for the remainder of the visit. His father had to be taught a gently but firm restraining hold. Things seemed to calm down somewhat on this and when they finally reached a means by which the hold could be terminated he was exhausted."

One of the last behavioral observations before the intervention was by the private speech/language therapist who described Carl as "an engaging, attractive young boy." She saw Carl for a total of three hours in two sessions. She reports he cooperated fully with all procedures with periodic play breaks. Verbal prompts were required to focus attention or stop fidgeting with his hands. Non-attentive behaviors increased as tasks became more difficult. She described a "game" Carl would play in which he would deliberately answer incorrectly (she was aware he knew the answer from previous responses), giggle; she would tell him not to play and repeat the item. She reports "Echololia occurred intermittently." She described his history of a significant language delay which had been diagnosed as a developmental language disorder, pervasive developmental disorder and autism or autistic-like characteristics.

In the Spring of 1995, Carl's mother reported he would cover his ears, twirl his hair and even "pulled some of his hair out at times." She said that his hair was "sticky"

from applesauce and other foods he transfers to his hair in this manner. She said Carl is still uncomfortable in a large group of people and will not participate in activities such as doing the "Hokey Pokey." He will sing and do it two days later alone.

Carl participated in Auditory training the last two weeks in July, 1995. Mrs. Y. felt there was some improvement in that she saw less covering of his ears and he seemed to exhibit less sensitivity to noises (she related a party at Chucky Cheese when he was three and one half and "freaked out" due to the noise). She reported he liked the auditory training sessions and asked to go back; however, he also would ask them to make the sounds "softer" and "slower" and he didn't like certain sounds.

During the Fall semester of the 1995-96 the research was conducted and an attempt was made to replicate the study at home during the summer, 1996. Mrs. Y. was unable to complete this replication due to the resistance of Carl to wearing the technology and his younger brother interfering with the process.

Light/Sound Technology Research Results

The researcher met with the teacher, aide, coordinator of the SECEP program, and Mrs. Y. in September, 1995. The meeting was very positive and the teacher most cooperative. The intervention protocol would be for the subject to spend a session on the technology at home before school and an additional session at school. The technology would be transported via Carl's lunchbox. Qualitative data in the form of anecdotal records were documented by both mother and teacher but neither was consistent in the process. The student would not consistently wear the technology in the home or at school. The teacher recorded the percentage of time the subject spent on the machine. It was noted the results were considerably more positive the more the technology was worn which supports Drs. Carter & Russell's research with learning disabled boys. They found the effects of

the AVS training increased as the number of sessions increased (Carter & Russell, 1994 p. 9).

The subject referred to the device as "sunglasses" and according to his mother liked taking them to school. He asked to continue to take them after the initial two weeks of treatment. His mother's comment after the two weeks off, was "Very hyperactive 2 weeks. Asked everyday to bring 'sunglasses' to school or to do treatment at home. Seemed to enjoy it (the two weeks on)." He was not as enthusiastic about the earphones and would frequently take them off.

First Treatment Intervention Anecdotal Records

Date	Time	Behavior (before and after)	Comments
10/30/95 Home	7:50A	Takes glasses on and off Very distracted during treatment	Fed him cracker snacks to keep glasses on I read books to keep him occupied.
10/30/95 Home	2:38A	Before - grouchy During - easily distracted but cooperative with redirection	Read book. Then relaxed on couch during treatment.
10/31/95 School	12:25P	Before - agitated During - calmed down some but didn't keep glasses on consistently.	He calmed down though.
11/1/95 Home	7:19A	Very hyper during treatment. Can't sit still. Always touching control box	Not cooperative - didn't want to keep it on.
11/1/95 School	12:50P	Initiate headphones. Kept on 75% of time	Calmer after PE before treatment and after treatment.
11/2/95 Home	7:10A	Restless and hyper. Kept headphones on 10-15 minutes. Wouldn't put on glasses.	Not cooperative.
11/2/95 School	12:15P	Before - fidgety. Calmed down became tired. Headphones on 100%.	After - excited and very loud!
11/3/95 Home	7:00A	Uncooperative. Would not sit and do treatment.	
11/3/95 School	12:15P	Before - very hyper During - hyper and squirmy Headphones on 98%	Singing song during 1st five minutes of treatment.

First Treatment Intervention Anecdotal Records Cont.

Date	Time	Behavior (before and after)	Comments
11/6/95 School	12:20P	Very hyper all day even during treatment	
11/8/95 Home	7:50A	Kept on for 10 minutes. Then uncooperative. Doesn't keep headphones on	
11/8/95 School	1:00P	No use.	
11/9/95 School	1:00P	No use.	
11/10/95 Home	6:30A	Good compliance with glasses wouldn't keep headphones on at all	

End of first two-week treatment intervention.

Second Treatment Intervention Anecdotal Records

Date	Time	Behavior (before and after)	Comments
11/27/95 School	12:13P	100% headphones 98% glasses	No hyperactivity or aggression
11/27/95 Home	2:30P	100% glasses, 10% headphones won't wear headphones for me	Happy, good mood at school. Eager to wear "sunglasses"
11/28/95 School	12:17P	100% glasses and headphones 100% relaxed during treatment.	Outstanding day at school.
11/29/95 Home	2:30P	100% glasses. Wore in car on way to appointment with Doctor. Relaxed	
11/30/95 School	12:17P	Excitable, irritable and loud. 100% glasses and headphones	
11/30/95 School	7:30P	Slightly hyper before and after	Broke headphones.
12/1/95 School	12:17P	100% headphones and glasses.	Sleepy and calm: good day.
12/4/95 School	12:16P	No use.	
12/4/95 Home	2:40P	Calm before and after. Glasses 100%. Headphones 75%.	
12/5/95	12:16P	Calm during and after. 95% glasses - 90% headphones	Very good days at school last week and this week.
12/6/95		No use.	
12/6/95 Car	2:00P	Glasses 97%. Headphones 100%. Tired, fidgety, kicking table.	
12/7/95 School	12:17P	Glasses 97%, headphones 100% Tired, fidgety, kicking table	
12/7/95 Home	2:40P	Glasses 90%, Headphones 0 %	Quiet.

Of the sessions recorded, 11 were reported as having positive outcomes according to the anecdotal records. During the first two weeks, there were problems with compliance but the second two weeks of treatment the teacher wrote down if it was 100% for both glasses and earphones. On each of those occasions, the comments were very positive. For example, "No hyperactivity or agitation; happy, good mood during school, eager to wear 'sunglasses'; relaxed during treatment; outstanding day at school; sleepy and calm - good day; very good days at school last week and this week."

Teacher's overall comments were that subject "has changed a great deal since the beginning of the study. Nothing has really changed towards the negative aspects of the survey. Either he has improved or stayed the same."

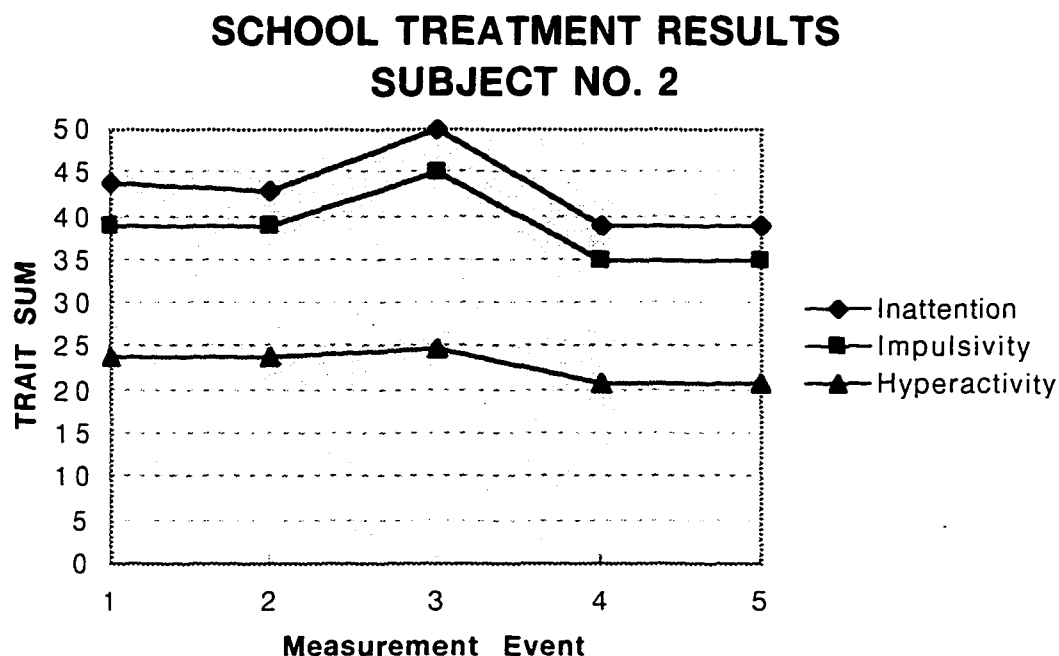
Results of the ADDES data on Case No. 2 were.

Table 2.1
School Version

Design Phases	Inattention	Impulsivity	Hyperactivity
Baseline	44	39	24
After 1st Two Weeks	43	39	24
After 2 Weeks Off	50	45	25
After 2nd Treatment	39	35	21
After 2 Weeks Off	39	35	21

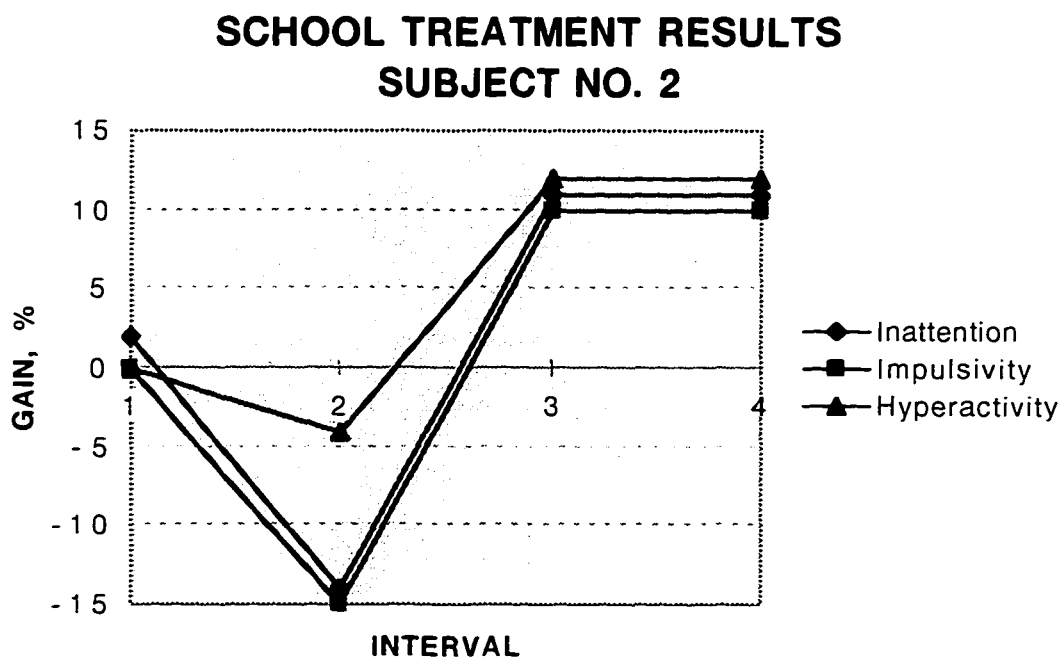
These results are graphically represented in the following figure.

Figure 2.1



The behaviors did not decrease after the first session on the technology; however, they increased without the technology for two weeks. The scores decrease to below baseline for the second two weeks on the technology and then were maintained until after the study was over. An analysis of the net effect (positive/negative) of the individual behaviors within each variable are presented graphically in Figure 2.1. It is assumed that each trait within each variable category has equal weight. Therefore, net effect is defined as the difference between the sum of the trait scores measured after each interval and the sum of the baseline scores. Since the number of traits were different for each category, the results were reduced to percentage values. The equation for this procedure has been stated in Chapter 3 and the first case.

Figure 2.1 (a)



There was a 12 % gain in all variables after the second intervention.

Table 2.2

Home Version

Design Phases	Inattention	Impulsivity	Hyperactivity
Baseline	38	37	35
After 1st Two Weeks	35	38	36
After 2 Weeks Off	39	39	36
After 2nd Treatment	37	35	32
No final evaluation by parent			

These results are graphically represented in the following figure.

Figure 2.2

**HOME TREATMENT RESULTS
SUBJECT NO. 2**

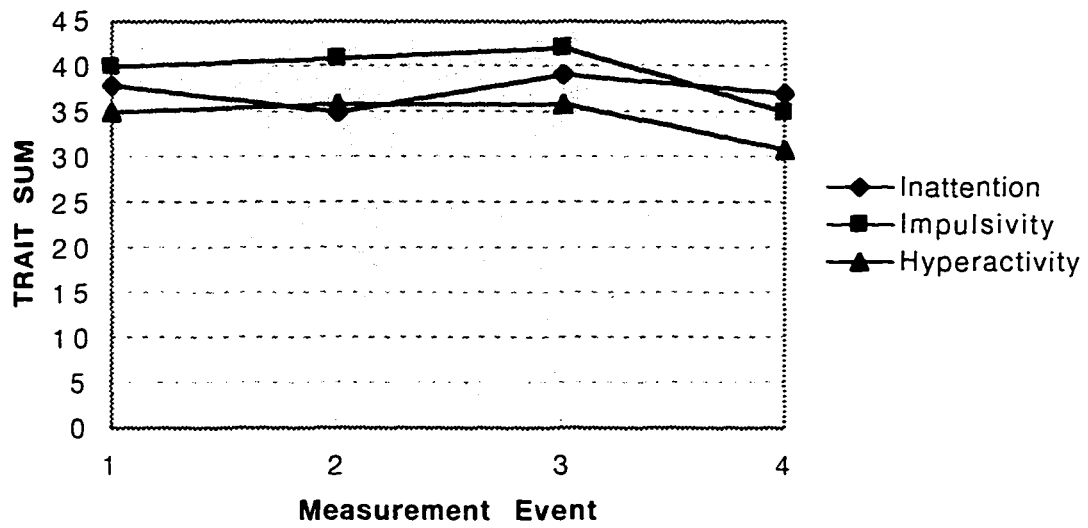
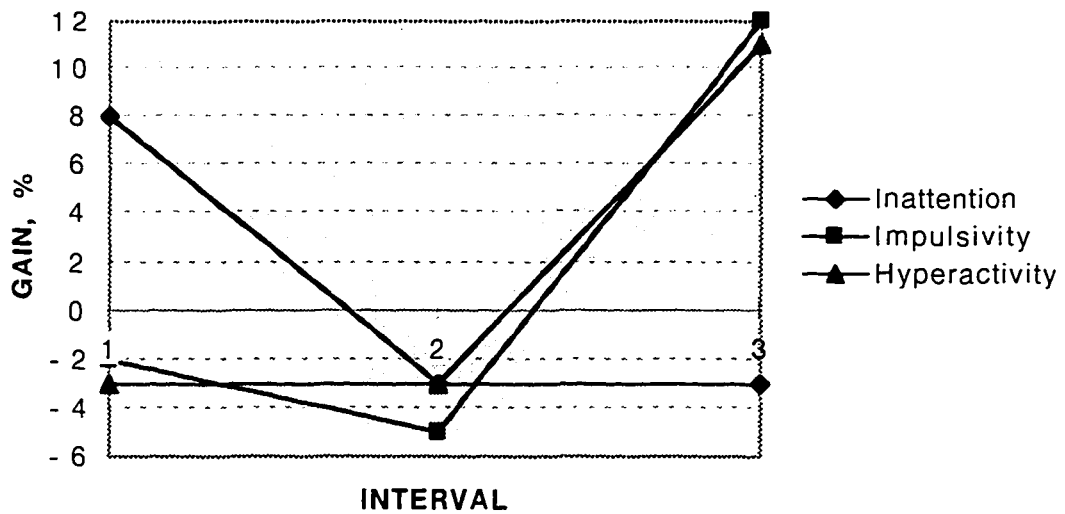


Figure 2.2 (a)

**HOME TREATMENT RESULTS
SUBJECT NO. 2**



Post-Treatment Data

For the 1996-97 academic year, Carl is being mainstreamed in a regular kindergarten class for the morning hours. At noon, he returns to the same SECEP classroom with the same teacher he had last year. Three days per week, Carl goes to a learning disabilities (LD) classroom for one hour in the adjoining regular elementary school.

The researcher interviewed Carl's SECEP and LD teachers and observed him in both of those classrooms.

When asked about the effects of the machine, the SECEP teacher reported she felt it was very effective in calming Carl down and those effects lasted for a short time after use but she did not observe long term results. She said Carl performs well in his regular kindergarten classroom until about 11:30 AM when his medications start to wear off.

Carl had just returned from taking his medications and was in the play area of the room. He was engaged in putting pegs in a board and another student was trying to take it from him, at one point causing him to drop the board. When the teacher corrected the other child, Carl smiled at her and said, "Can you leave us alone, you meanie?" He sat with the pegboard, placing the pegs in it and then stacking them. He was completely absorbed in the task, so much so that he grabbed himself in the crotch four times before finally running to the bathroom. After he had used the bathroom he headed back to the play area and the teacher reprimanded him for walking too fast. She physically held him and he slowed to a very deliberate walk back to the play area. The other student continued to bother him but Carl just moved to another table and put a chair there. He counted the colored pegs aloud from time to time and glanced out the window when a bus went by. He said, "567, that's my bus!" He continued this independent play for another 15

minutes. Then the class went to lunch. Carl did not interact with the other children at lunch but leaned on his elbow while eating almost half his sandwich. He talked to himself and held three fingers up which he talked to and about, but the observer could not understand him. He seemed self-absorbed and held his ears at one point. He drank some of his juice and then put the remainder of his lunch in the trash when the teacher said it was time to go. He then quietly walked to the door and waited for the other students, teacher, and two aides to join him. His body was moving but he stayed in the doorway and led the line back to the room. He went back to the play area and began to play with a toy that had a handle that turned on top. He twirled the top for about five minutes and went back to the pegboard. The other student continually tried to disrupt and fight him for the board but Carl maintained his focus. He was overheard counting backwards (5 4 3 2 1) as he emptied out the box of pegs, placing them in the board. He then began stacking the pegs in columns of twos and threes. The aide said it was time to go to LD and Carl said, "You better get me!" smiling at the teacher. She asked him, "Where do we run?" and he replied, "Outside." The aide again said it was time to go and Carl said, "Wait!" This was repeated and the third time she reminded him he said, "Just wait." while taking all the pegs and placing them back in the box. He then said, "Coming."

In the classroom for students with learning disabilities, Carl was at a table by himself doing a math worksheet. He was counting with his fingers and adding $9+3$, $9+8$, $9+9$, etc. There were fifteen problems on the sheet and he only missed one. The teacher was on the floor with four other children doing color patterns with bears. She verbally reminded Carl four times that as soon as he finished he would get computer time (there were two other students at the computer). These verbal reminders seemed unnecessary since Carl worked steadily only looking up once or twice toward the computer. When he

finished he took his paper to the teacher who asked him if he should get a happy face or sad face. Carl replied, "Happy face." Because the other students were still at the computer, the teacher apologized to Carl and said he should sit down on the floor with the others and do the color patterns until the other students had finished. He seemed upset and momentarily gestured with his arms in a frustrated manner but then complied and did the patterns. Finally, he went to the computer and played a game that taught beginning sounds. When the notice, ONE MOMENT PLEASE came on the screen, Carl read it aloud. He was engaged in the game which involved a letter of the alphabet (b) and three illustrated pictures one of which started with the letter "b." He talked to himself, "B is for boot, C is for cake, C is for cane, B is for bird, etc. His body was in constant motion but he remained focused and appeared to enjoy his time at the computer. His LD teacher says academically he performs very well and has no problems keeping up with the others.

Summary

Carl is a slender, blonde student who appears to be performing well in his mainstreamed settings. He appears to be higher functioning than the other students in the SECEP autistic classroom. Many of them did not have as much language facility as he and they were not toilet trained or able to follow directions.

The effects of the light/sound technology were more positive (approximately a 12 % gain on all three variables) after the second two weeks of use. The results may have been contaminated by the other medications and interventions being tried. Carl has improved and has advanced in speech and behavior from the pre-intervention observation and baseline checklist according to his mother and teacher.

Carl's mother says he still asks to use the machine, particularly when he is in the car but she has not replaced the battery. She and her husband have initiated the immune

therapy but she is not telling the school because she wants to see if they notice any difference without knowing about it.

Case Report Number Three

Background

Case number three, herein referred to as Don, is a seven-year-old male who lives with his mother, father and younger sister in an affluent neighborhood in Norfolk, Virginia. The researcher has followed Don for a year and the light/sound technology intervention was replicated during the Summer, 1996. Don was being mainstreamed in a first grade TMR class at a neighborhood school at the time of the initial study. He still attends that school and is in a self-contained EMR classroom for the 1996-97 school year. A new placement is being considered for Don by the Eligibility Committee.

Document analysis was conducted at both home and school. The following documents, and their interpretations when applicable, were available at the home visit: school entrance physical examination and immunization certification; speech and language evaluation reports (private and public school reports); psychological evaluation; developmental assessment; neurological evaluation; developmental disabilities specialist report; occupational therapist reports; several neurodevelopmental follow-up evaluation reports; auditory training certificate; educational appraisal and reappraisals; all individual education plans (IEP's) for every placement; report cards; child study team minutes; eligibility committee minutes; parent permission to evaluate; oversight needs assessment form; daily anecdotal records of correspondence between teacher and parent; parent reply to conduct letter; and a letter from a legal assistant from the Department of Rights of Virginians with Disabilities.

Mrs. Z., Don's mother, is one of five girls whose father was in the US Army. One of her sisters lives nearby and has a child who is AD/HD. She reported no significant health problems in her immediate or extended family with the exception of her maternal grandmother who died of leukemia. There is also some heart disease in the family. She said her mother took DES (drug given to prevent miscarriage) when she was pregnant with her. Mrs. Z. has a master's degree in dental hygiene but does not work outside the home.

Mr. Z. has a degree from a private school in Atlanta, Georgia and is a funeral home director. His mother died of cancer in her 50's and there is diabetes in his family. When Mrs. Z. was asked about the relationship between Don and his father, she said her husband still had a problem accepting Don's disability and they disagree over discipline. The only time father and son interact is on their boat but they don't do things like go to the movies, according to the mother.

Don was born in 1987 and was seven years old at the time of the initial study. He has a younger sister who is currently four years old, and is considered normal. His mother reports Don "loves his sister a lot" and he asks about her when she is gone. She feels they are operating at about the same developmental level.

Mrs. Z. said there were no problems during her pregnancy with Don. She did not use drugs/alcohol or smoke. The pregnancy was full term and the labor and delivery were "fast and natural." His APGAR scores were 9 and 10. Don weighed 6 lb. 9 oz. at birth and was in the hospital two days.

When asked about Don's temperament, Mrs. Z. described him as "sweet and funny" but "when things don't go his way, he blows and doesn't seem to have the tools to deal." She circled the following things that were a concern for her about Don: speech

problems: will not mind; and temper tantrums. Discipline consists of 123 Magic, time out, and positive reinforcement.

Developmental Milestones

Mrs. Z. reported that Don reached most developmental milestones within normal limits except for walking, which he did not begin until he was 18 months old. He had early coordination problems according to his mother and would become very frustrated when he could not do things. She reported Don had a lack of body awareness and she noticed he had difficulty with sensory integration.

Don sat alone before seven months and began babbling as a baby. He did not say any words until he was 15 months old. He would say "cookie" and "Mama" but not very frequently, according to his mother. He made no attempt to imitate words or sounds. She described Don as "shy" and said he had little interaction with anyone, ignored commands, but used jargon when playing on his own.

When asked how old Don was when Mrs. Z. noticed something was not normal, she said she "felt it sooner than I verbalized it; my brain knew but my heart wouldn't admit it." She said she made excuses for Don's behaviors for a while and the pediatrician kept telling her everything was O.K.

Toilet training was not begun until Don was four years old and he was not completely trained until he was five and one half. Mrs. Z. said they worked on it "a long time."

Mrs. Z. reported Don's eating and sleeping habits have always been good except when he was on Ritalin. She said he is an early riser but goes to bed without a problem.

Medical Factors

Don was born with mild hypospadias (a medical condition concerning the urethra). This condition was so mild it was not detected by the pediatrician, but was picked up by the urologist who performed a circumcision (under sedation) when Don was six months old. Mrs. Z. said Don experienced a number of ear infections as an infant. She could recall at least three of them: 9 months, 15 months, and 2 years but there may have been more that she wasn't aware of because, he did not run fevers and has a high tolerance for pain. She would notice that he was "fussy" and "irritable" so she would check on the possibility of an ear infection. She said he never "threw up" until he was four years old and was generally healthy.

Don was evaluated by a neurologist when he was three and one half and diagnosed as having a pervasive developmental disorder with a marked lag in the development of receptive and expressive language. The parents went to another neurologist for a second opinion when he was four and that doctor has done all subsequent reevaluations. He was placed on Ritalin and there was improvement in his attention span. The neurologist's report at age five reported Don's cranial nerves as normal but "the child is mildly diffusely hypotonic, with dystonic posturing of the hands." Deep tendon reflexes were reported to be normal and symmetric. The pediatric neurologist recommended occupational therapy once per week for one hour to deal with the aforementioned neurologically based lack of coordination.

There was also a letter in the medical file from a pediatric psychologist when Don was five and one half years of age. The psychologist reported he had evaluated Don and followed him for over a year. His diagnosis was pervasive developmental disorder with

autistic features and he recommended placement in the SECEP program due to its structured, behaviorally-oriented program in the management of autism.

There was a certificate of completion for Don's participation in a series of auditory training in 1993. It was reported that the mother had not observed any significantly positive results from the training.

When Don was 6 years 10 months old, a reevaluation of his neurodevelopment in association with his developmental delays and diagnosis of autism was conducted. The pediatric neurologist reported continued hyperactivity and inattention problems. The Ritalin Don had been taking was felt to decrease his verbalizations. Don had been stung by insects and prescribed Atarax which had a "rather significant effect on his hyperactivity and inattention." No side effects were reported so the doctor prescribed a trial of that medication with his mother assessing its effectiveness. If there were any side effects, Ritalin was to be reconsidered or a trial of Clonidine.

In June of 1995 when Don was seven and one half years old, he was again reevaluated by the neurologist. He was taking Ritalin again and had just finished school with an assignment to enter the Ghent School in Norfolk with an inclusion-type class. The report indicated Don was receiving speech therapy and occupational therapy; he also had an electronic communication device which the doctor felt was "greatly improving his communicative intent." A delay in coordination was still documented as well as cognitive impairments and a speech /language disorder characteristic of children with autism.

The mother reported that Don was having a reaction to Ritalin (it was causing him to be more hyper) during the time of the first light/sound intervention and the medication was discontinued in early 1996. Clonidine was prescribed in March, 1996 and he is still taking it. There has been the attempt to add the Ritalin back in gradually.

Educational History

Don attended a private preschool for two mornings per week when he was two years old. The first speech and language evaluation was conducted by the Scottish Rite Center for Childhood Language Disorders when Don was two years five months old. The report pictures Don as a shy child who had little interaction with the examiner. He would make eye contact when his name was called by the examiner and his mother when they requested or showed objects. It was noted he did not produce any words or vocalizations in communicating but used jargon while playing independently. The following instruments were used to evaluate Don:

1. Receptive-Expressive Emergent Language Scale (REEL)

This instrument is a parent interview evaluation tool. It was reported that Don could follow simple commands such as: "Put that down," "sit down" and comprehend questions such as "Where is the ball?"; he could get a familiar object from another room when requested and showed interest in speech. He was not able to respond with appropriate gestures or make verbal responses to verbal requests; sustain interest in pictures for two or more minutes; recognize a number of objects or pictures of objects or identify body parts. His performance placed Don at the 12 to 14 month level in receptive language skills. His expressive language skills were at the 10-11 month level with scattered skills to the 14 month level.

2. The Sequenced Inventory of Communication Development (SICD)

Don demonstrated 100% success in skills at the 12 month level, 57% success in skills at the 16 month level and 38% success in skills at the 20 month level when compared to his chronological age of 2 years 5 months. He was able to comprehend the names of toys, family members, and the command, "Come here." He could also comprehend

names of outdoor items such as "swing," "slide," "earth" and identify his nose. He was not able to comprehend verbs, identify objects from a group of 3; recognize names of facial features or respond to commands without gestures. According to the results of this test, Don demonstrates receptive language skills between the 12 and 20 month level with an overall receptive language age at the 12 month level. His expressive language skills were between the 12 and 20 month level with an overall expressive language age of 12 months.

Pragmatics were also evaluated as well as voice and oral peripheral examination. A cursory oral mechanism exam revealed slight tongue protrusion but no lateralization was produced. Normal lip pucker and palate were observed but it was noted the subject did not willingly cooperate for a more thorough examination of the oral mechanism.

Summary: Don exhibits a severe delay in receptive and expressive language skills, demonstrated by parent report on the REEL and results on the SICD. He demonstrates a variety of pragmatic skills at the paralinguistic level, but these are characteristic of a child of a much younger age.

A psychological evaluation was conducted by the department of special education services of Norfolk Public Schools when Don was 2 years 11 months. This preschool evaluation reported that Don was receiving speech therapy two times per week and had an audiological evaluation before the above speech/language assessment that indicated adequate hearing for normal speech and language development. The psychological assessment was completed using the Bayley Scales of Infant Development, review of records and observations as a data base.

The testing took place in two settings: Don's preschool center and in his home. The examiner reported Don had a difficult time interacting with her and participating in the required activities. It was reported he was dependent on his mother and fearful of others.

In his home environment, he participated more willingly in attempting tasks and interacting with the examiner.

Results of the Bayley indicated an obtained age equivalent of 9 to 10 months which is significantly below his chronological age. These results were qualified as a "very limited estimate of Don's over-all ability due to his very limited verbal expression as well as his unwillingness to participate and interact." He was referred to the eligibility committee to determine the most appropriate educational placement.

A developmental assessment was also conducted by the Norfolk Public Schools on the recommendation of the preschool child study team. Don was 35 months old at the time of the assessment. The Learning Accomplishment Profile-Diagnostic Edition (LAP-D) was administered and the following results reported:

Fine Motor: Manipulation	Approximately 15 months
Fine Motor: Writing	Approximately 12 months
Cognitive: Matching	No basal established
Cognitive: Counting	Not administered
Language/Cognitive: Naming	No basal established
Language/Cognitive: Comprehension	Approximately 18 months
Gross Motor: Body Movement	Approximately 21 months
Gross Motor: Object Movement	Approximately 18 months

Don's behaviors were described as clinging to his mother and refusing to attempt many items presented to him. He often threw undesired objects and reached for desired objects. It was reported his mother said he enjoyed television commercials, toy cars, trains and telephones. He was attending a day school three days per week and was receiving private speech therapy twice a week.

As a result of the evaluations, Don was placed in a preschool handicapped classroom when he was three. He stayed with that teacher through a generic kindergarten class for two years. He was then transferred to Ghent Elementary School and was mainstreamed in a first grade TMR classroom. According to his mother, that placement was a disaster. He is currently in a self-contained EMR classroom but his teacher does not feel it is an appropriate placement. Mrs. Z. has just had another full evaluation done so a different placement can be considered. The parents and school want SECEP to evaluate Don again for possible placement in their autistic program.

The triennial assessment reports consisted of a speech/language evaluation and an educational reappraisal. Don was six years old and the following results were reported:

1. The Hawaii Early Learning Profile (HELP). Expressive language section was administered and information reported by Don's mother was included in the assessment. Results indicated expressive language functioning at 17 to 22 months with scattered skills to 29 months.
2. The Assessment Log for the Carolina Curriculum for Infants and Toddlers with Special Needs and Preschoolers with Special Needs was completed. Again parent information was included. Results were :

Pre-vocabulary/Vocabulary	24 months
Receptive Skills	24 months with scattered skills to 36 months
Conversation Skills	21 months with scattered skills to 24 months

Receptively, Don was able to follow simple commands, answer yes/no questions either by gesture or verbally and understand simple "what" and "where" questions. Expressively he uses gestures (pointing, nodding, head shakes) and a few signs. He had an expressive vocabulary of about 36 words although some are not used on a routine basis.

3. The Preschool Language Scale-Revised (PLS-R) was administered with the following results:

Auditory Comprehension	21 months
Verbal Ability	22.5 months
Language Age	21.75 months
Language Quotient	30 (-4.66 SD)

Receptively, Don was able to answer a simple "where" question by gesture, identify a picture of a dog, recognize three body parts, and follow four simple directions. Expressively, he was able to ask for a simple need, use ten words, name one object and combine words (all items reported by parent).

4. The Peabody Picture Vocabulary Test-Revised (PPVT-R), form M, was administered. Don earned a standard score of < 41 and an age equivalent of 22 months, indicating significantly poor performance in receptive vocabulary.

Voice, fluency, oral peripheral examination, and articulation analysis were not assessed.

In summary, Don continues to exhibit a severe delay in the development of receptive and expressive language.

Educational reappraisal was done with the Brigance to determine the following developmental functioning levels:

Readiness/Academic: Scores ranged from 2 years 0 months to 4 years 0 months. No basal was attained in most subtests and improvement was noted in the last six months in knowledge of body parts (2-0 to 3-6) and picture vocabulary (no basal - 4.0). Matching colors and shapes was noted to be emerging but not consistent.

Psychomotor: Fine motor, 2 years 6 months; Gross motor, 2 years 0 months (scattered to 5-6).

The Peabody Developmental Motor Scales yielded scattered scores from 25-41 months.

It was noted that Don does not perform non-routine tasks upon request. Therefore the examiner felt testing was difficult and scores tend to underestimate Don's developmental age. A summary by the examiner stated that Don has shown limited improvement in developmental test scores; however, she felt he had made a great deal of progress within the last six months. His eye contact and communication skills had improved according to this report and since he was taken off medication, he had become more verbal and intelligible. Two word phrases were being heard on a frequent basis. A pictorial augmentative communication system paired with verbal communication had been implemented the included items pertaining to breakfast, lunch, snack and play situations with Don making requests and choices. The report also notes Don's socialization skills continue to be solitary with some parallel play. She reports Don has an awareness of the activity around him and he initiates some physical contact/rough and tumble play with a favorite classmate. In a activity such as Looby Lou, he only holds one classmate's hand. For non-contact circle movement activities he moves around independently with the class but does not usually alter his responses as requested.

Don's strengths were listed as : responds positively to school, enjoys circle activity and gross motor musical activities, sand table, monkey bars, follows classroom routine, feeds self independently. His weaknesses were listed as : self-help skills (needs assistance with toileting, clothing, opening drink cartons), fine motor skills, tactile sensitivity, severe language deficits, severe social deficits, and cognitive delays.

The teacher who conducted this assessment has been tutoring Don since he was in her preschool class. She sees him three times per week all year long and has been employed by Mrs. Z. to help with behavior management techniques. An example of this was when the mother was out shopping with Don and he started acting out. she called this teacher who came and got him and took him home. This system has worked according to the mother.

Pre-Intervention History

The baseline behaviors were indicated on the ADDES- Home and School Versions plus an interview with Mrs. Z. She was very interested in using the technology but wanted to introduce the light/sound machine to Don herself because of his reticence with strangers. In addition, she preferred interacting with the school principal and teachers rather than having the researcher do so. Mrs. Z. and the researcher had a lengthy meeting and interview in order for her to understand the study and comply with all requirements of the college. She informed the researcher that she had conducted research for her master's thesis and was well aware of the necessary restrictions and precautions. She reported to the researcher any behaviors and concerns whenever they occurred.

Baseline data on the school version of the ADDES included items and behaviors such as: Is easily distracted by other activities in the classroom, other students, the teacher, etc.; Needs oral questions and directions frequently repeated; Attends more successfully when close to the source of sound; Requires eye contact in order to listen successfully; Has difficulty concentrating; Does not remain on task; Grabs things away from others; Ignores consequences of his/her behavior; Cannot follow the rules of games; Becomes overexcited; Moves about unnecessarily; and Engages in nervous habits (e.g., bites fingernails, twirls hair, chews inside of cheek, chews pencils or pens, spins or twirls objects, etc.).

In addition to the severe acting out behaviors at home and on trips outside the home, the mother rated the following behaviors as being extreme: Has difficulty concentrating; Does not remain on task to do homework; Has a short attention span (e.g., cannot sit still while a story is being read, cannot keep his/her attention on homework assignments, easily distracted, etc.); Cannot remain on task to study or prepare for tests or quizzes; Is impulsive (e.g., reacts immediately to situations without thinking, is impatient, is unable to wait for a turn or for assistance, etc.); Is easily angered, annoyed, or upset; Bothers others while they are trying to work, play, etc.; Moves about while seated, fidgets, squirms, etc.; Appears restless; Cannot adjust behavior to expectations of different situations; Climbs on things; and Moves about unnecessarily (e.g., walks around, rocks, shakes head, etc.).

Light/Sound Technology

Don wore the technology at home and at school during the first intervention in the Fall of 1995. A protocol of use of the technology was set up to reflect the mandates proscribed by the Human Subjects Committee and the approved proposal.

Don was on medication, Ritalin, and measurements were made both at home and school. The home scale was filled out with and without medication (Ritalin). This subject was also participating in private speech and occupational therapy sessions. After the first two week treatment period, the parent reported both the speech and OT therapists had "wonderful sessions with student—lots of speech and on-task concentration." Other anecdotal data that were reported verbatim by both parent and teacher follows:

First Treatment Intervention Anecdotal Records

Date	Time	Behavior (before, during and after)	Comments
10/28/95 Home	4:45P	Playing in playroom-removed headphones and glasses, couple of times, then sat quietly-occasionally looked over glasses. Played with sister and 12-year-old girl	Don sat quietly after adjusting to earphones & glasses. Very little fidgeting.
10/28/95 Home	8:00A	Playing-sat for device to be put on-afterward wanted sister and Katheryn to try them on	Don asks for device to be put on-keeps pointing to his ears.
10/29/95 Home	9:45A	Playing with balloons w/Katheryn showed device to him and he ran upstairs and sat quietly throughout.	Appears to enjoy using device-have not seen carryover of calming effect. Need to try when off Ritalin.
10/29/95 Home	3:55P	At Joan's-running around -did not want to cooperate-when device on, settled down and sat quietly for duration. No Ritalin.	Seemed calm, played with truck and watched movies.
10/30/95 Home	6:55A	Running around house. Sat after device on, but not quietly. Sister and Don took turns pushing each other in the stroller. No Ritalin.	Left for school at 7:45A.
10/30/95 School	3:15P	OT: Before-just off Ritalin- moderately focused-attending 2 to 3 mins. each task. During: No! No! Agitated, wouldn't leave on. Grabbed genitals each time, but didn't want to use bathroom.	*Note: Don will tell you he has to use the bathroom to avoid doing something.
10/30/95 Home	6:30P	Settled down after placed- at first, kept taking glasses off-played with sister, wanted to go to bed at 7:15P. No Ritalin	When off Ritalin, doesn't want to sit still for placement-settles down somewhat afterwards.
11/1/95 Home	7:15A	Same as 10/30	
11/1/95 School	12:45P	Math and Computer-following directions very well! (before). Sucked fingers and played with tongue during, OT activity/cooperated and then acted out after.	Don remained off task all afternoon.
11/2/95 Home	7:20P	Playing with computer, acted like had to potty, but sat with device	Finished playing with computer
11/3/95 Home	7:15A	Same routine as 11/2	Played with computer until bus came.
11/3/95 School	12:45P	Before: Math/Computer, very cooperative. During: Cooperative, ate shirt a bit. After: nap time, cooperative, then started to annoy another child	Don was more willing to do an activity. He did start to annoy another kid, but was cooperative in time out then rejoined group at story.

First Treatment Intervention Anecdotal Records Cont.

Date	Time	Behavior (before, during and after)	Comments
11/4-5/95			We were away for the weekend. Don wouldn't let the baby sitter put the device on.
11/5/95 Home	7:30P	Don let me put the device on and pulled glasses off one time.	Played with computer and then went to bed 8:15.
11/6/95 Home	7:15A	Finished getting dressed-removed glasses-kept removing glasses-went to bathroom-he was up & down. total time: 10 mins.	Played with computer and left for school.
11/6/95 School	12:50P	Before: Math/not cooperative. During: Cooperative After: Was cooperative for a time, then acted out	Don was more willing to do the activity. He acted out @ 1:50P as Ritalin started to wear off.
11/7/95 Home	7:15A	Did not want to stop playing to put on device-moved-to computer and pulled glasses on and off.	Played with computer and left for school.
11/7/95 School	12:55P	Before: Math/not following directions. During: Cooperative After: totally off task and aggressive.	Don displayed aggressive behavior and non compliance immediately after and all afternoon.
11/8/95 Home	7:30A	At computer, pulled glasses on and off.	Left for school.
11/8/95 School	12:55P	Before: Math/following my directions. During: Cooperative After: Playing with other kids.	Don was not cooperative after, nor did he follow rules.
11/9/95 Home	7:15A	At computer, pulled glasses on and off.	Went up to playroom and played with cars.
11/10/95 Home	8:00A	Playing and watching movie, kept pulling glasses off.	Played with trains.
11/10/95 Home	5:30P	Came in from outside, kept pulling glasses off, watched part of video while playing upstairs	Doesn't seem to mind ear phones, seems to dislike the glasses.
11/11/95 Home	8:30A	Playing with cars-eating, did not want to stop, kept pulling off glasses, finally settled down.	Left for bowling.
11/11/95 Home	6:00P	Babysitter attempted, kept taking on and off-she said no real length of time on	
11/12/95 Home	9:00A	Playing with computer, no problems removed glasses a couple of times	Cooperated getting dressed, but always does if we are going "bye, bye."
11/13/95			Private speech and occupational therapist said they had wonderful sessions with Don-lots of speech and on task concentration.

End of first two-week treatment intervention.

Second Treatment Intervention Anecdotal Records

Date	Time	Behavior (before, during and after)	Comments
11/29/95 Home	7:00A 7:45P	Getting dressed for school, would not cooperate. Watching TV & played with trucks. Bedtime looked at books w/Mom	Kept pulling headphones & glasses off, finally cooperated, but only at 5 min. stretches of time.
11/29/95 School	12:55P	Before: math-followed my directions. During: pulled glasses down. After: joined next scheduled activity, cooperative.	Worked well with OT, very accurate cutting.
11/30/95 Home	7:15A	Put on, kept pulling off, finally kept on about 2 min. w/out pulling off.	
11/30/95 School	12:55P	Before: math-not doing assignment. During: pulled glasses down. After: cooperative.	Don was in a good mood! Very cooperative.
12/1/95 Home	7:15A	Dressed for school, a little more cooperative, pulled off after 5 min., left on for another 4.	
12/1/95 School	12:55P	Before: Playing bingo with assistance, a lot of calling out. During: pulled glasses down. After: Large group activity, a lot of calling out.	Calling out <before> was not diminished <u>after</u> .
12/1/95 Home	8:00P	Don pulled headphones off, when placed on again, started crying and was extremely distressed-did not push him. I asked Don on a couple of occasions if he would wear the device and he said no!	
12/4/95 School	12:50P	Before: Math-not following directions, passive. During: Cooperative. After: Nap time, played around with others.	Don was off task before and later on as well.
12/5/95 School	12:55P	Before: Off task, refused to do math. During: Pulled glasses down. After: Off task, tantrum after recess.	After recess he put his hands in another child's pants.
12/6/95 School	12:55P	Before: Math, not following directions. During: Pulled glasses down. After: In trouble.	Throughout day, a lot of sleeve biting, agitated.
12/7/95 School	12:55P	Before: Playing Bingo, cooperative. During: Pulls down glasses. After: No problems.	Agitated, sleeve biting, difficulty with transitions.
12/8/95 School	12:15P	Before: Lunch, cooperative. During: Pulls down glasses. After: Biting sleeve and annoying others.	Don after prefers negative responses to nothing.
12/11/95 School	12:55P	Before: Not participating in math activity. During: Pulls down glasses. After: Annoying others at rest time.	He started to act out and then left early for OT
12/13/95 School		Missed	
12/14/95 School		Missed, field trip	

As noted from the following chart of raw scores on the ADDES, no significant gain was made in the home environment. The school ratings on Don showed no significant improvement with the exception of the hyperactivity variable in which the behaviors decreased from 42 to 30.

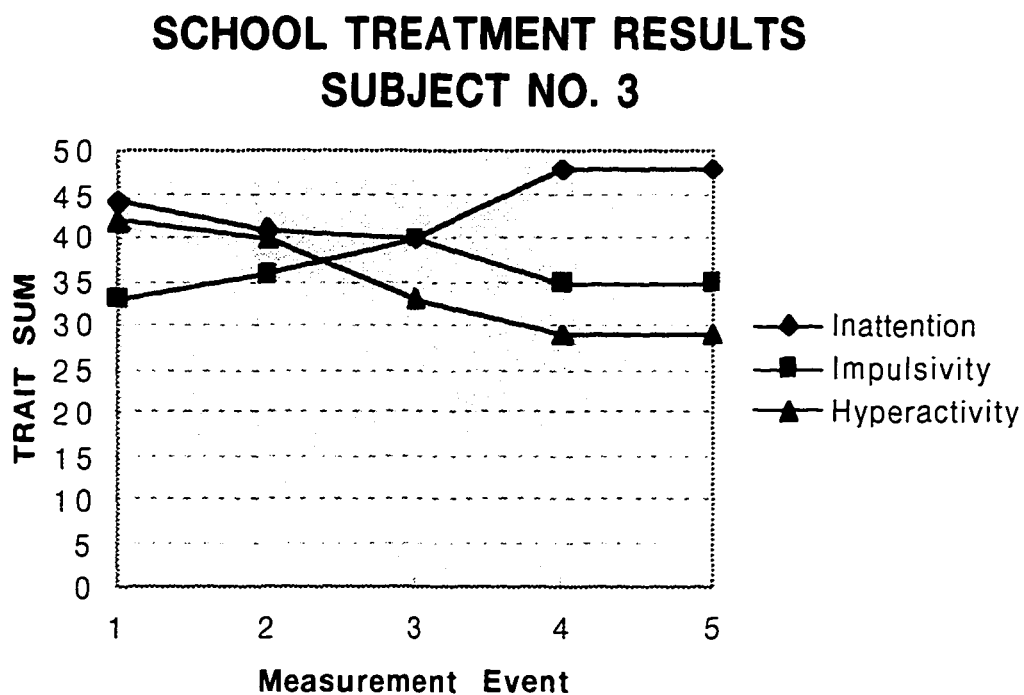
The results of the ADDES are presented in Table 3.1.

Table 3.1
School Version

Design Phases	Inattention	Impulsivity	Hyperactivity
Baseline	44	33	42
After 1st Two Weeks	41	36	40
After 2 Weeks Off	40	40	33
After 2nd Treatment	48	35	30
After 2 Weeks Off	48	35	30

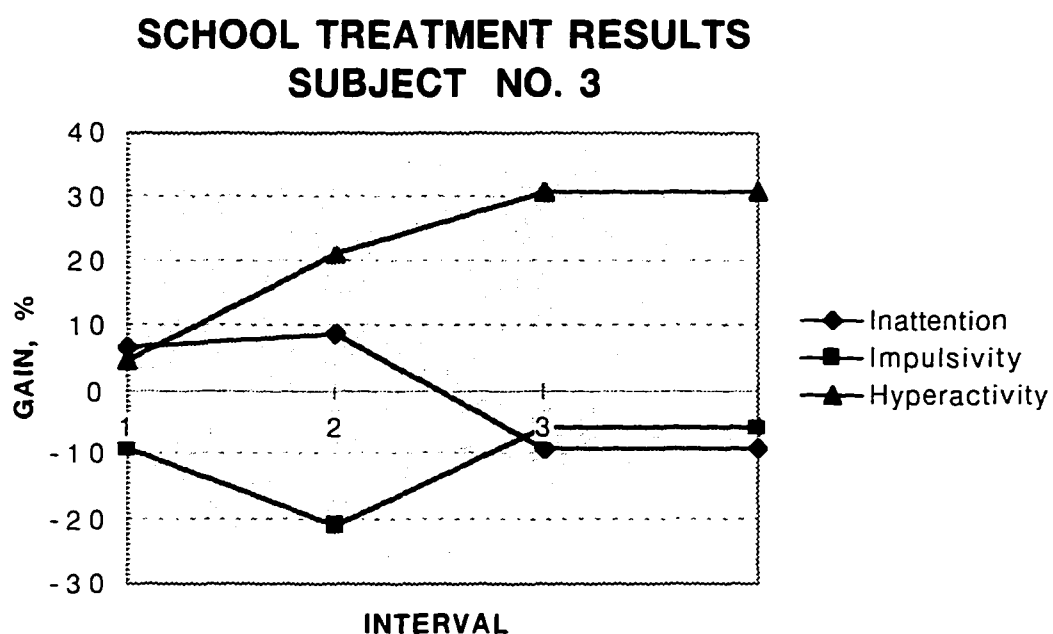
The scores were mixed and no definitive pattern emerged. These results are graphically represented in the following figure.

Figure 3.1



The following figure graphically represents the net effect expressed in percent of gain on each interval when compared to the baseline. The only variable that showed gain was hyperactivity.

Figure 3.1 (a)



Results of the ADDES are presented in the following table.

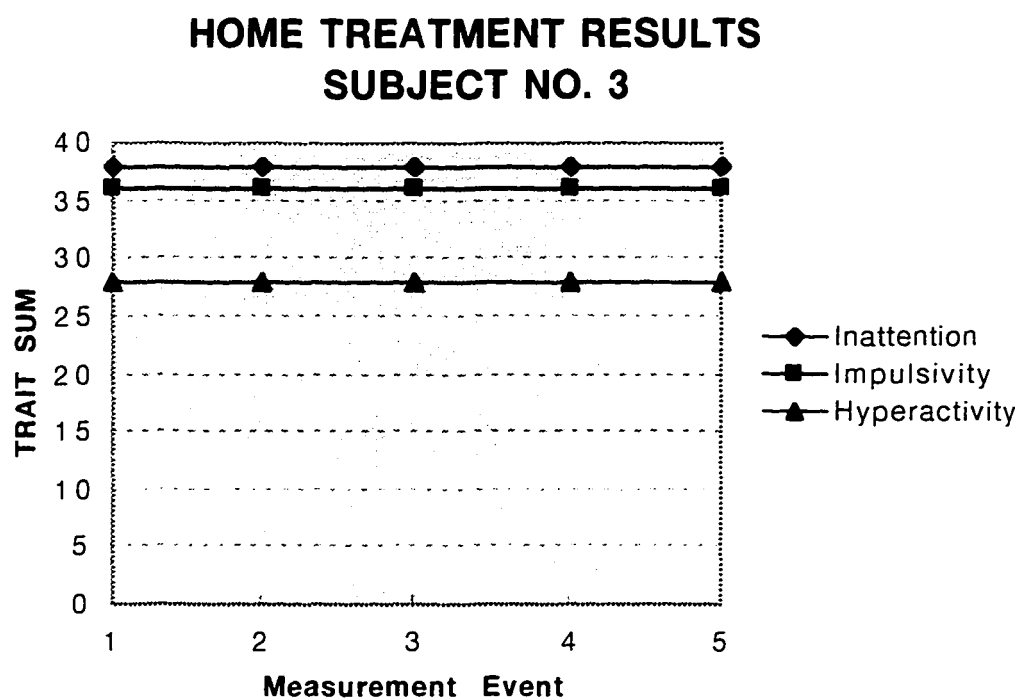
Table 3.2

Home Version With Ritalin

Design Phases	Inattention	Impulsivity	Hyperactivity
Baseline	37	36	28
After 1st Two Weeks	38	36	28
After 2 Weeks Off	38	36	28
After 2nd Treatment	37	36	28
After 2 Weeks Off	37	36	28

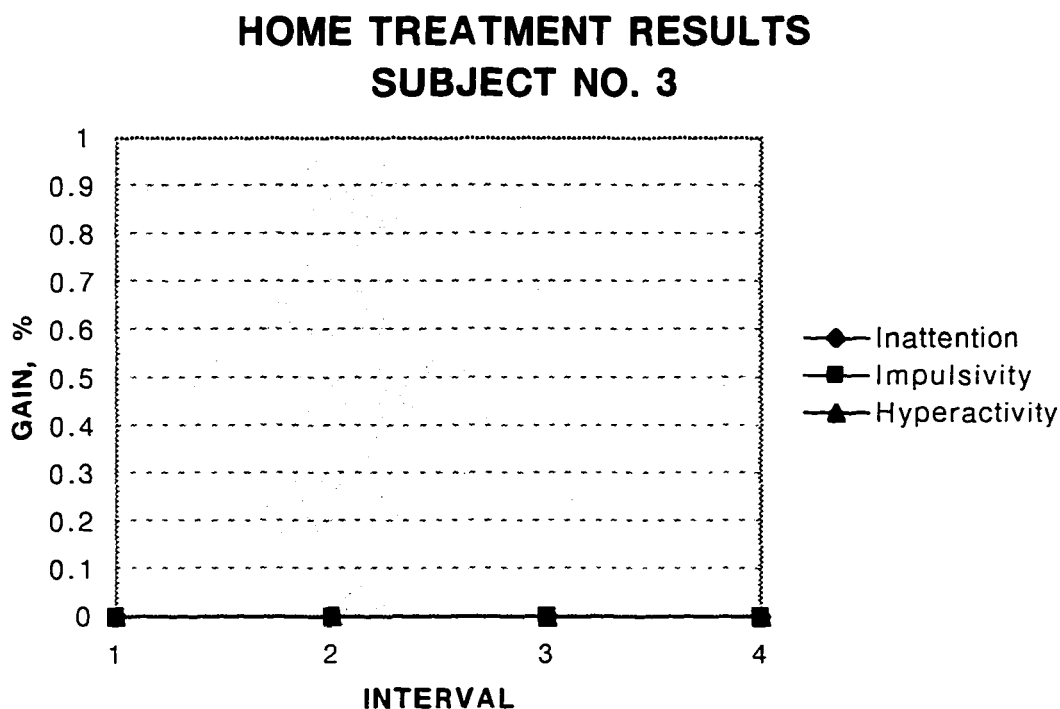
These results are graphically represented in the following figure.

Figure 3.2



The following figure illustrates no percentage gain in net effect for the Home intervention.

Figure 3.2(a)



As in the first two cases, the intervention results are presented graphically and represent the net effect of gain in percentage values.

Even though the ratings for the home were made with and without Ritalin, the only ones considered were the those on the medication so the conditions would be consistent with the school scores in which he was also on medication.

A follow-up interview with the mother was conducted after two months. She indicated that they had found out that the subject was having a reaction to Ritalin during the time he was in the study. This could explain his agitation, impulsivity and lack of focus. It is interesting that these symptoms (of the reaction to the Ritalin) were exacerbated after he went off the light/sound technology and that is when they investigated the possible problem with medication.

A replication of the original study was made during the summer and fall of 1996 in order to evaluate the light/sound technology when Don was on a different medication, Clonidine, that had stabilized his behavior.

The special education teacher that has worked with Don since kindergarten was the rater of the school version. It should be noted that on the baseline ADDES-school version the scores were very high compared to the original study and the rater noted many of the ratings were made because she had observed them over the years at school and in the tutoring situation. She tutored Don for two hours three times per week during this replication. The mother was the rater of the home version data baseline and subsequent ADDES checklists. The pre-intervention baseline behaviors were very similar to those of the first study.

The researcher observed Don in his home for over an hour before the replication study began. He was introduced to the researcher but did not choose to interact at that time. Don is a very attractive child who is average to above average in size for his chronological age. His speech is very difficult to understand but he repeated a few phrases when prompted. He spent most of the time at his computer while the researcher spoke with the mother and teacher. At one point, he became very quiet and it was observed that he had fallen asleep in an upright position in the chair in front of the computer with his head leaning over on the table and his arms hanging down. He slept for about ten minutes and then resumed his computer programs. He showed the researcher the programs he was working on and got up at one point, took a flower out of a dried arrangement and handed it to the researcher. He repeated this action several times and would have continued to give the whole arrangement if the teacher had not told him it was time for school. He reluctantly followed her.

In addition to the ratings on the ADDES-Home and School Versions, anecdotal records of the replication study were kept by the parent and teacher and are listed below:

First Replication Treatment Intervention Anecdotal Records

Date	Time	Behavior (before, during and after)	Comments
7/30/96 Home	9:30A	Playing w/ trucks, pushing under bed. Tried to remove headgear and tried to push buttons on controls, finally settled down. Took cars and trucks to playroom	
7/30/96 School	2:30P	Before(B): Working well, finished working on name at computer, went to bathroom. Told me "no" but lay down on futon & allowed me to "hook him up"; deep breathing after 5 minutes, movement, let me know it was done. After: Good attending-no sign of frustration with nesting cups.	
7/31/96 Home	8:20A	Playing in Mom's room-jumping on bed TV off and on. Did not want to cooperate @ first then sat still, played with trains afterward.	
7/31/96 School	2:00P	Before: puzzle, some frustration. D-Fell asleep, lots of deep breathing, didn't wake up when over or when I took off glasses. A: Eyes heavy, working with #s and manipulatives-difficulty attending.	
8/1/96 Home	8:00A	Watching Barney, but cooperated. Then finished watching Barney.	
8/1/96 School	1:00P	B: Puzzle well D: very still A: Attended well, but many incorrect trials -much more than usual	
8/2/96 Home	8:30A	Was going to playroom did session before he started playing-cooperative played with car wash cars	
8/2/96 Home	5:30P	Bath time finished-cooperative during session-played game of timber with mom and sister afterward.	
8/3/96 Home	8:20A	Playing in den-watching Thomas the Train-playing with sister, cooperated but fidgeting with glasses, afterward played with computer.	
8/3/96 Home	6:00P	Came in from playing outside, initial resistance-went to playroom afterward-good evening.	
8/4/96 Home	8:50A	Ate breakfast, cooperative then pulled off after 10 min.	

First Replication Treatment Intervention Anecdotal Records Cont.

Date	Time	Behavior (before, during and after)	Comments
8/5/96 School	8:30A	B-Difficulty with puzzle-frustration. D-After 5 min. deep breathing, clucking noises, asleep. A-Attended well, usual accuracy on trials, lots of vocalization.	
8/5/96 Home	5:40P	B-Came home from speech and OT and playing at McDonald's. D-Sat in chair, cooperative A-Watched program with sister.	
8/6/96 School	8:20A	B-Distracted doing puzzle, smiled at equipment. D-Lots of hand waving/movements w/ watch hand. A-Great mood, #s 25/30 correct, better than ever.	
8/6/96 Home	5:00P	Had been playing outside-cooperated during-went outside and played in wading pool.	
8/7/96 School	8:20A	B-smiled to work puzzle quickly, smiled for "star" D-fell asleep. A-Attended well.	Seems to enjoy sessions more. 2nd day.
8/8/96 School	8:10A	B-Good mood, exhibited no frustration when difficulty w/ couple of pieces. D-fell asleep. A-Attended well, with some distractions, good work overall.	Cut off three times and had to be restarted-didn't go according to manufacturer's program time on its own.
8/8/96 Home	7:30P	Came in from swimming, cooperated, went to bed for evening.	
8/9/96 Home	8:00A	Finished breakfast, cooperated. Watched Barney, but fell asleep in 5 min. (Don was up at 4 A that morning.)	Device ended before time, had to restart.
8/9/96 Home	6:30P	Finished dinner, cooperated, did bath time.	Device was restarted twice.
8/10/96 Home	8:00A	Finished breakfast, cooperated, but not joyfully, started watching TV then fell asleep.	Device did not need readjustment.
8/10/96 Home	6:00P	Removing cushions from chair, had been playing with remote, cooperated, but removed glasses once.	Don was sick today, throwing up, sleeping a lot, he threw up after dosage of medication-may have thrown it up, slept a lot during the day, when he woke up at 5:00P-resumed great eating, playing, etc.
8/11/96		Spent night w/Aunt, forgot to take device	

First Replication Treatment Intervention Anecdotal Records Cont.

Date	Time	Behavior (before, during and after)	Comments
8/12/96 School	1:20P	B-Had been to McDonald's and played, was not happy to see me, some difficulty with puzzle, asked for help D-Fell asleep, after 7 min. A-Attended well.	No spontaneous vocalizations.
8/13/96 School	11:40A	B-Great mood, good attending. D-Stirring and movement. A-Great mood, lots of vocalizations.	"I know" "datway" "don(t) do (d)at" "this is it" "what (d)at?"
8/13/96 Home	7:00P	Had finished dinner, started opening drawers, cabinets, moving from me to them D-cooperated, sat, told me when finished "all done." A-Ate dessert watched 15 min. TV with Dad	
8/14/96 School	7:45A	B-Good mood, puzzle in record time. D-Fell asleep w/in 5 min. A-Good attending & many vocalizations.	
8/15/96 School	7:45A	B-Agitated, frustrated easily, puzzle in record time, but not in control. D-Very still. A-Much better mood.	Verbal imitation.
8/14/96 Home	5:30P	B-Playing with trucks. D-Cooperated, sat in chair. A-Wanted to go outside, went outside with older girls.	Forgot to record data, because neighbors came over, filled out 8:15A.
		Don cooperated much more during the toward the end of the two weeks. The OT commented 8/19 that Don appeared more friendly, outgoing and relaxed today.	

End of first replication treatment period. The second two week treatment period follows:

Second Replication Treatment Intervention Anecdotal Records

Date	Time	Behavior (before, during and after)	Comments
8/27/96 Home	7:30A	B-Turning lights on and off, peeling cushions off couch. D-At first removing glasses and earphones, finally settled down & fell asleep. A-Took nap.	
8/28/96 School	4:20P	B-Fell asleep playing. D-fell back asleep. A-"No, no" didn't want to work, but did well on most tasks.	

Second Replication Treatment Intervention Anecdotal Records Cont.

Date	Time	Behavior (before, during and after)	Comments
8/29/96 School	4:15P	B-Eating puzzle, told me "don(t) wan(t) i(t)." D-Lay still. A-Worked hard.	
8/30/96 Home	9:00A	B-Came in from outside playing. D-Sat still (said all done) right after the earphone placed. A-Watched movie with sister.	
8/31/96 Home	6:30P	B-Finished dinner. D-Sat, cooperative. A-Played in playroom.	
9/4/96	2:30P	B-Watching movie w/ sister. D-Fell asleep, 5 min. into session. A-Went outside to play after 1 hour nap.	Don started school in addition to getting bronchitis-the whole routine changed Monday getting back on track.
9/8/96 Home	12:00P	B-Playing outside. D-Sat in chair. A-Fell asleep.	
9/9/96 Home	5:00P	B-Playing Playroom. D-Not cooperative, but kept headphones on. A-Went outside to play.	
9/10/96 School	4:30P	B-Puzzle well. D- Fell asleep. A-Worked well.	
9/11/96 School	4:30P	B-Worked well. D- Fell asleep, long coughing spell, turned red, went back to sleep. A-Worked well, more trials correct than wrong.	
9/12/96 School	4:35P	B-Worked well. D- Fell asleep. A-Worked well.	
9/17/96 School	5:30P	B-Worked well, lots of concepts coming together. D- Fell asleep, long coughing spell, turned red, went back to sleep. A-Worked well.	

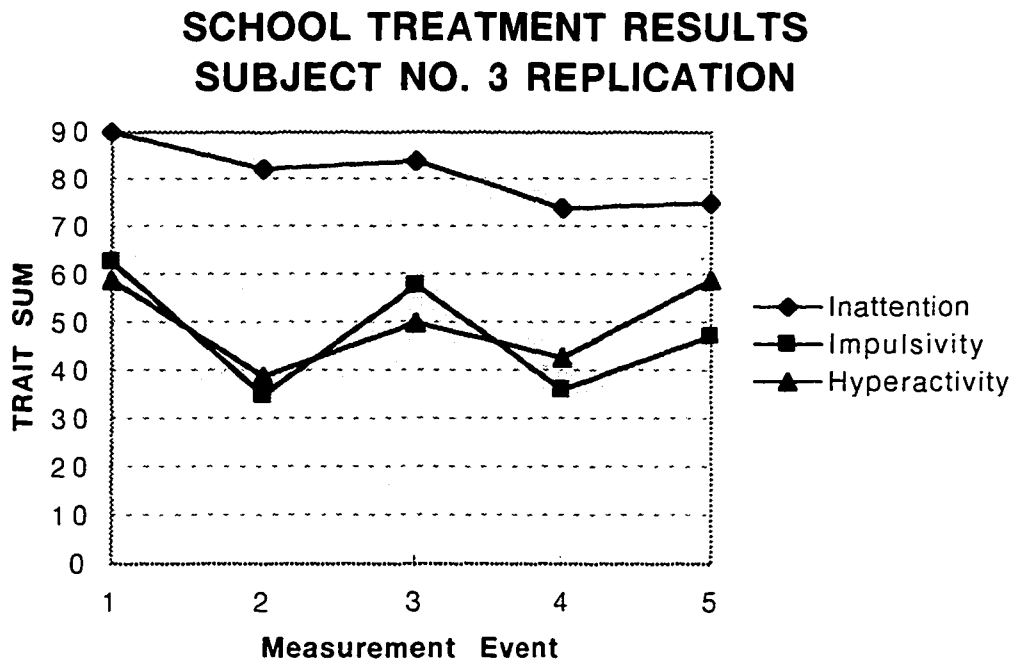
Following is the baseline and subsequent repeated measures data on the ADDES-School and Home Versions of the replication study.

Table 3.3
School Version Replication

Design Phases	Inattention	Impulsivity	Hyperactivity
Baseline	90	63	59
After 1st Two Weeks	82	35	39
After 2 Weeks Off	84	58	50
After 2nd Treatment	74	36	43
After 2 Weeks Off	75	47	59

These results are graphically represented in the following figure. There was a definite “ratcheting” effect (behaviors decreased on the technology and increased when off the technology) noted in the results.

Figure 3.3



The following figure graphically represents the net effect expressed in percent of gain on each interval when compared to the baseline. A 15%, 27% and 43% gain were noted in inattention, hyperactivity and impulsivity noted in the graph. The ratcheting effect was again evidenced.

Figure 3.3(a)

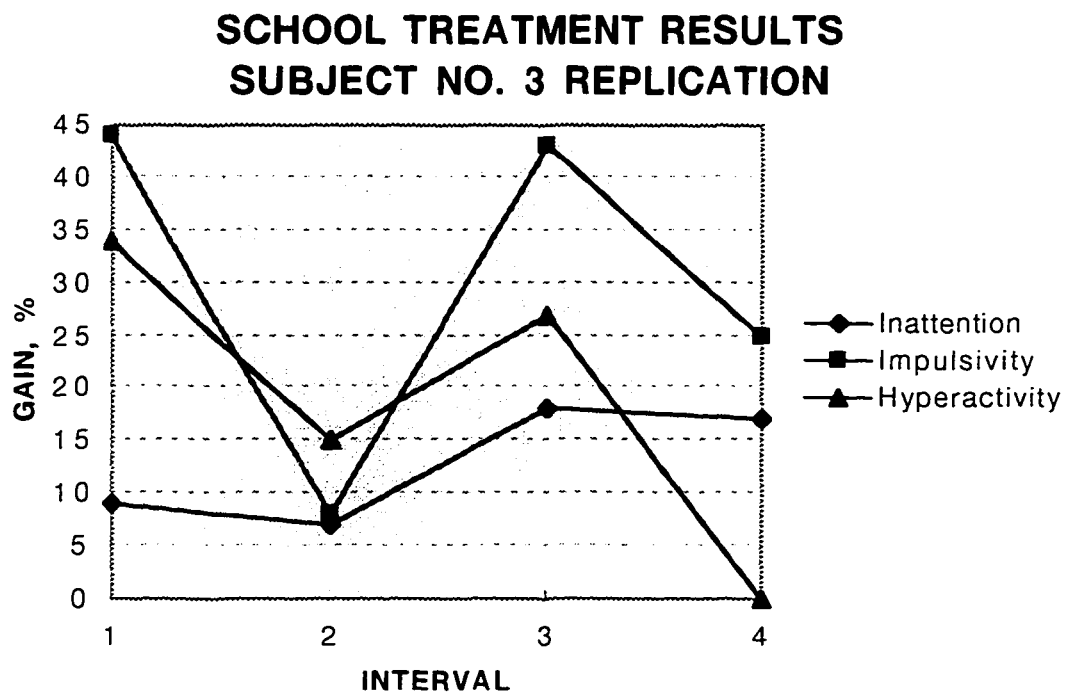
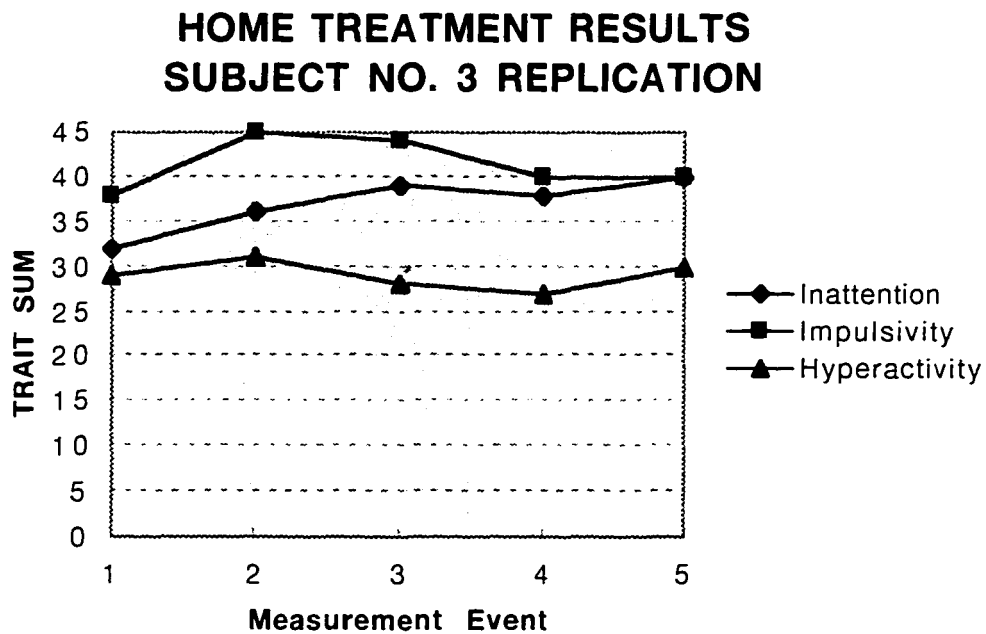


Table 3.4
Home Version Replication

Design Phases	Inattention	Impulsivity	Hyperactivity
Baseline	32	38	29
After 1st Two Weeks	36	45	31
After 2 Weeks Off	39	44	28
After 2nd Treatment	38	40	27
After 2 Weeks Off	40	40	30

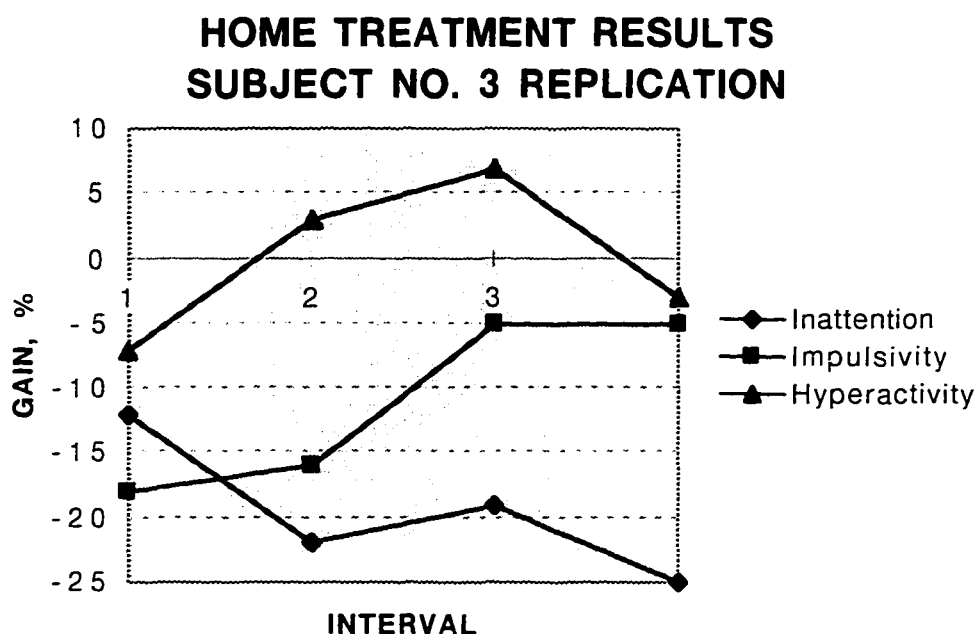
These results are graphically represented in the following figure.

Figure 3.4



The following figure graphically represents the net effect expressed in percent of gain on each interval when compared to the baseline. The hyperactivity variable was the only gain noted in the Home treatment results.

Figure 3.4 (a)



Summary

The results of the initial study indicated no change in any of the variables but according to his mother, during the time of the intervention Don was having a reaction to Ritalin and when the light/sound technology was terminated, the reaction exacerbated. The technology may have been stabilizing the reaction to the medication and keeping the behaviors controlled.

The replication results were more positive with net gain effects noted in all three variables in the replication study in school. Even though the ratings were higher by the teacher initially, the net gain effect (lowering of the number of behaviors) was greater. In the home intervention, the only positive gain was in the hyperactivity variable.

Mrs. C. reported enough positive results that she wishes to continue using the light/sound technology and conduct an independent study of her own to see if longer periods of wear will result in more permanent results.

Case Report Number Four

Background

Case number four is an eight-year-old male herein referred to as Casey. He lives with his mother, father and twin brother in Illinois. The family lives in a middle to upper middle class neighborhood and Casey is mainstreamed in a second grade classroom.

Information for this case was gathered through documents filled out by Mrs. A., a phone interview with Mrs. A. and an interview with Mrs. A.'s sister who works with the researcher. This sister was pregnant with her daughter when Mrs. A. was pregnant with the twins and the two "compared notes" and were very close during this period of time. The sister's child was born two weeks before the twins and again they made comparisons and observations.

Other documents supplied by the mother included a social behavior checklist and a health inventory that covers developmental information and general information concerning a medical history.

Mrs. A. received an Associate's degree and later a Bachelor's degree. She is currently in the second year of a program to become a registered nurse. She has not worked outside the home since the twins were born.

Mr. A. is a nuclear engineer who works for a nuclear power plant. He received a lot of training in the US Navy before he met and married Mrs. A., who is his second wife.

After Mr. and Mrs. A. were married, she desperately wanted children. She had several miscarriages before becoming pregnant with triplets. About two months into the pregnancy, Mrs. A. had a miscarriage of the third child but successfully carried the twins until one week before the due date. The twins were facing the correct way for a vaginal

delivery but during the very long labor, they turned and eventually had to be delivered by cesarean section.

Casey weighed 6 lb. 12 oz. and was the first born of the twins. His APGAR scores were eight and nine respectively. The other twin is also a male and weighed well over six pounds. Casey stayed in the hospital three days and was jaundiced according to the health inventory.

When the twins were two weeks old, Casey was hospitalized because he stopped breathing and turned blue. Both children were put on heart monitors for a year and the breathing crisis events occurred more than once with Casey according to Mrs. A. who said the doctors had told her not to touch the child or give him CPR.

When asked about temperament, Casey's mother wrote, "He is very loving and happy. He has a great sense of humor." Although he fights with his twin, Mrs. A. says, "He is very loving to his Mom and Dad." She also marked the item; he usually laughs, cries, gets angry, etc. when the situation calls for it. He responds well to praise and enjoys doing things with his family. Also indicated was the fact he shares his belongings, goes to school willingly and gets along well with teachers and other students. Mrs. A. reported Casey seems to feel good about himself, is cheerful, takes pride in his appearance and his accomplishments and asks for help when necessary.

It was reported by both the mother and aunt that Casey has a strong need for routine, sameness, and exactness. Simply touching something of his can "set him off" and his twin brother delights in doing just that. He also is obsessive about some possessions and activities; for example, the aunt says Casey has a "thing" about American flags and the flagpole at his house and one that is in front of his grandparent's home. She watched him for a period of several hours raise and lower the flag, fold it in certain way,

and tie the knots in certain way in order to raise and lower it. Her daughter went over and simply touched the flag and he began screaming and pushed her away. He has also been fascinated by credit cards and has his own wallet of expired cards which he plays with constantly.

His mother noted on the behavior checklist that Casey wore a long sleeve shirt and tie to school every day. The reason, according to the aunt, is that one of his favorite programs on TV is the Home Improvement show and he identifies with the lead character who wears a shirt and tie every day. His mother had not washed his shirt one day and he put on a raincoat and refused to take it off until he had a clean shirt and tie. He engages his mother to play the part of the female lead on the show and even found a part for his father to play.

His aunt reports that Casey is somewhat oblivious to danger in that he will run away before you are even aware he is gone. He has to be watched very carefully and related a story of going to a park for a family reunion when Casey was three or four and he ran away; after a frantic search, he was found hiding under a nearby building.

Developmental Milestones

The health inventory does not ask for specific information; rather it requires "yes" and "no" responses for more general milestones. For example, Casey sat alone before seven months, walked alone before fifteen months but did not say whole words by eighteen months. Mrs. A. marked "no" when asked if her child learned things at home or play as fast as other youngsters his age.

The aunt indicated it was obvious that Casey was "always different." He did not start talking when her child did and other behaviors were not within the norm as well. Her family thought Mrs. A. just did not discipline the twins properly and some in the family

still feel that way. Mrs. A.'s sister said Casey did not like to be left alone and once sat with his hands over his eyes for three hours. He could not be left with family members except for his grandparents because he had to be watched so carefully. Mrs. A. fortunately found a "very accepting and tolerant baby-sitter" to help with Casey.

By the time they were three, the twins were both in special preschool programs. Her sister reports Mrs. A. has always been aware of her rights as a parent of a child with disabilities and has been able to get the services that are due under the law.

The aunt reported that Casey has always been "hyper" and it was difficult to take him anywhere because he could get away so quickly. If Mrs. A. tried to use a child harness, he was able to slip out of it "in two seconds" according to the aunt. She related another story of Casey falling out of the car because he managed to get out of the car seat restraint and open the door. Fortunately, they were not going fast and he wasn't badly hurt. She said he was always "scraped and scratched up" because of his hyperactivity and impulsiveness. She said the twins would bite each other and both report that Casey's brother loves to "torment him" and knows exactly how to "set him off." Mrs. A. confirms this in the social behavior checklist by marking "almost never" to: Avoids harmful situations or dangerous things; Learns from mistakes; Tells what happens to him; and Follows detailed directions. Some of the other developmentally appropriate independent items marked were: Uses household equipment; Uses scissors, pencils, games, etc., appropriate to age; Knows his way around neighborhood; Follows daily family schedule; and Chooses his own friends.

Medical Factors

When Mrs. A. was asked to send any medical records she had to the researcher, she replied that she did not "have any clue as to where the medical tests are." They had

made a move since Casey was diagnosed with autism and she thought they were in a box that was packed away.

In addition to the sleep apnea, Mrs. A. reported that up until Casey was three years old, whenever he would get hurt, he would be unable to catch his breath and would pass out. She expressed feeling grateful that he had stopped that.

Casey had recurring ear infections beginning at the age of two. He had tubes placed in his ears and his mother felt that the lack of language was due to not being able to hear. His language still was not normal even after the tubes were inserted and he was diagnosed as autistic (high functioning) at the age of three and one half by a psychologist at Southern Illinois University School of Medicine.

The aunt says the other twin is also "full of energy" but has not been on any medication for AD/HD and does not exhibit the behaviors that Casey does. She reported both boys are highly energetic and she has never seen them tired.

Ritalin was prescribed for Casey and is effective enough for him according to his mother to be maintained in a regular classroom. His aunt says when he first takes his medication in the morning, he is almost "zombie-like" but returns to his exuberant self as it wears off. Clonidine was also prescribed to help him sleep.

Family health problems include high blood pressure for grandfather, Paget's disease and diabetes for grandmother and glaucoma for father. The only childhood disease listed that Casey has had was chicken pox.

Educational History

Casey started school when he was three years old. He started in an early childhood program but his mother said he would not cooperate with the early childhood teacher and "would just scream." The severe and profound teacher took him in her room and "gave

him the love and attention that he needed” according to the mother. She said that his severe and profound teacher taught him so much and he started to talk at around four years of age. Casey remained in the early childhood school until he was five. Mrs. A. did not feel that he was ready for kindergarten at that time. According to the mother, he was transferred to the Harris school and classified as EMI (educable mentally impaired). He was placed in an EMI classroom half time and regular kindergarten half time. His mother wrote, “He did great in kindergarten.” The next year he was in EMI and regular first grade for most of the day. She said he was on the honor roll every semester. This year he is in a regular second grade and is classified as a student with a learning disability (LD). However, he has not spent any time in the LD classroom so a staffing was held in early November, 1996. He is still in regular second grade and will have an LD monitor check on him once a week to see if he needs help. His full-time, one on one aide has been with him for two years and Mrs. A. says, “She is fantastic!” The aide has an autistic teenage daughter so she knows how to relate to Casey.

When asked if there were any school related problems, the mother wrote, “I worry that he won’t be able to keep up.”

It was noted on the health forms that Casey had repeated kindergarten.

No records were available for analysis or reporting of results.

Pre-Intervention History

On the social checklist the items circled that were of concern to the parent were: speech problems; will not mind; hits others; doesn’t pay attention; sleep problems; overactive; and social skills (written in).

Mrs. A. reported that Casey does not get along well with other children. On the social behavior checklist, Mrs. A. indicated Casey is not careful with others’ belongings.

does not get along well with adults, is usually not a leader, and is not a good listener. Although his mother reported Casey gets along well with his class mates, "the neighborhood kids are cruel and won't let him play." She also reported that the "neighbors don't like having a special needs child in their neighborhood so they treat him cruelly." She wrote that she thought he would like to play with the kids his own age but "they won't play with him. "That has a lot to do with their parents' attitudes." She says he is almost never asked to play by others and does not defend himself compared to other children in the neighborhood. His aunt confirms the fact the neighbors do not like Casey. It should be noted he is impulsive and isn't always aware of social boundaries.

Mother reports he almost never does assigned jobs, does not stick to the job, and only occasionally makes appropriate decisions. She says he does not accept change in routine easily and uses both words and signs to communicate.

Casey watches TV for the whole program and loves the "game shows" such as Jeopardy, Wheel of Fortune, and Home and Family talk show. Mrs. A. thinks Casey wants to be a talk or game show host.

Mrs. A. stated her goal for Casey is for him to be independent and happy when he grows up and when asked if she thought he could do that, she wrote, "I hope he can. I have to believe he can." She answered the question concerning the way she would change her child if that were possible by writing, "I would like him to be able to control his behavior. I want him to be able to fit in."

The ADDES-Home version was used as the way of collecting baseline data before the intervention with the light/sound technology. Following are some of the highest rated items and concerns expressed by the mother: Is easily distracted by other things happening in the home; Has difficulty concentrating; Cannot remain on task to study or prepare for

tests or quizzes: Rushes through chores or tasks with little or no regard to quality of work: Interrupts others: Moves about while seated, fidgets, squirms, etc.: Appears restless: Cannot remain seated: Becomes overexcited (loses control in group activities, becomes loud, etc.); Runs in the house, will not sit appropriately on the furniture, yells, etc.: runs in the shopping mall, pushes and makes noises in line at the movies, yells in stores, etc.: and Makes excessive noise.

The school version noted the following baseline behaviors: Is easily distracted by other activities in the classroom, other students, the teacher, etc.: Needs oral questions and directions frequently repeated (e.g., student says, "I don't understand": needs constant reminders; etc.): Is unable to perform assignments independently (e.g., continually asks for assistance or reassurance: will not begin, work on, or complete assignments without assistance; etc.): Moves about while seated, fidgets, squirms, etc.: Handles objects (e.g., twirls pencils, plays with things in desk, spins rulers on pencils, clicks ball-point pens, repeatedly sharpens pencils, etc.).

Light/Sound Technology

Mrs. A. expressed the desire for Casey to participate in the study and agreed to use the technology according to the intervention protocol during the summer of 1996 when Casey was home from school. Her sister took the technology to Mrs. A. and explained carefully the directions and procedures. In addition, the researcher kept in contact with Mrs. A. by phone throughout the intervention. Anecdotal records were kept in addition to the ADDES-Home version being completed every two weeks. Following is the anecdotal documentation of immediate behavior changes during the two treatment periods of the technology.

First Treatment Intervention Anecdotal Records

Date	Time	Behavior (before, during and after)	Comments
6/4/96	8:00A	Before: Was wound up. During: Had a hard time keeping eyes closed. After: Same.	
6/4/96	12:00P	Before: Very talkative and active. During: Refused to go for the full 15 min. After: Same.	
6/5/96	8:15A	Before: Very wound up and uncontrollable. During: Had a hard time sitting through it. After: Still very wound up.	The roofing people were here, so he was very excited.
6/5/96	11:30P	Before: Calmly watching TV. During: Wouldn't keep eyes closed. After: Calmly watched a movie.	
6/6/96	8:45A	Before: Watching TV, repeating everything said. During: Sat calmly through it. After: Same behavior.	
6/6/96	12:00P	Before: Screaming at his brother. During: Hard time keeping eyes closed. After: No change.	His brother torments him until he screams.
6/7/96	8:30A	Before: Very quiet, watching TV. During: Sat quietly, hard time keeping eyes closed. After: Same.	
6/7/96	12:45P	Before: Outside riding his bike. During: Hard time keeping eyes closed. After: Sat and watched TV.	
6/8/96	8:00A	Before: Crying. During: Upset and repetitive. After: Same.	Kyle lost his wallet and was very upset.
6/8/96	12:00P	Before: Sad and quiet. During: Wouldn't keep eyes closed. After: Clingy.	Could not find his wallet and favorite credit cards.
6/9/96	8:45A	Before: Playing with his new wallet and fake credit cards. During: Wouldn't keep his eyes closed. After:	
6/9/96	2:00P	Before: Quietly watching TV. During: Kept taking it off. After:	He gets frustrated when I keep telling him to close his eyes.
6/10/96	8:15A	Before: Fighting over the TV channel with his brother. During: Did not want to do it. After: Defiant.	

First Treatment Intervention Anecdotal Records Cont.

6/10/96	12:15P	Before: Playing quietly w/ his airplane. During: Cooperated nicely. After: sat and watched cartoons.	
6/11/96	8:00A	Before: Quietly playing with airplane. During: Cooperative. After: Lining up his power rangers in the fireplace.	
6/11/96	12:00P	Before: Playing baseball. During: Wouldn't sit still. After: Defiant.	He did not want to do it.
6/12/96	7:30A	Before: Quietly watching TV. During: Wouldn't keep eyes closed. After: Same.	
6/12/96	12:10P	Before: Playing grocery store in garage. During: Cooperative. After: Screaming & fighting w/ his bro.	
6/13/96	9:00A	Before: Very wound up and excited. During: Wouldn't keep eyes closed. After:	It's their birthday today. so he is very excited. Kept asking about his presents.
6/13/96	2:00P	Before: Running around. wouldn't sit still. During: Wouldn't sit still. After: Ran outside and rode his bike.	
6/14/96	8:00A	Before: Screaming & fighting w/ his bro. During: Wouldn't keep eyes closed. After: Playing by himself in the garage.	
6/14/96	11:00A	Before: Pinching his brother. During: Wouldn't go the full time. After: Still fighting with his brother.	His brother torments him until he screams or hurts him.
6/15/96	9:30A	Before: Screaming at his brother. During: Pretty cooperative. After: Outside riding his bike.	
6/15/96	11:00A	Before: Running in and out of the house. During: Wouldn't cooperate After: Defiant.	Did not want to.
6/16/96	7:30A	Before: Screaming & fighting w/ his bro. During: Wouldn't keep eyes closed. After: Playing grocery store in garage.	
6/16/96	11:00A	Before: Chasing his brother through house. During: Wouldn't cooperate. After: Fighting with his brother.	Was exhausted from going to Jungle of Fun.
6/17/96	7:00A	Before: Playing quietly by himself. During: Cooperative. After: Same.	
6/17/96	3:00P	Before: Playing with his new toys. During: Wouldn't keep eyes closed. After: Watching his new video.	

End of first two-week treatment intervention.

Second Treatment Intervention Anecdotal Records

Date	Time	Behavior (before, during and after)	Comments
7/2/96	6:45A	Before: Quietly watching TV. During: Sitting quietly. After: Playing w/ cars outside.	
7/2/96	11:00A	Before: Playing in garage. During: Wouldn't keep eyes closed. After: Quietly eating lunch.	
7/3/96	8:00A	Before: Screaming. During: Wouldn't keep eyes closed. After: Fighting with his brother.	
7/3/96	12:05P	Before: Playing "talk show host." During: Sat quietly. After: Playing talk show host.	
7/4/96	8:20A	Before: Watching cartoons. During: Wouldn't keep eyes closed. After: Fighting with his brother.	
7/4/96	11:40A	Before: Fighting with his brother. During: Didn't want to go full time. After: Riding bike.	
7/5/96	9:05A	Before: Crying. During: Crying. After: Crying.	He lost his credit card.
7/5/96	11:35P	Before: Playing with his credit card. During: Wouldn't keep his eyes closed. After: Playing talk show host.	We found his card.
7/6/96	6:50A	Before: Watching TV. During: Wouldn't go full time. After: Playing grocery store in garage.	
7/6/96	11:20P	Before: Eating lunch. During: Wouldn't keep his eyes closed. After: Playing talk show host.	
7/7/96	7:30A	Before: Fighting with his brother. During: Wouldn't do it. After: Screaming at his brother.	
7/7/96	11:00A	Before: Watching TV. During: Sitting quietly. After: Playing talk show host.	
7/8/96	9:00A	Before: Playing with credit cards. During: Didn't want to sit. After: Playing grocery store.	
7/8/96	11:20A	Before: Eating lunch. During: Sitting quietly. After: Playing talk show host.	
7/9/96	7:30A	Before: Watching TV. During: Sitting quietly. After: Riding his bike.	
7/9/96	11:40P	Before: Watching TV. During: Wouldn't keep eyes closed. After: Playing talk show host.	

Second Treatment Intervention Anecdotal Records Cont.

7/10/96	8:20A	Before: Screaming at his brother. During: Wouldn't keep eyes closed. After: Playing talk show host.	
7/10/96	12:20P	Before: Playing Sega. During: Sitting quietly. After: Playing talk show host.	
7/11/96	6:20A	Before: Screaming at his brother. During: Wouldn't cooperate. After: Fighting with his brother.	
7/11/96	12:00P	Before: Playing Sega. During: Sitting quietly. After: Playing talk show host.	
7/12/96	8:30A	Before: Fighting with his brother. During: Wouldn't do it. After: Screaming at his brother.	
7/12/96	11:40P	Before: Watching TV. During: Sitting quietly. After: Playing talk show host.	
7/13/96	9:05A	Before: Fighting with his brother. During: Wouldn't do it. After: Screaming at his brother.	
7/13/96	11:25P	Before: Eating lunch. During: Wouldn't close eyes. After: Playing talk show host.	
7/14/96	6:45A	Before: Watching TV. During: Hard time sitting still. After: Playing Sega.	
7/14/96	11:20A	Before: Rearranging canned goods. During: Sitting quietly. After: Playing talk show host.	
7/15/96	7:30A	Before: Fighting with his brother. During: Wouldn't do it. After: Running through house.	
7/15/96	12:00P	Before: Eating lunch. During: Wouldn't keep eyes closed. After: Acting out Jeopardy.	
7/16/96	8:10A	Before: Playing with his pretend groceries. During: Hard time keeping eyes closed. After: Screaming at his brother.	
7/16/96	12:25P	Before: Playing talk show host. During: Would do. After: Playing talk show host.	

Following are the ADDES results from the in-home intervention during the summer.

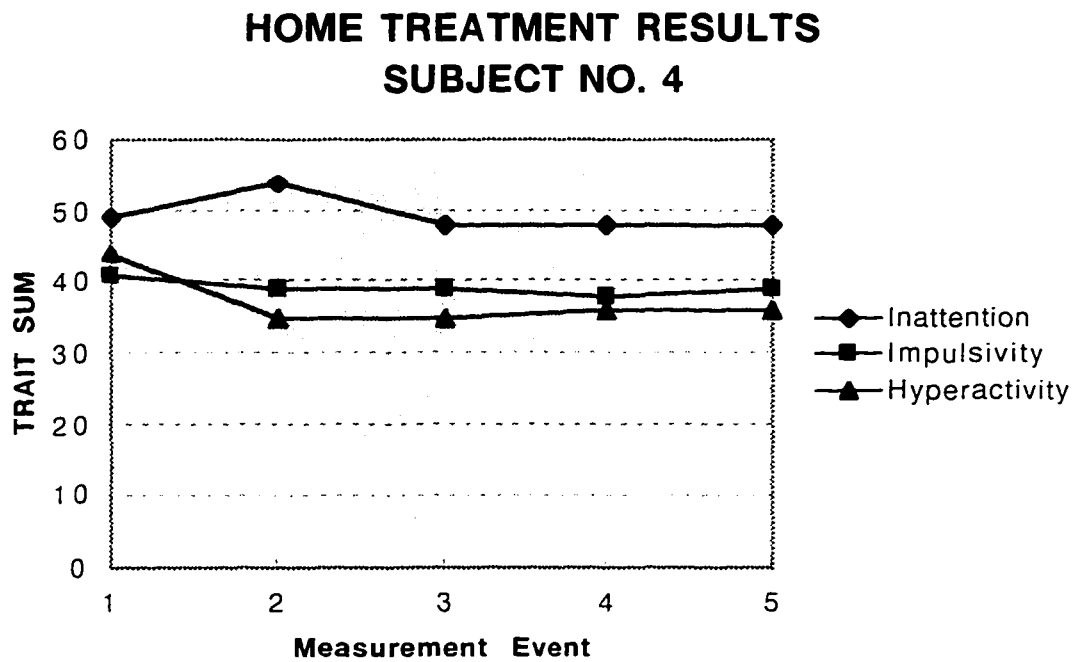
Table 4.1

Home Version

Design Phases	Inattention	Impulsivity	Hyperactivity
Baseline	49	41	44
After 1st Two Weeks	54	39	35
After 2 Weeks Off	48	39	35
After 2nd Treatment	48	38	36
After 2 Weeks Off	48	39	36

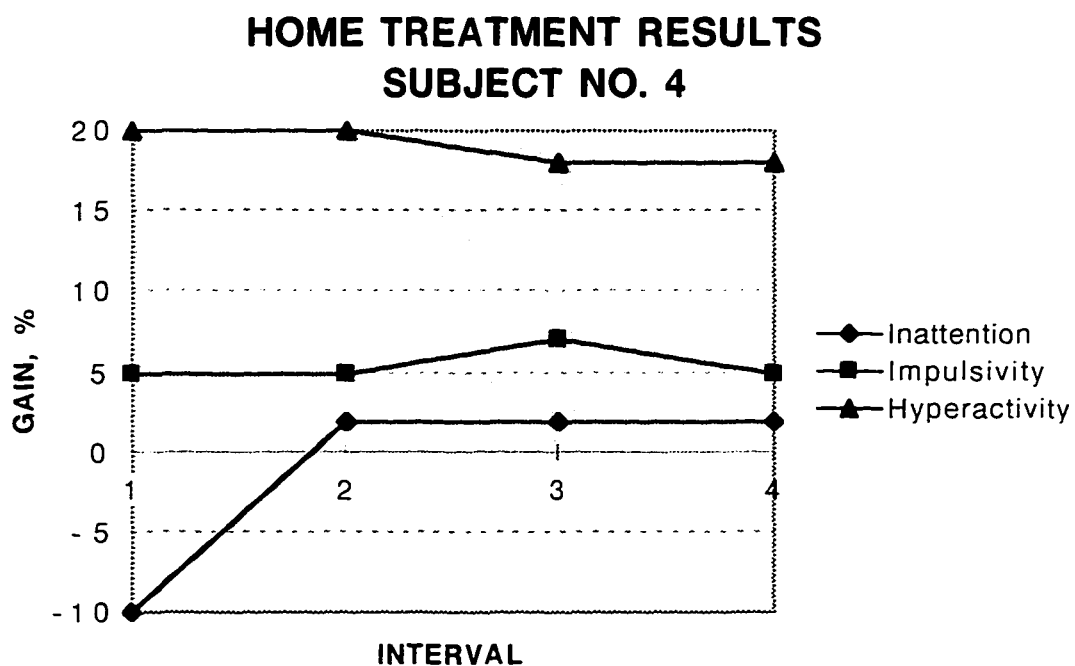
These results are graphically represented in the following figure. The impulsivity and hyperactivity variable decreased slightly and all three variables stabilized and were constant for the last four weeks of the intervention.

Figure 4.1



The net gain is represented graphically in the following figure. There was a 20 % gain in the hyperactivity variable, a five % gain in impulsivity and a two % gain in inattention overall in inattention.

Figure 4.1(a)



A replication study was conducted using the ADDES-Home Version: in addition, the school agreed to participate in the study and the results were completed during the fall semester, 1996.

Table 4.2
School Version

Design Phases	Inattention	Impulsivity	Hyperactivity
Baseline	19	4	7
After 1st Two Weeks	7	1	5
After 2 Weeks Off	5	3	4
After 2nd Treatment	4	1	4
After 2 Weeks Off	2	0	4

These results are graphically represented in the following figures. The trait sum results overall represent a decrease in behaviors from 19 to two in inattention; four to zero in impulsivity and seven to four in hyperactivity.

Figure 4.2

**SCHOOL TREATMENT RESULTS
SUBJECT NO. 4**

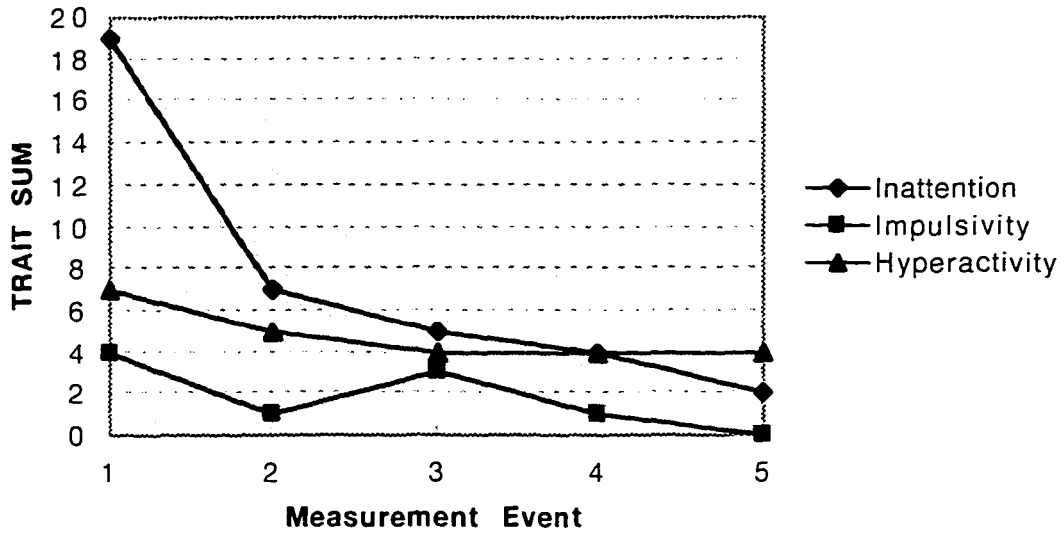
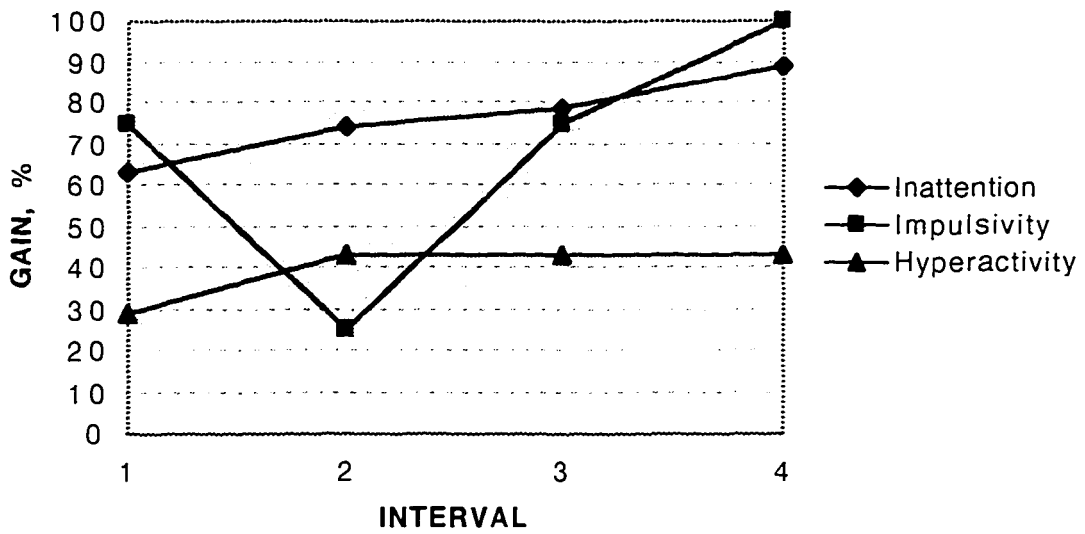


Figure 4.2 (a)

**SCHOOL TREATMENT RESULTS
SUBJECT NO. 4**



The net gain effect was positive on two of the three variables for the first interval and then all were the same or positive for the second interval. Since the net gain scores are represented in percents and there were small raw scores, the gains are somewhat exaggerated.

Following is the anecdotal documentation of immediate behavior changes during the two replication treatment periods of the technology:

First Replication Treatment Intervention Anecdotal Records

Date	Time	Behavior (before, during and after)	Comments
9/13/96	5:50A	Before: Climbing on the back of the couch. During: Squirming on the chair. After: Acting out the game show.	
9/13/96	3:25P	Before: Running through the house and getting into things. During: Didn't want to sit the whole 15 min. After: Playing loudly with his brother.	
9/14/96	9:00A	Before: Sitting in front of TV eating. During: Sat quietly. After: Sat on the couch and watched cartoons.	
9/14/96	1:10P	Before: Taping paper to the house. During: Squirming in the chair wouldn't keep eyes closed. After: Fighting with his brother.	
9/15/96	7:05A	Before: Quietly watching TV. During: Wouldn't sit still, wouldn't keep eyes closed. After: Acting out TV program.	
9/15/96	11:00A	Before: Sitting with Dad reading the ads in the paper out loud. During: Sitting in Dad's lap quietly. After: Taping paper to the house.	
9/16/96	5:25A	Before: Sitting and eating breakfast. During: Fidgeting. After: Watching exercise show.	
9/16/96	3:15P	Before: Playing outside. During: Singing. After: Playing "grocery store"	

First Replication Treatment Intervention Anecdotal Records Cont.

Date	Time	Behavior (before, during and after)	Comments
9/17/96	7:05A	Before: Watching cartoons. During: Refused to do! After: Crying and looking for his Cub Food Name Tag.	
9/17/96	3:22P	Before: Arranging his preferred groceries. During: Singing. After: Playing super-market sweep.	
9/18/96	5:30A	Before: Playing on the computer. During: Sitting quietly. After: Working on homework.	
9/18/96	3:15P	Before: Watching TV. During: Squirming around in chair. After: Working on homework.	
9/20/96	7:10A	Before: Rearranging the cabinets. During: Sitting quietly. After: Watching TV.	
9/20/96	3:10P	Before: Playing hot wheels. During: Wouldn't keep the machine on. After:	
9/21/96	8:10A	Before: Watching TV. During: Sitting quietly with his Dad. After: Reading the paper with his Dad.	
9/21/96	11:25A	Before: Eating lunch. During: Wouldn't keep eyes closed. After: Playing in the garage.	
9/22/96	7:45A	Before: Sitting with his Dad. During: Sitting with his Dad. After: Watching TV.	
9/22/96	12:05P	Before: Fighting with his brother. During: Wouldn't do it. After:	
9/23/96	5:30A	Before: Rearranging the kitchen cabinet. During: Sitting quietly. After: Watching TV.	
9/23/96	3:10P	Before: Playing in the garage. During: Fidgeting. After: Playing super-market sweep.	
9/24/96	7:00A	Before: Fighting with his brother. During: Yelling at his brother. After: Watching TV.	
9/24/96	3:25P	Before: Riding his bike. During: Talking. After: Playing with his cars.	

First Replication Treatment Intervention Anecdotal Records Cont.

9/25/96	5:15A	Before: Sleeping. During: Sitting quietly. After: Doing homework.	
9/25/96	3:40P	Before: Playing with his brother. During: Fighting with his brother. After: Watching TV.	
9/26/96	7:00A	Before: Playing on the computer. During: Sitting and talking. After: Chasing his brother through the house.	
9/26/96	3:10P	Before: Eating a snack. During: Talking. After: Playing with his groceries in his shopping cart.	
9/27/96	7:10A	Before: Watching TV. During: Yelling at his brother. After: Doing homework.	
9/27/96	3:15P	Before: Playing in the garage. During: Sitting quietly. After: Working on homework.	

End of first two-week replication treatment intervention.

Second Replication Treatment Intervention Anecdotal Records

Date	Time	Behavior (before, during and after)	Comments
10/11/96	6:45A	Before: Playing on the computer. During: Sitting quietly. After: Playing hot wheels.	
10/11/96	3:10P	Before: Playing with the flagpole. During: Talking. After: Playing with the flagpole.	
10/12/96	8:10A	Before: Sitting with Dad. During: Sitting quietly with Dad. After: Reading the paper with Dad.	
10/12/96	11:30A	Before: Playing in the yard. During: Talking. After: Raking leaves.	
10/13/96	7:05A	Before: Watching TV. During: Sitting quietly. After: Playing outside.	
10/13/96	11:30A	Before: Fighting with his brother. During: Yelling at his brother. After: Eating lunch.	
10/14/96	5:40A	Before: Watching TV. During: Wouldn't cooperate. After:	

Second Replication Treatment Intervention Anecdotal Records Cont.

Date	Time	Behavior (before, during and after)	Comments
10/14/96	3:15P	Before: Watching TV. During: Sitting quietly. After: Playing grocery store.	
10/15/96	7:00A	Before: Fighting with his brother over TV channel. During: Wouldn't do it. After:	
10/15/96	3:25P	Before: Paying outside. During: Fidgeting. After: Playing hot wheels.	
10/16/96	5:25A	Before: Rearranging his groceries. During: Fidgeting. After: Playing hot wheels.	
10/16/96	3:10P	Before: Watching TV. During: Sitting quietly. After: Fighting with his brother.	
10/17/96	7:10A	Before: Playing Jeopardy. During: Singing. After: Crying, he lost his Cub Food name badge.	
10/17/96	3:17P	Before: Taping things to the house. During: Talking. After: Playing in the garage.	
10/18/96	7:05A	Before: Fighting with his brother over TV channel. During: Did not want to do.	
10/18/96	3:10P	Before: Watching TV. During: Sitting quietly. After: Eating popcorn and playing jeopardy.	
10/19/96	8:18A	Before: Sitting with Dad watching TV. During: Sitting quietly with Dad. After: Reading the paper with Dad.	
10/19/96	11:30A	Before: Eating lunch. During: Talking. After: Playing on the computer.	
10/20/96	8:20A	Before: Cutting the newspaper up. During: Fidgeting. After: Taping coupons to the house.	
10/20/96	12:00P	Before: Eating lunch. During: Non-stop talking. After: Playing outside.	
10/21/96	5:25A	Before: Watching TV. During: Sitting quietly. After: Doing vacuuming.	
10/21/96	3:15P	Before: Playing with the flagpole. During: Sitting quietly. After: Playing with his flag.	

Second Replication Treatment Intervention Anecdotal Records Cont.

10/22/96	7:05A	Before: Watching TV. During: Talking non-stop. After: Playing outside.	
10/22/96	3:05P	Before: Playing in the garage. During: Fidgeting. After: Playing super-market sweep.	
10/23/96	5:12A	Before: Watching TV. During: Wouldn't sit still. After: Fighting with his brother.	
10/23/96	3:18P	Before: Playing with his flag. During: Sitting quietly. After: Doing homework.	
10/24/96	7:00A	Before: Playing on computer. During: Singing. After: Playing outside.	
10/24/96	3:10P	Before: Playing with the flag pole. During: Sitting pretty quiet. After: Doing homework.	
10/25/96	7:13A	Before: Watching TV. During: Wouldn't do full time. After: Crying because he couldn't find his name tag.	
10/25/96	3:30P	Before: Playing outside. During: Talking non-stop. After: Fighting with his brother.	

The results of the replication study follow. The results were not as positive as perceived by the mother. There were net gains in all variables and they were maintained throughout the study.

Table 4.3

Home Version Replication

Design Phases	Inattention	Impulsivity	Hyperactivity
Baseline	49	41	44
After 1st Two Weeks	54	39	35
After 2 Weeks Off	48	39	35
After 2nd Treatment	48	38	36
After 2 Weeks Off	48	39	36

Figure 4.3

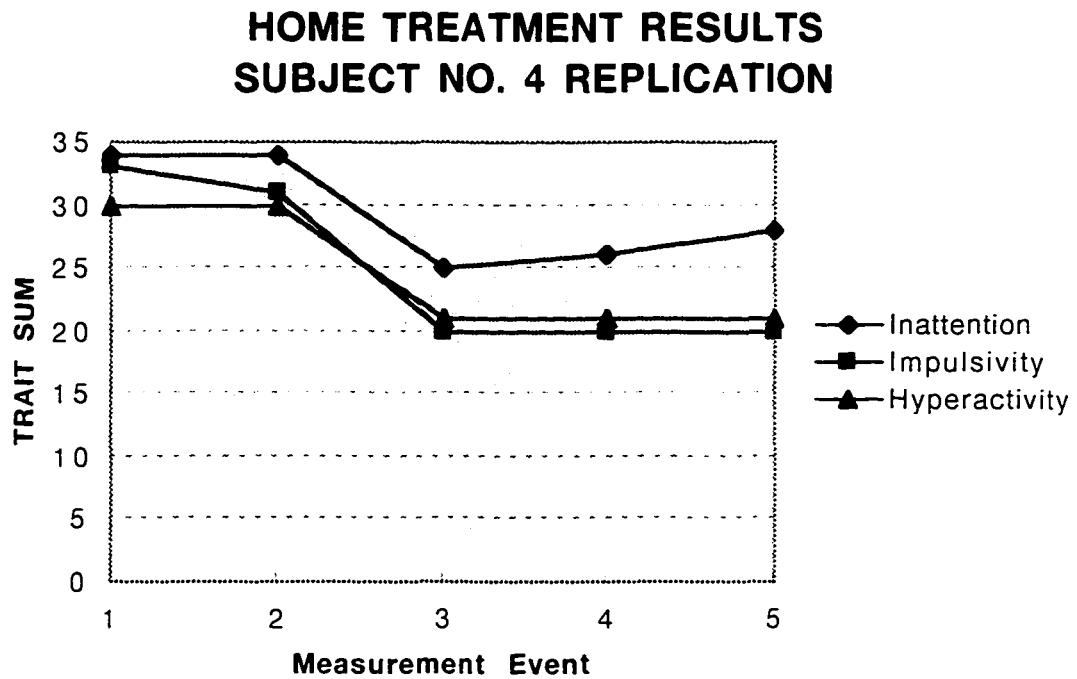
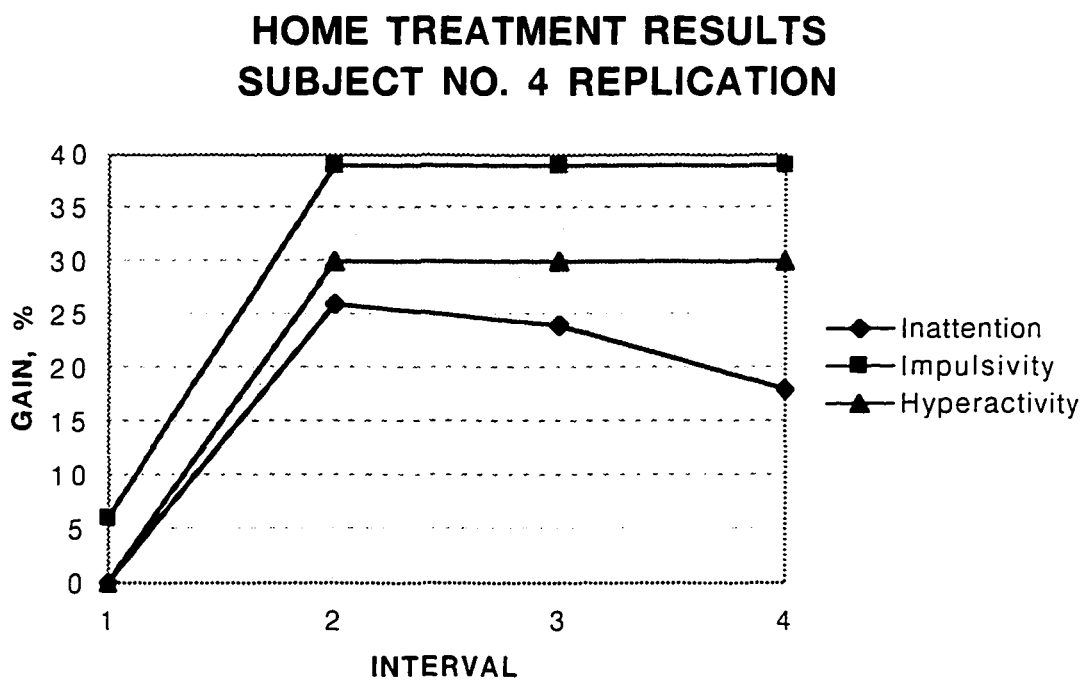


Figure 4.3 (a)



The net gain effect was very positive in the home replication study and the school intervention results. The continued use of the light/sound technology without a long break produced more positive results. The parent used the technology seven days per week instead of just the five school days.

Post-Intervention Data

Casey's mother reports being very happy that he is no longer classified EMI. She also felt he had benefited from the light/sound technology. After the first intervention she wrote on the back of the ADDES-Home Version form: "Casey has made great improvements in his social skills. He makes his brother and I act out a talk show every afternoon. He is letting us into his world now."

The researcher called Mrs. A. to clarify some information and Casey picked up the phone. He chatted constantly and it was very difficult to hear Mrs. A. She was not bothered by his interrupting and did not request that he hang up. He kept asking the researcher what her name was and then he would say, "Hi, Pat!" He then would ask again what the researcher's name was and when asked, "Who am I?", he would again greet the researcher and use her name. He also asked if she ate dog food and said that he did. His voice was very intense and he spoke very rapidly.

A second phone call resulted in a conversation with Casey's father and he again got on the phone but was told to get off which he did. The mother and aunt report Casey loves the telephone and will often use it and leave it off the hook for hours.

Mrs. A. wrote a paragraph at the end of the study when she sent the forms. The note said: "Casey's socialization skills have improved dramatically. He lets us in his world more and more everyday. He interacts more and more with other children. He is doing terrific in school! He is no longer classified as EMI."

She also sent a paragraph written by the teacher and Casey's aide: "Casey is much calmer when he arrives at school. There are not as much loud or inappropriate voices or behavior. He can work independently for longer periods of time. He read an entire book of about 40 pages by himself during free time. He certainly seems more focused. He has adjusted to the school routine and seems to really enjoy being at school. There is more positive interaction between Casey and the other students. At recess, he runs and plays with the other children many times. He often asks if he gets to come to school tomorrow. He seems to know on Friday that he doesn't have school the next day. I think he would like to go even on the weekend. Casey is having a very good year."

Summary

Casey is an eight year old twin with autism. He has had a long intervention history and is currently being mainstreamed in a regular second grade classroom. He was reclassified at the end of the replication study and the EMI label has been dropped. He is now on LD monitor status.

Mrs. A. used the light/sound technology during the summer, 1996. She noticed some positive results in socialization skills. When the study was replicated there were positive net gains in both the Home and School Versions of the ADDES. In addition, the anecdotal data and summary paragraphs were very positive. For example, the teacher wrote, "Casey is much calmer when he arrives at school. There are not as much loud or inappropriate voices or behavior. He can work independently for longer periods of time. He read an entire book of about 40 pages by himself during free time. He certainly seems more focused. He has adjusted to the school routine and seems to really enjoy being at school. There is more positive interaction between Casey and the other students. At recess, he runs and plays with the other children many times. He often asks if he gets to

come to school tomorrow. He seems to know on Friday that he doesn't have school the next day. I think he would like to go even on the weekend. Casey is having a very good year."

Mrs. A. included Casey's report card in the packet of ADDES forms and anecdotal records. He made the honor roll with two A's, a B plus, a B and four S's. He had not missed any days from school and his teacher wrote a note saying, "I am really pleased so far."

On the school intervention the percent gain scores were positive for all three variables. The replication intervention in the home reported positive gain scores in all variables and they were lasting throughout the study. This subject wore the technology without a break of several months that was in the other two replication interventions.

Case Report Number Five

Background

Case number five is a three and one half year old male herein referred to as Mikey, who lives with his mother, father and older sister in a middle class neighborhood. Mrs. B., is 44 years old is and a real estate agent; Mr. B., who is 39, is on active military duty. Mr. and Mrs. B. have been married six years and have a five year old girl who is described by Mrs. B. as "very bright." Mrs. B. was married previously and has a 23 year old son who she says was on Ritalin for AD/HD from the time he was seven until he was eleven.

When the researcher arrived at the home for the interview, Mrs. B. had just taken Mikey to the sitter after speech therapy. She said, "Mikey's not himself today." He had exhibited major tantrums and although "his behavior is the main problem," she felt the reason for the display that morning was due to her husband baby-sitting all weekend while she worked.

There are lots of health problems in the extended family: her mother is diabetic and has a heart condition, her father has cancer and both grandparents died of cancer. Mr. B.'s father has multiple sclerosis; his mother has cancer and his brother has celiac disease.

Both Mr. and Mrs. B. have high school diplomas. She said she had always wanted to be a lawyer and believes she would have been a good one. She said she and her husband have different ideas about ways of dealing with children: he yells a lot and spanks. She believes you should "pick your battles." She continued, "Mikey is a big control freak and once he snaps, it is difficult to get him calm again." Just getting him into a car booster seat is a battle but she said his behavior has gotten better.

Mrs. B. requested CVS testing while she was pregnant with Mikey. She requested this instead of amniocentesis because tissue can be used and she felt it was less intrusive. It can be done between the 10th and 12th week of pregnancy. She wanted to know if anything was wrong with the baby because of her age and she "did not want a handicapped child." Absolutely nothing showed up as being wrong with the baby.

Mrs. B. did not use drugs or alcohol during either pregnancy. She did experience severe gall bladder attacks while she was pregnant with Mikey and took Tylenol for the pain. She had gall bladder surgery when he was four months old.

Mrs. B. reported that labor had to be induced with both children.. Her daughter weighed over nine pounds and Mikey weighed 8 lb. 9 oz.; both were delivered vaginally. She reported his APGAR scores were "almost perfect" and he was a "beautiful baby": not at all like her daughter who was somewhat misshapen due to a difficult delivery.

When Mikey was three days old, Mrs. B. had to return to the hospital due to a bad bacterial infection. Her temperature was very high and she was told if she did not go back, she would die. She is allergic to most antibiotics which further complicated her recovery.

She was going to nurse but things did not go well in the hospital and her illness finalized the decision. Her sister came down to help out while she was in the hospital. Mikey was given Similac but he was allergic to it; she added that all three of her children had been allergic to milk.

When asked about Mikey's temperament, Mrs. B. reported he had "always been kind of a loner. He didn't like being held. He liked to be in a playpen for hours." She also said he liked the Johnny Jumpers swing and did not like being on the floor. She further described Mikey as a "child of little needs" who "didn't cry a lot to sleep," and did not want to be rocked or held when he cried. She said she would put him down to sleep wrapped in a blanket like they do with newborns in the hospital.

Mrs. B. says Mr. B. is very accepting of Mikey's disability. She said she doesn't feel it affects his ego and he is not embarrassed by it. She did say that she is the initiator of activities with the children. She urges him to take them places and do things (i.e., McDonald's Playground) but he doesn't. She said if it was only Mr. B., Mikey "wouldn't be where he is." She said the type of job she has carries a lot of stress with it and it takes a lot of time so they never sit down as a family to eat. Instead, they use TV trays because she feels Mikey needs something going on while he eats. Most of the time they eat out because "My husband is never here." She concluded by saying her job, with its related time and stress factors, has probably hurt their marriage more than dealing with Mikey's problems.

His sister is very accepting of Mikey according to Mrs. B. even though he "gets away with more." She reported they interact really well: "She is like a little mother."

Mrs. B. reported she makes more money than her husband and "All he has to do is go to work." She has the responsibility for job, home and kids but she said, "I accept it; this is what I have to do; its not that bad. I don't have to cook!"

Developmental Milestones

Mrs. B. reported Mikey didn't crawl: "He did not like anything against his belly." He started to stand up in his playpen at five months and was right on schedule for walking (11 months) and talking baby talk (gaga) and a few words by the time he was a year old. When he did not continue to develop language, other people excused it by saying he had a sibling to do the talking so she believed them and wasn't alarmed. "And then came that day!" Mikey was 22 months old and she said to herself, "Something's wrong here. He should be talking more."

Every time Mrs. B. took Mikey to the pediatrician, she would end up crying because he was so uncontrollable. She would put him in a stroller to have him examined. She reported even to weigh or measure him cause him to "flip out" if they tried to take his clothes off. He would run from one wall to the next and go "berserk." Only when they were out of the office and back home would he calm down.

Mikey is not yet completely toilet trained. He is more regular at school and is pee-pee trained only. At home, it is a "hit or miss" situation because of the schedule Mrs. B. has in real estate. She says her husband isn't home a lot and doesn't do much with the kids; he doesn't work on the potty training when he baby-sits. Mrs. B. reported Mikey had always had "loose bowels" and she had a battery of tests done but no conclusive results were determined.

When Mrs. B. finally went to a pediatrician and said, "I think something's wrong." The doctor started asking a lot of questions that she recognized as relating to autism so she

asked him. "Do you think he is autistic?" The doctor was shocked and asked her how she knew about autism. He wouldn't give her a diagnosis but tried to comfort her because he had a handicapped child. He told her she should be concerned and needed to consult a developmental specialist. She tried to make an appointment that day but there was a two month waiting list. She said to herself that there was really something wrong and read a book on autism. Her reaction was "everything fit" and she decided that she was not going to wait two months before taking action so she started exploring as she said. "What's out there?" She said she did not need a doctor to tell her that so she called and interviewed the early intervention specialist for the city of Virginia Beach. They told her Mikey was "tactile defensive." She was disappointed but got him into speech therapy five days a week.

Medical Factors

Mrs. B. took Mikey to the Developmental Specialist and was given a diagnosis of severe communication deficit. She was told that if something wasn't done to change the situation, Mikey would end up in an institution. She then consulted a neurologist and told him she wanted to know what was wrong. She felt this doctor is the "only action in town" in that he didn't beat around the bush. He told her Mikey had autism after performing an MRI, EEG, and ABR (hearing test done while sleeping).

In addition to the problem with loose bowels, Mikey was tested for a reflux problem due to spitting up constantly. The test was negative and Mrs. B. later learned that the reason for the difficulty was an internal sensitivity to many foods. She reported Mikey was obsessive about the shape, color and texture of food; for example, he will only eat tan foods like poptarts and bananas but he likes apples as long as they don't have red on them.

He likes the color orange so he will eat carrots. She said he was attracted to "long" stuff (hot dogs) but mashed potatoes would "set him off."

The neurologist has seen Mikey every six months since the original evaluation and Mrs. B. reports he can't believe the "tremendous change" in Mikey. He is doing so well that the doctor is amazed. Mrs. B. said when the doctor told her Mikey was autistic, she thought to herself, "It is just a label; who cares?" She said the doctors don't tell you what to do and have not asked her what she has done. She reported, Mikey has "had more therapy than any other kid you have ever seen!" She observed Mikey using sign language to communicate and reacted by saying, "This is not enough!" She has engaged two private speech therapists so that they can work on different things. She requests them to work together in programming and Mikey also receives speech therapy at school.

Mrs. B. has a friend who has a child with autism who went to visit her family in Canada. The friend's uncle is a chiropractor and had been working and conducting a study with 40 children with autism who were progressing significantly after only a few sessions of chiropractic adjustments. Mrs. B. asked for a referral but the uncle did not know one in this area. A week later one of Mrs. B.'s clients spoke of going to a chiropractor and she asked the client if the doctor worked with children. She called the chiropractor and asked if he would work with Mikey, explaining some of his behaviors; although he was apprehensive, the chiropractor told her to bring Mikey to see him and he would "make them comfortable." Mrs. B. said they set up a room just for Mikey and he is allowed to make all the noise he wants. She said it was a struggle at first but now Mikey gets up on the table and lays there for them to the chiropractor to make the adjustment.

The theory Mrs. B. related concerning the chiropractic treatment is that there is a bone out of place in many children with autism that causes pressure on an artery in the

brain. Mrs. B. stated that her chiropractor is "not out there to make money, he is out there to make a difference." She has seen incredible changes since beginning this therapy. Mikey has had treatments three times per week since July, 1995. Mrs. B. reported that a week after Mikey started this therapy, (he was around 30 months old) he was in a swimming pool in the backyard. She was holding him on to him while he was in the pool even though he hated being touched. He kept pulling away from her to get to another child. Mrs. B. put him on a raft with the child (a little girl) who had been there to play before. Suddenly Mikey wrapped his arms around the child and "held on." Mrs. B. said she was "floored" and felt somewhat jealous. She thought, "Wow!" and Mikey screamed when she tried to pull him away from the girl. Mrs. B. said she had to literally pull him off the child. After they were out of the pool, Mikey walked over and took the little girl's hand, gently placed it in his and gazed into her eyes in what his mother described as a very loving and sexual way. She further described the event as being like Mikey had experienced an "emotional surge" but she said, "Ever since that day, he has allowed us into his life." He has started to talk more and had a real breakthrough in emotions. It was gradual but now Mikey "hugs us, kisses us, lays beside me on couch to watch TV, sits on my lap and initiates these actions now." Mrs. B. said they have had the child come back since that day but there has not been another strong reaction, just normal interaction.

Mrs. B. said she is paying for another child with autism who is four years old to go to the chiropractor and since he started, the child has begun to sing and talk in sentences.

Educational Background

Mrs. B. does not give much credence to tests; she said, "I can take them or leave them; a test is only as good as the tester." She read everything she could about autism and continues to do so. She shared a newspaper article she had cut out concerning creating a

virtual reality atmosphere for individuals with autism. She said she explores every avenue to deal with Mikey's problem.

When asked about facilitated communication, she said she did not think it made sense; it wasn't logical and did not like the fact that it required an aide to communicate.

She stated her philosophy by saying, "I think the brain is self-healing." She said, "I read a lot and some things kept popping up like lack of oxygen to brain and eye contact in children with autism." Mrs. B. also feels that in order to progress and heal, the brain needed stimulation. She says she is a very logical person and it just made sense to her to take the course of action she has pursued to deal with Mikey's autism educationally.

In addition to obtaining services from the school system, she put mirrors up in her house; there are two in the den and one in his room. "I figured if he could see himself more, he would look at others," and she felt imitation was important. He could look at TV and then look in the mirror and imitate it. "It seemed the logical thing to do."

Mrs. B. had an electrician install an outlet in Mikey's closet so she could play classical music every night believing that hearing the notes would stimulate his brain. She is considering putting a strobe light in his room.

Mikey's fine and gross motor development were reported by Mrs. B. to be "off the scale, great!" She said, "White (color) freaks him out." He doesn't like paste and the OT had been working with him to put his finger in Elmer's glue and spread it on paper. She said he wants to do it and he tries so hard but he screams and behaves as if it is "against everything that is in him." She remarked, "I understand because string freaks me out!" She said she works with Mikey every night with different types of textures: i.e., scratchy, soft, and she uses Playdoh a lot.

Mrs. B. describes Mikey as having a brain that thinks in an orderly way. She commented, "He is good at building blocks but he doesn't want to knock them down. The kid is bright - he's got it! The kid's been great!"

Mikey participates in a preschool program for children with autism that is run by SECEP. He is the youngest in the class. This is the second year he has been there and Mrs. B. said the teachers report to her that he is the most improved. She requested the afternoon placement for Mikey so that he would be in the class with the older, presumably higher functioning and more developed students.

Pre-Intervention History

The ADDES-School and Home Versions could not be utilized because the evaluation scale was deemed inappropriate to assess Mikey due to his young age (three and one half). Therefore, baseline data was gathered through parent and teacher interviews and observations by the researcher.

The researcher observed Mikey in speech therapy, his classroom and a session in occupational therapy.

In speech therapy, Mikey was participating with another student. He was immediately distracted by the researcher's presence and stopped following the directions of the speech therapist. He smiled at the researcher, then hid his face in a shy way, peeking out in a flirting manner to look at the researcher. He put his head in his arms when the researcher ignored him and he would not respond to the therapist. The researcher walked away and removed herself from his view. Mikey finally began participating again; they were singing the song "Bingo" and he got up and jumped. His clapping was somewhat haphazard and mixed with jumping. The speech therapist had to fix his shoe and then he saw the researcher again and stopped participating. The researcher again removed herself

from Mikey's view and he started playing with the puppet that was a part of the next song/game. He took the puppet and got down behind the table, using the puppet with his left hand. At one point he said, "I love that song." The puppet was an alligator and he grabbed the therapist's hand and said, "Finished!" He complied with the speech therapist's requests and was verbally and physically rewarded with "Good job, Mikey!" and a hug. Mikey hit at the therapist with the Monkey which was being used in the song during the speech session. The teacher turned the lights off due to the level of noise in the room and Mikey immediately reacted saying, "It's dark!" and "Why dark?" He continues to persevere about the dark. He hugs and kisses the speech therapist good-bye at the end of the session.

The teacher tells Mikey to check his schedule but he refuses. She sits him in a chair; he screams and starts throwing the chair and crying. The teacher gives him a forced choice to check the schedule or sit in the chair. He refuses so she sits him in chair where he continues to cry while observing what is going on in the classroom. He does not try to get up but grabs some earphones that were nearby. The teacher tells him to put them down and he screams again. He turns the chair over and falls with it, crying, "I fall down." He continues to "try" to cry but again he is looking around the room. There is another researcher in the room: the coordinator of the program is also observing. Mikey stops crying momentarily and looks at him. The coordinator remarks, "Nice sitting quietly." Mikey immediately reacts negatively by crying and moving the chair. He hides his face but peeks out to look at the researcher. The teacher has been asking him if he is ready to work and using the 123 Magic approach which she later told the researcher "usually always works." Finally the teacher walks him to the chair and tells him to sit again and he might get a cocoa puff. Mikey won't comply. The teacher then forced him to check his

schedule: he cried the whole time. She keeps counting and he keeps saying, "No." The teacher keeps asking him if he is ready and he says, "No." He continues to scream but there are no tears.

The OT aide comes to take Mikey to his session which, according to the teacher, he usually loves. The coordinator tells the aide he believes that the reason all this started was that his schedule indicated OT and she was late. Mikey will not say he wants to go to OT and the teacher won't let him go until he says it. She keeps asking, "What do you want to do now?" He gets upset and tries to turn the chair over again and she puts him back in the chair. He continues to tantrum and finally the teacher has to physically hold him because he is so out of control. She finally gets him to the door and tells him to open it so he can go with the aide to OT. He refuses and she again gives him a forced choice - OT or work. He goes back to seat on his own (still crying) but watches out of the corner of his eye. Finally, the teacher takes his hand and opens the door; Mikey goes with aide and is immediately quiet. He goes up a set of stairs in the hall and hangs on to the rail. He sits down and won't continue on; the aide starts to force him to go and he says, "Stay step, please." She tells him to come on after a few minutes and Mikey complies. He goes into the room and announces, "I been crying." to the other staff in the room. The aide asks him what he wants to do. He chooses several activities and she makes him say what he wants. He says, "I don't want sing" but he wants to swing on the horse swing that moves back and forth. The aide sings and Mikey is given a piece of candy which he eats. Mikey then chooses to play with a bat and ball. He hits the ball from left to right but demonstrates good eye hand coordination for his age. He is told to get the ball and put it away before he is allowed to use a huge air mattress; he says "I turn on" indicating he wants to activate the pump to get the air into the mattress. He does so and then jumps up and down counting 1

to 10 by himself while he is bouncing on it. He asks to release the air when he is finished and aide makes him say, "Turn off, please." She rolled him in the mattress as it was deflating and he laughed, seeming to enjoy it. She told him to come back to her and he replied, "I can't." He does after she says, "Ready, 123, go!" He asks to "Go see Sandy" and "Ride my bike." He was told to go to the bike and sit, which he does. He rides it down the hall back to class but runs into the walls deliberately, commenting, "Oh, Oh." "I crashed." "What happened?". "Oh, man!" Back at the classroom he is told to open the door twice and does. The teacher asks him to check his schedule, "OK?" and he says "OK!" Mikey then goes to the bathroom, checks in at his work station with prompting and tells the teacher, "I fall down." She tells him to work and he does, putting the finished product in the basket by his desk. He rings the bell on his desk to indicate he is finished and is verbally and physically rewarded with "Good job!" and a hug. He repeats with another set of work and again rings the bell and receives reinforcement.

The teacher assistant comments to the researcher that she is "shocked" at his behavior and he wasn't usually that bad. Mrs. B. had reported earlier that behavior is Mikey's main problem.

The OT aide reported Mikey has trouble with transitions. She has worked with him since the previous March until the end of the school year. She has observed a big improvement in Mikey and in particular fine motor skills (good at puzzles).

Light/Sound Technology

When Mrs. B. heard about the light/sound technology study, she immediately wanted Mikey to participate. She said, "It makes sense and goes along with everything I have been trying to do." She wanted to know if there was a way it could be incorporated

into a room and the researcher shared the information about the Snoezelen Room and Dr. Sommer's attempt at creating such a room at the Chileda Institute in Wisconsin.

As discussed earlier, the ADDES-School and Home Versions was not an appropriate evaluation instrument for Mikey due to his age. Mrs. B. was asked to keep anecdotal data when he wore the technology. She had said she would but when she was asked about it she said she was not able to do so due to the demands of her job and lack of time.

Mrs. B. wanted to be the one to try the technology on Mikey because of his young age and tactile defensiveness. She realized that the design would not work in its present configuration because Mikey kept pulling off the ear phones and glasses and playing with them. She asked the researcher if she could modify the design by incorporating it into a helmet. She attached the glasses to the helmet by glue and the earphones were permanently wired inside the helmet. The technology would run by battery and would be more portable (could use it in the car) and she tried having him to wear it while he was asleep.

When Mrs. B. was asked about the results she had observed, she said she felt the technology definitely was helping Mikey. In particular, she had noticed his social skills had improved and that he was more calm after the sessions. She said the calmness was not permanent but felt that was because even though she had tried to have him use it on a regular basis but the hours of her job had precluded a regular routine with the helmet. She felt it would be better if the school would have him use the technology so that it would be done on a regular basis.

The mother and the researcher met with the teacher and coordinator and made arrangements for Mikey to use the helmet at school. The teacher was very cooperative but she has a class of very difficult youngsters and does not always have time to write the

anecdotal remarks. She also felt the ADDES-School Version was inappropriate as had the researcher and said she would rather report verbally the changes she observed.

Basically, Mikey is wearing the helmet at least twice per day for about five minutes. He is given a choice after he finishes his first work session to use the helmet or something else (the teacher tries to make it something she know he won't want). He always chooses the helmet and the other students are interested and want to wear it which delights Mikey. He then has another work session and after that he uses the technology again.

The teacher reported she had seen improvement and he was calmer after the sessions. The most dramatic results reported by the teacher were in his socialization skills. She related the following example. Mikey is mainstreamed in a kindergarten play period once per week. The first week (before the technology) he played by himself and was non-compliant. After using the helmet for a week, he went to the play period and the teacher reported, "His social skills were phenomenal!" He played with the other kids and there was total interaction. When Mikey arrived at the kindergarten class, he greeted the teacher and said, "Hi, buddy!" He followed in line; said "Hi" to another student and called him by name; got a drink of water with everybody else, and when the whistle blew (it usually freaks him out), he lined up and made a complete transition with no problems.

Some of the teacher's other remarks were that Mikey seemed to enjoy the helmet; he liked showing it to everyone; was very compliant after use; sat appropriately and did not want to start work afterwards. There were four other references to being compliant and starting his work.

The teacher is going to try to have Mikey use the helmet when she senses he is about to "go off" but doesn't want him to view it as aversive or punishing.

The OT assistant also spoke about Mikey's problems with transitioning having improved (since the day of the initial observation). She reported a great improvement in his social skills. He now asks for a change of activity and "asks for help appropriately."

The researcher observed Mikey again in his classroom after he had been using the helmet for several weeks. The teacher had not used it for two days because the battery was dead. She said Mikey had brought the console to her and gestured for her to make it start and that is when she discovered the battery was dead. The researcher replaced the battery and Mikey was observed using the technology after his first work session. He was very adept at putting the helmet on and punching the buttons to start it. Occasionally, he would pull out the earplug and eye-stim connections but would immediately put them back in the correct hole. He was again distracted by the researcher and took the helmet off to smile at her.

Post-Treatment Data

Mrs. B. was asked by the researcher if she would have had Mikey aborted if she had known how he would be. She replied, "Absolutely not, he is not that severe. I have had a lot of joy out of Mikey. No way would I trade him. He has been a learning experience and a challenge." She said when she left the doctor's office where she had been told he would end up in an institution, she had said to herself, "No way is this going to happen." She doesn't think you should "give up on a child." She remarked that she "had felt very guided" in finding help for Mikey and she said, "No one thing can make the difference." Mrs. B. said, "Just look at Einstein! He had learning problems." She added she just wished she didn't have a full time job.

When asked what she felt was ahead for Mikey, Mrs. B. said that by the time he gets to kindergarten, she hopes he will be able to "blend in." She said that "Mikey will always be a little different - eccentric because he will always be autistic."

The teacher and parent wish to keep using the technology since it has only been used for six weeks.

Summary

Mikey is a three and one half year old child with autism who, according to his mother and teacher, has made a great deal of progress since being diagnosed at 22 months of age. His mother has been very pro-active about exploring any avenue to deal with her son's disability. When she heard about the light/sound technology, she immediately contacted the researcher and said, "It makes sense, I want him to be in the study." The researcher had reservations about Mikey's age, but his mother adapted the technology into a helmet and he chooses to wear it at school. He does not wear it for long periods but he uses it at least twice per day. Both the teacher and parent reported positive results particularly in the area of social skills.

When the researcher went to the school to pick up the technology, the teacher asked, "You aren't going to take this for good, are you?" She reported when asked that Mikey had "been so good for the last three weeks" that she wanted to continue using the technology with him. She said, "Everybody has noticed the difference."

The technology has been worn on a steady basis for six weeks unlike the other cases that had intervals on and off the technology for measurement purposes. Since Mikey was too young to utilize the ADDES, the researcher allowed him to use the technology without following the proscribed protocol for the ADDES evaluation.

Cross-Case Analysis

The five case studies documented in this research represent a variety of characteristics. All of the subjects were male and the ages ranged from three and one half to nine. The grade placements were preschool to grade two but most of the subjects were not in their age appropriate grades due to the delays their development. All of the subjects were on at least one medication and three of them were on two or more. The multiple medications/interventions and the frequent changes of medication/interventions were confounding to the data collected and limited the interpretation of the data.

Functioning levels of the five cases have been approximated due to the difficulty evaluating students with autism. Levels ranged from those with mental retardation to those of average to above ability as measured on batteries of tests.

The three variables measured by the ADDES were Inattention, Impulsivity and Hyperactivity. Results of a summary comparison of the results on those variables of the four cases who were evaluated on the instrument are presented in the following graphs. Replication data is also included.

Figure 5.1

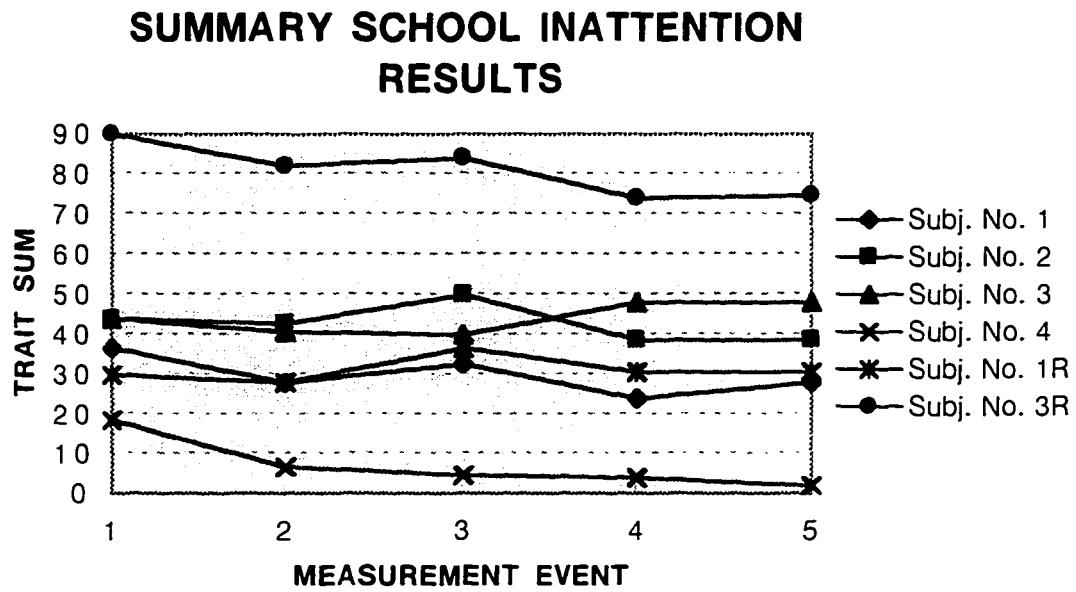


Figure 5.1 (a)

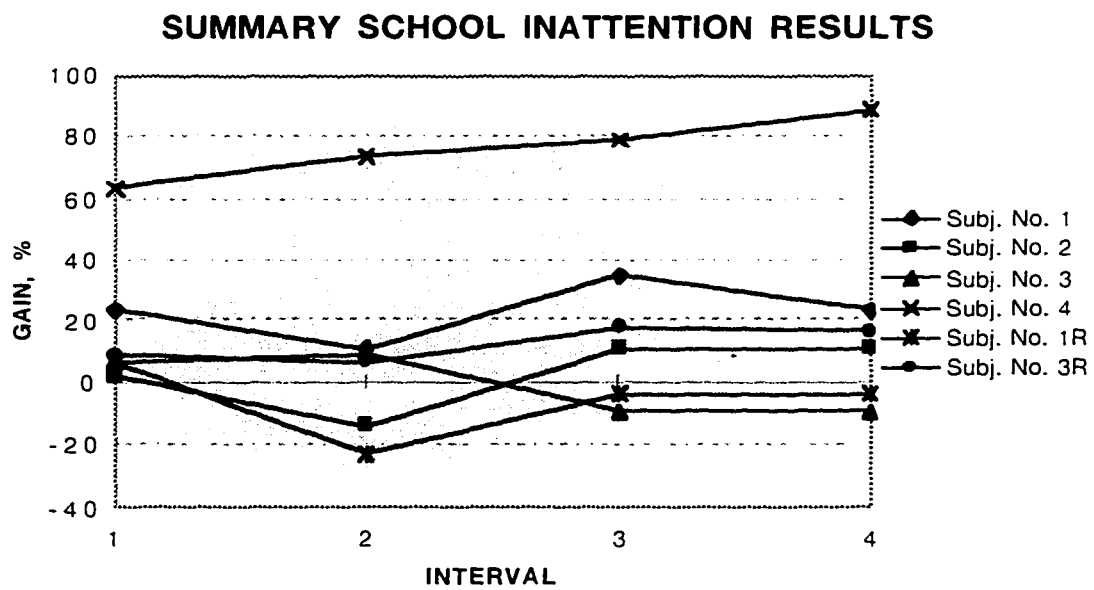


Figure 5.2

SUMMARY SCHOOL IMPULSIVITY RESULTS

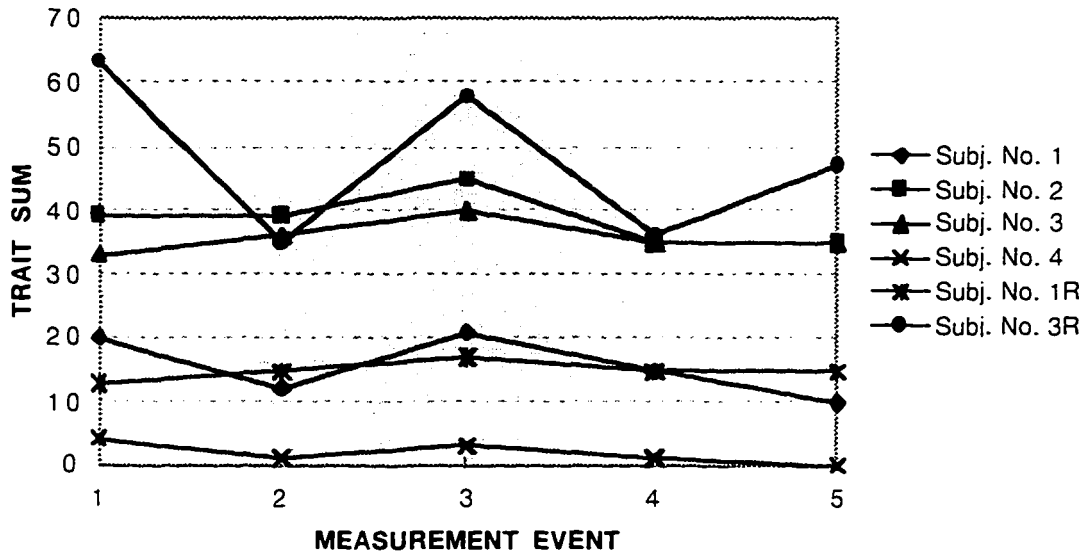


Figure 5.2 (a)

SUMMARY SCHOOL IMPULSIVITY RESULTS

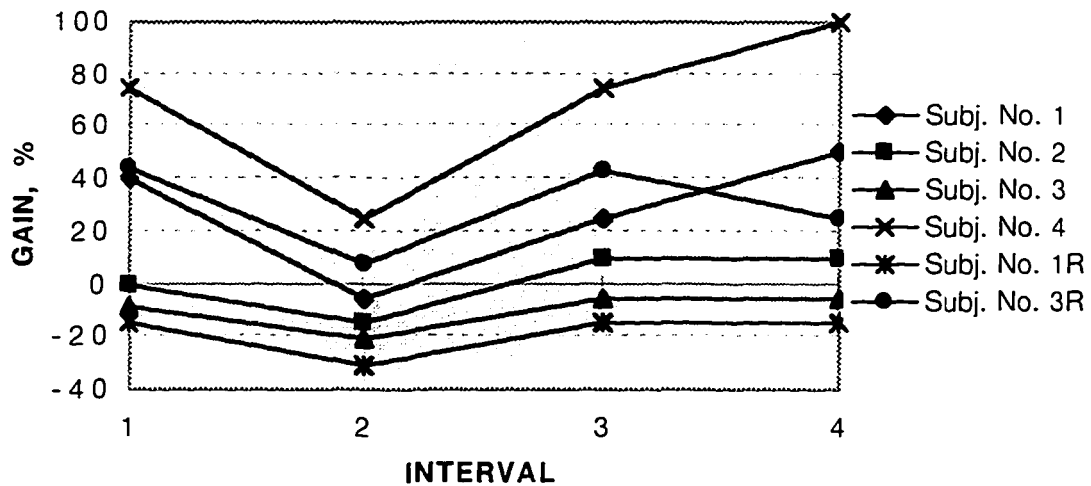


Figure 5.3

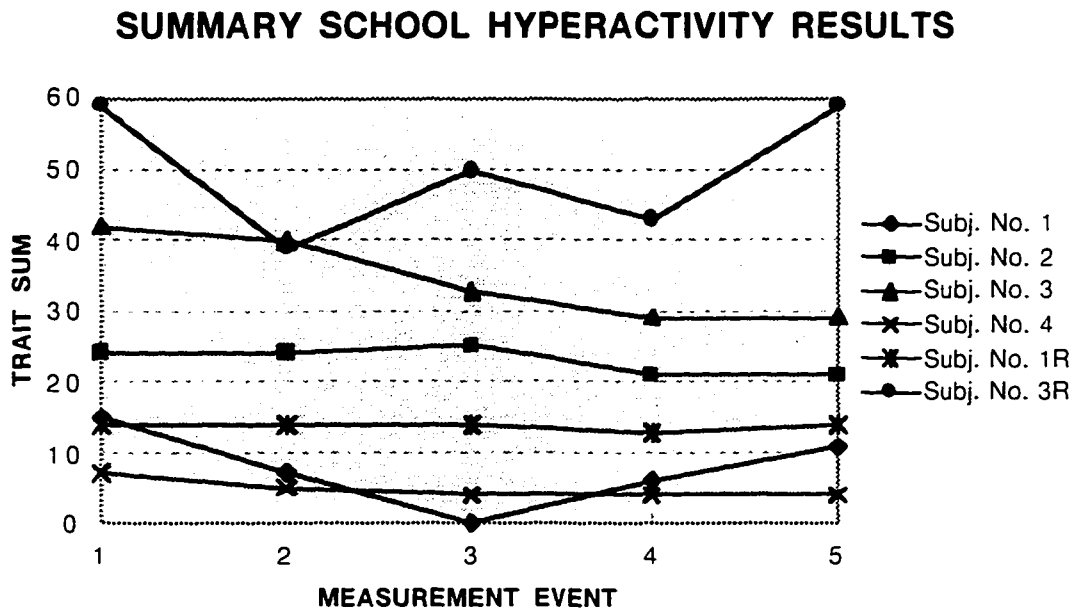


Figure 5.3 (a)

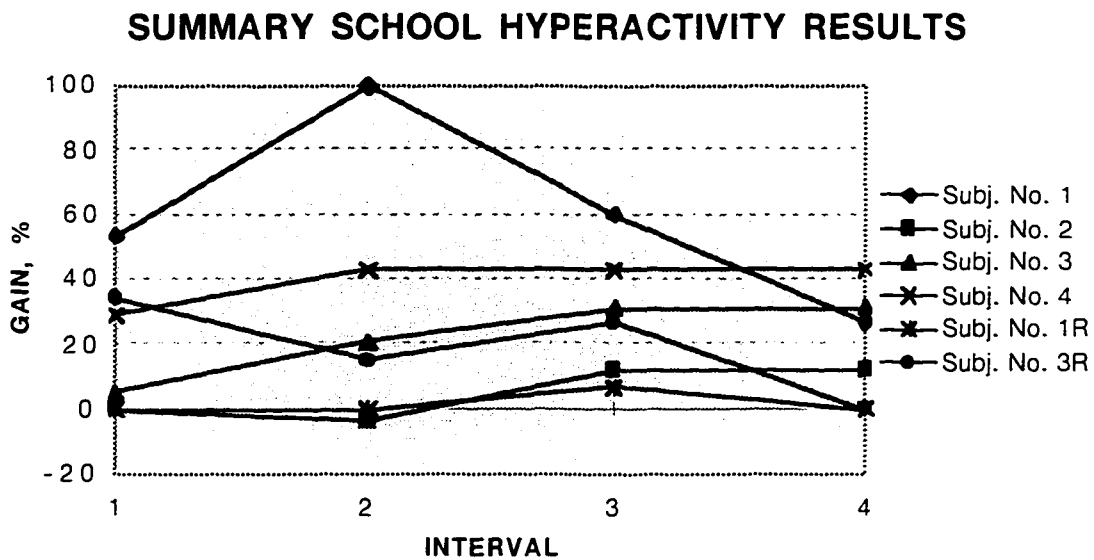


Figure 5.4

SUMMARY HOME INATTENTION RESULTS

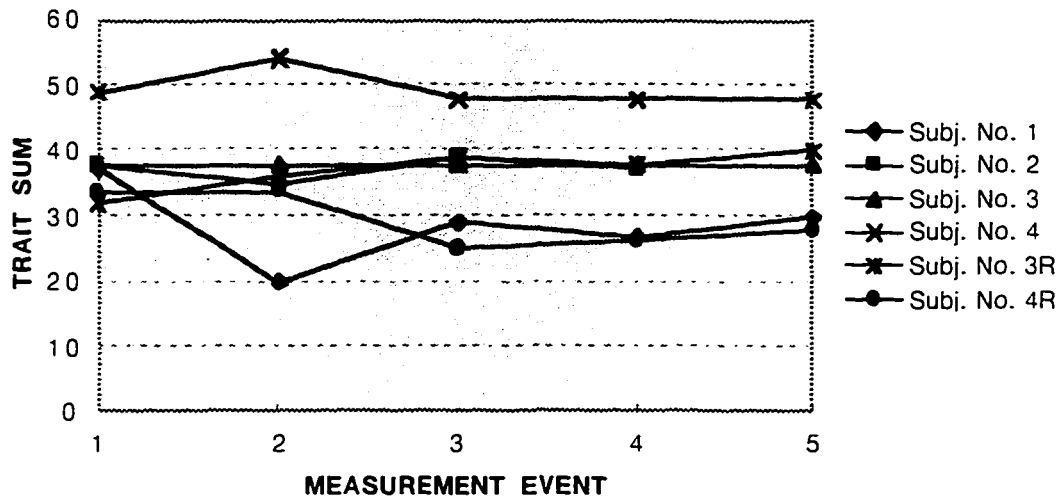


Figure 5.4 (a)

SUMMARY HOME INATTENTION RESULTS

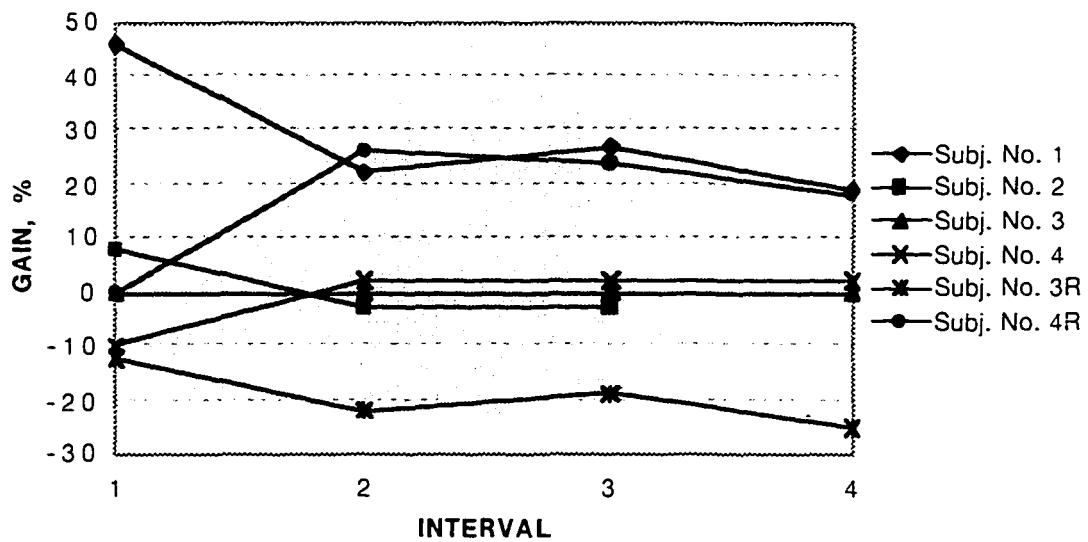


Figure 5.5

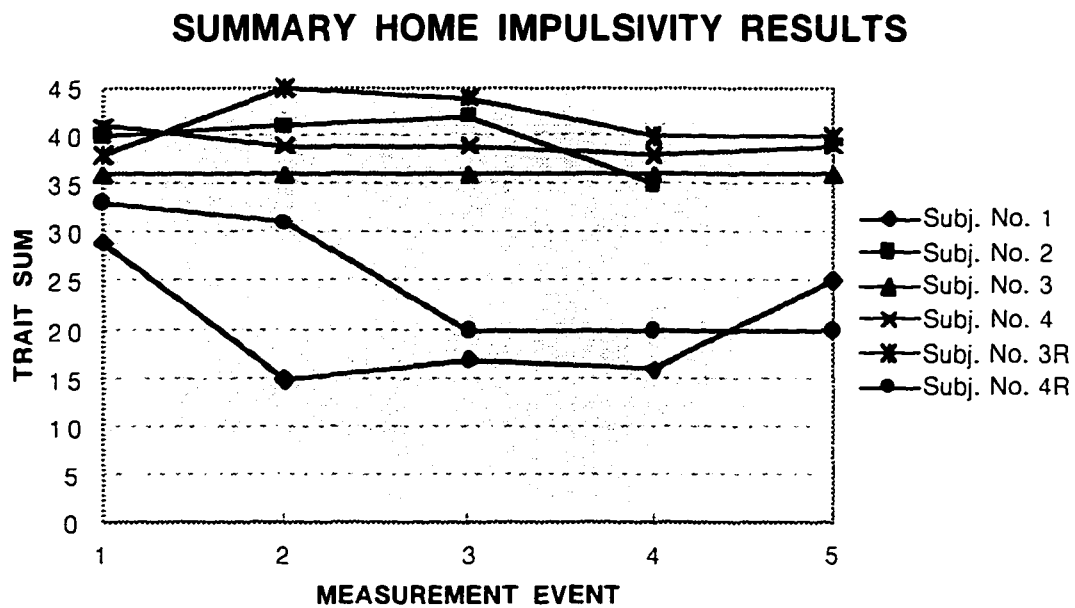


Figure 5.5 (a)

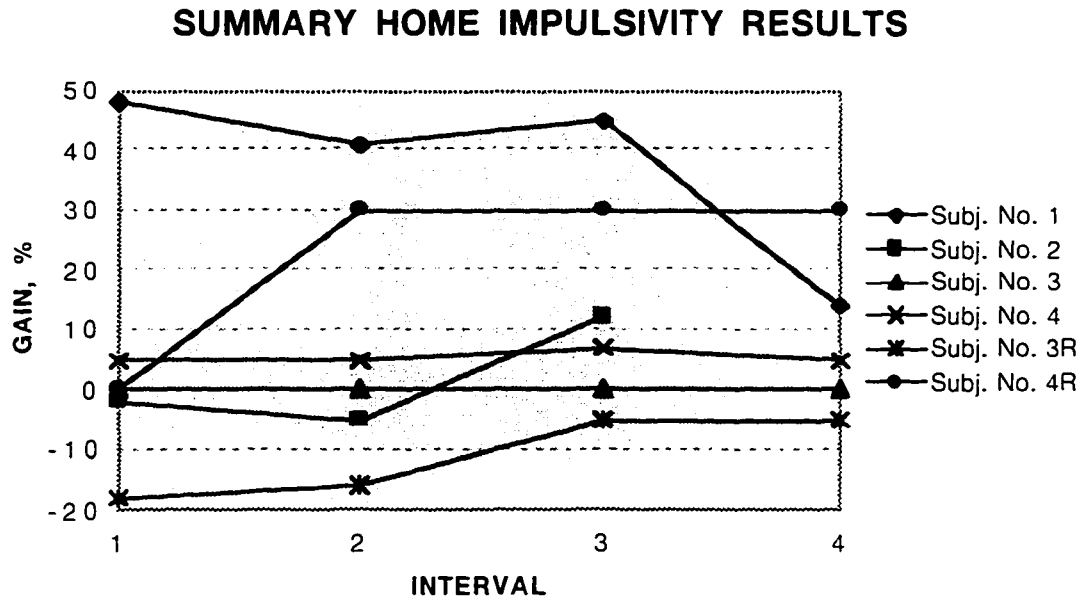


Figure 5.6

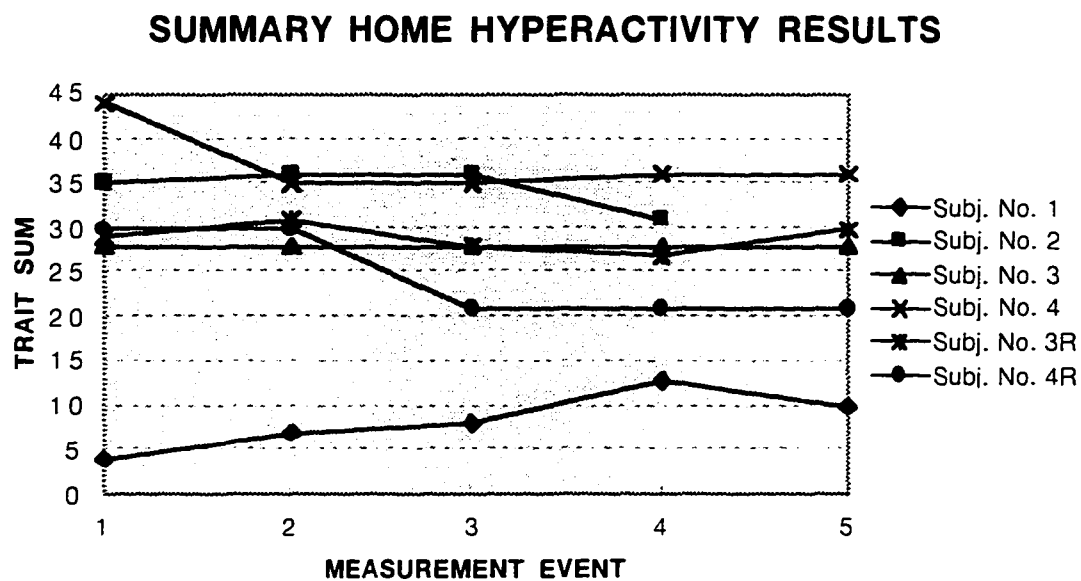
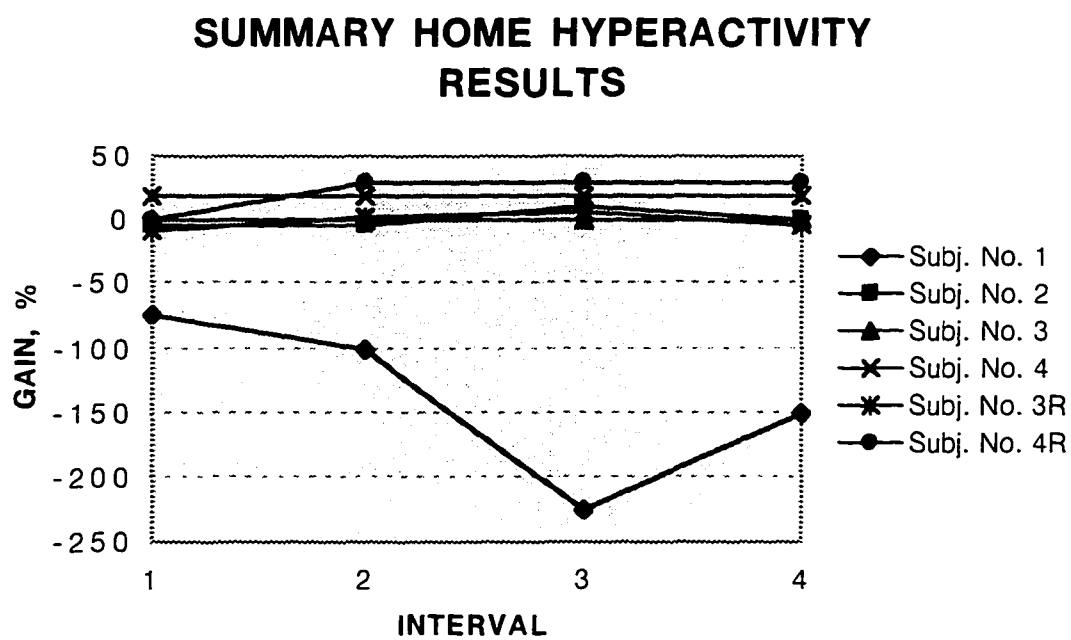


Figure 5.6 (a)



The summary charts of all the cases indicate overall improvement in the inattention and impulsivity variables for the four cases when they were on the technology. On the

replication results the behaviors were reduced more than on the original interventions except for case number one. Only case three improved in the hyperactivity variable. The gain scores reflect the comparison of the measurement events with the baseline scores of each of the cases. In cases four and five, the reported improvement in social skills was documented in the anecdotal records and post-treatment interviews.

Chapter 5

Summary and Conclusions

This chapter is organized in three major sections. First will be a summary of the study. Second, conclusions will be presented and discussed based on the analysis of the data and finally, recommendations will be made for future research.

Summary

The purpose of the study was to investigate the effectiveness of light/sound technology to promote sensory integration which may facilitate the learning capacity of children with autism by reducing their high state of arousal, increasing time on task and decreasing acting-out behaviors.

Since the Individuals with Disabilities Education Act (1990) made autism a separate disabling condition, the identification criteria have allowed for a greater number of people with this syndrome to be identified. Therefore, it is incumbent upon the educational system to investigate and utilize "cutting edge" technology and methods that will allow more of this population to optimize their potential. The light/sound machine used in this study represents an attempt to add to the literature additional data on the efficacy of alternative and innovative techniques in dealing with the varied characteristics of autism.

The definitions of a majority of researchers agree that autism is a neurologically based condition. A group of psychiatrists and pediatric neurologists from UCLA consider autism a neurological disorder or sensory integrative disorder.

The study attempted to extend the body of research that deals with the concept of sensory integration which encompasses the body of work developed by A. Jean Ayres, Ph.D., OTR, and expanded by Lorna King, OTR, FAOTA, during the past thirty years. According to Ayres, the autistic individual's brain does not register, modulate or integrate many sensations that normal people notice: in particular, auditory and visual inputs are ignored more than other types of sensory stimuli. They may over-register or under-register sounds and seemingly ignore their visual environment, avoiding or staring through people or objects. The nervous system develops in response to incoming stimulation. The student with autism seems unable to process and organize these sensations or coordinate them with hearing and vision. The ability to learn depends on predictable and stable perceptions. Processing sensory input into meaningful information is the approach that helps individuals with autism make sense of their world.

Physiological research indicates many children with autism routinely operate in a high state of arousal due to extreme sensitivity to and modulation of sensory stimulation. The theory of the use of sensory integration techniques pioneered by Ayres (1979) and further developed by King (1987) was extended by this study to investigate the use of light/sound technology to desensitize students with autism to light and sound sensory inputs in order to facilitate their capacity to learn.

The light/sound technology consists of a brain-wave synchronizer computer, earphones, "eye-stim" glasses fitted with gently flickering light/color patterns that duplicate the patterns and frequencies of the brain. Through "entrainment" (the brain's tendency to mimic the patterns of the frequencies) the computer duplicates the frequencies of the brain, using gentle light and sound to stimulate the production of alpha and theta brain waves. As the whole brain responds, the hemispheres begin to synchronize in the slower rhythms of

the alpha state. The machines used in the study were furnished by Harold Russell, Ph.D. who along with John Carter, Ph.D. have conducted numerous studies with the Learning Disabled and Attention Deficit/Hyperactivity Disorder (AD/HD) populations. Results have been statistically significant for improvement in learning, behavior, self esteem, and handwriting (1979, 1981, 1985, 1993, 1994). Their research indicates that the more sessions spent on the machines the greater the positive results. They report: "The increase in Verbal IQ in the experimental group found after twenty sessions (4.30 points) and the increase found after forty sessions (9.20 points) were, in each comparison, significantly greater ($p < .01$) than the changes seen in the placebo and control groups (Carter & Russell, 1994, p.9).

The technology used in this research has a microchip that controls the frequency patterns to prevent possible seizures and insure standardized treatment patterns.

The study was originally designed as experimental research utilizing a crossover design (frequently used in medical research). Confounding events necessitated the research design to be changed to include both qualitative and quantitative data. The rationale for this design has been delineated in Chapter 3.

From the pool of twelve subjects who participated in the study partially, a total of five completed the study and their case studies were reported. The research design utilized was a combination multiple baseline measures and qualitative anecdotal records that produced a triangulation of data.

Conclusions and Limitations

Case study comparisons across cases were not possible due to the unique characteristics and differing functioning levels of the subjects. In addition, there was no consistency of results between the five case studies. This is presumably due to the

continuum of characteristics of the condition of autism from severe to high functioning. Therefore the results of each subject had to be compared to his own baseline and pre-intervention data to determine differences.

Other confounding conditions were the differing number and amount of medications that were prescribed for each subject. Due to the length of the study (a year for three of the cases) medications and therapies were constantly changing. Another problem was the desperation of these parents and teachers to try anything to help the child and therefore introducing other therapies that might have masked the effects of the light/sound technology results. This is an understandable condition but it does contaminate the results.

Rater reliability was another confounding element. It was questionable if some of the raters really were thoughtful about marking the ADDES at the end of each interval. One could understand if the ratings were based on subjective feelings that reflected a difficult day or interaction, rather than an objective assessment of the behavior.

The ADDES scales may not have been the best choice for this population and it was limited in scope; that is, a scale of one to ten (instead of 0-4) may have been more appropriate so that the results could be mathematically analyzed to show more discreet differences. There were many items on the scales that were not applicable for the population but no other checklist that addressed the variables was available at the time.

Although the rater may be biased high or low, the differencing technique applied to the overall data compensates for that bias and the results were compared to the same rater's baseline. This added to the validity of the percent gain factors that were computed for four of the five cases. This was particularly evident in Case number three where the replication raw scores were significantly higher by the second teacher than the original teacher.

A brief summary of results on each case follows:

Case number one evidenced improvement on both the home and school versions of the ADDES. He tired of the technology and the parents chose not to continue use despite the teacher's recommendation. The parent reported the teacher did not express that desire to her. A "mini" replication study was conducted at the end of the school year that resulted in minimal improvement due the gain factor and the other reasons enumerated in the case study.

Case number two reported minimal positive, measurable results on the ADDES in the school version; however, this was also the subject who had several other medical interventions during the study and even though the qualitative data appears positive, it is difficult to determine if the light/sound technology was the reason. He has made progress in the last year according to both his mother and teacher that has resulted in his being mainstreamed in kindergarten and an LD class.

Case number three showed no measurable improvement in the initial study at home. The school scores on the ADDES resulted in overall gain in the hyperactivity variable. Later it was discovered he was having a reaction to his medication during the study and according to the mother, his symptoms "increased dramatically" when the technology was discontinued. It could be theorized that the factor that was keeping his behaviors stable was the use of the technology. On the replication study with his medication changed and stable, he showed improvement (12-45 %) according to the gain factor treatment results of the results of the school intervention replication. His mother was pleased and asked to keep Don on the machine and conduct a study herself.

Case number four was initiated during the summer of 1996; therefore, the home scale was the only one utilized initially. There was improvement but primarily in the area

of social skills. The study was replicated and data from both home and school were reported. In the replication study there was improvement as evidenced in the net effect of the gain scores. In addition, there was also more improvement in the area of social skills and interaction according to the anecdotal records which supports the theory that there are greater benefits when the technology is worn longer. This subject used the technology in the summer and again in the fall with very little interruption. He also used it seven days per week as opposed to five in some cases.

This subject has just been reclassified and is no longer considered educable mentally impaired (EMI). He is currently being mainstreamed in a regular second grade. The family live in Illinois and the subject was not available for observation by the researcher.

Case number five is a three year old who has made progress according to both his mother and teacher. He is also a child whose parent tries new things and it is hard to determine which intervention is having a positive/negative effect. The teacher reported improvement in social skills and behavior during the last three weeks of the study stating, "Everybody (at school) has noticed it." The ADDES could not be used to collect quantitative data due to age constraints and he was allowed to use the technology daily during the entire six weeks.

One of the areas that was reported as improved was in social skills, particularly in cases four and five. The gain in those skills that were reported by the teachers and parents were not measured on the ADDES scales per se. However, one can assume that if a youngster is more attentive and less impulsive, their social skills would be perceived as improved.

In summary, in examining the cross -case comparison of the results of the variable measured by the ADDES for both home and school, the researcher concludes the results of the study demonstrated that light/sound technology has positively impacted the behaviors of children with autism by increasing on-task behaviors, facilitating completion of tasks (reducing Inattention), and decreasing acting-out behaviors (Impulsivity). The results on the Hyperactivity scale were mixed and seemed to be more a reflection of the individual child; that variable did not change consistently across cases which supports similar findings of the research by Carter and Russell (1994).

The generalization of the results of the study is restricted due to the small sample size, range of ages and functioning levels of the subjects. In addition, all of the subjects were on medication and were experiencing multiple therapies and interventions.

Three of the parents have asked to continue with the machine. Many prefer to increase medications rather than continuing the treatment with the light/sound machine. With the negative side effects of most medications, alternative intervention might be a better option.

It was also noted that the higher functioning subjects seemed to benefit more than the lower functioning ones, perhaps due to their willingness to wear the technology on a consistent basis.

The research of Dr. Russell and Dr. Carter indicates the longer the subjects were on the technology the more benefits were noted (Carter & Russell, 1994, unpublished).

Recommendations for Future Research

The following recommendations for future studies are based on a review of the literature and the information gained from this study:

1. Although there are statistically more males than females identified as autistic, efforts should be made to include a proportionate number of females in future research.

2. A larger sample would be beneficial in order to generalize results and allow control groups and statistical analysis of the data. This could be accomplished by working with a center that serves individuals with autism from several school districts.

3. A more relevant checklist that was developed specifically for students with autism would possibly yield more pertinent and valid data.

4. More homogeneity in developmental functioning levels, medications and additional therapies of the subjects would increase generalizability to others in the population.

5. A longer study with more extensive time on the machine to determine if lasting effects could be realized would seem to be indicated. It would also serve to corroborate Drs. Russell and Carter's research.

6. Creation of a Snoezelen-like room or cubicle that mimics the light/sound technology could be used as a calming procedure and would not require the wearing of the technology.

7. Designing a follow-up study in a cooperative center in order to have enough students to conduct a controlled group cross-over design. The six machines could be used on multiple students.

8. Including students who have a history of seizures would also increase the number of available subjects. There were a number of subjects who had to be eliminated because they had experienced a seizure-like episode that was never really substantiated and may not have been related to their autism. This was suggested by Dr. William Deering, a pediatric neurologist whose letter of support for this research is found in Appendix C. He

felt the criteria should instead be whether the subject was photosensitive, an easily determined condition from an EEG which most of this population has had. He also suggested the potential benefits of including these subjects far outweighed any possible concerns about seizure activity.

9. Further development of incorporating all the technology into a helmet like that in case five would be advantageous for those who are stimulated or distracted by the computer and all the wires.

10. A parallel study in another part of the country would also help corroborate results and increase generalizability.

This investigator believes there is sufficient evidence in this study as well as the twenty years of research by Drs. Carter and Russell that there is benefit from the light/sound technology. The most appropriate populations seem to be those who are learning disabled, have AD/HD, or those with traumatic brain injury. There was a problem of children with autism wearing the technology. Continued research will be ongoing in this regard.

This was an original study in the use of light/sound technology with individuals with autism. Although it was difficult, this population needs reliable and verifiable interventions that can help them. In that light, more research with the technology on the autistic population seems indicated and desirable.

APPENDIX A

September 7, 1995


Dear Members,

As a part of the requirements for a doctoral degree from the College of William and Mary I will be conducting research with light/sound technology on children with Autism. This technology has been used successfully with ADHD children to decrease hyperactivity and increase attention span. It has also increased time on task for learning. I will only need six students for the initial research, but more can be included in subsequent studies. See attached Parent Information sheet.

I will be demonstrating this technology at the September 12th Autism Society of America Peninsula Chapter meeting. If you are interested, please come at 7:00 p.m. to the Northampton Public Library, located at the Pavilion Shopping Center off of Big Bethel Road.

If you are unable to attend and you are interested in having your child participate in the research, you can phone me at 804-727-5537(w) or 804-930-2755(h).

Hope to see you there.


Patricia Woodbury, Assistant Professor
Hampton University

CONSENT FORM

Autism and Light/Sound Technology

This consent form is to request voluntary permission for your child's participation in a research study that will be conducted during the 1994-95 school year. This study will be conducted as part of the requirements for the doctorate from The College of William and Mary.

Please read the following information and if you are willing to allow your child to participate, sign the section marked "Informed and Voluntary Consent to Participate" and return the permission form to the researcher.

Purpose of the Study

The purpose of this study is to investigate the effectiveness of light/sound technology to promote sensory integration which may allow an increase in the learning capacity of autistic children by decreasing their high state of arousal, increasing time on task, and decreasing acting-out behaviors.

Expected Benefits

It is expected that the subjects may benefit from this research by possibly increasing their ability to attend to task hopefully increasing the chance of learning. Should results be positive, the technology will be donated to the center for future use.

Amount of Time Required

Subjects will be assessed (baseline) prior to the beginning of the study. Each subject will be asked to use the light/sound technology a minimum of 15 minutes daily for two weeks. They will be reassessed and not use the technology for two weeks. After another baseline, they will use the technology for another two weeks and be reassessed again. No subject will be required to spend more than a total of three hours on the machine during the six week study.

Possible Risks

Since flashing lights can induce migraine headaches and/or seizures in individuals sensitive to them, the light/sound technology is contraindicated for those persons. Therefore, no subject will be considered for the study who has a history or tendency toward these conditions. In addition, school records will be checked for these conditions.

To further reduce the possibility of any risk of any adverse side effects, each subject will be screened by wearing the technology for one minute intervals on three separate occasions prior to the beginning of the study.

Assurance of Confidentiality

All data collected in this study will be kept in confidence. Subjects will be assigned numbers for research analysis and only the researcher will have access to this number. For the purposes of analysis, only group data will be used.

--over--

Assurance of Voluntary Participation

Participation in this study is strictly voluntary for both parent and subject. Subjects are guaranteed the right to decline to participate; this will be determined by their verbal or physical refusal to wear the technology. They may also withdraw at any time during the study without any penalty.

Availability of results

Please contact the following persons if you have any questions or concerns about the study or the technology:

Patricia Woodbury 111 Phenix Hall Hampton University Hampton, VA 23668	Phone: 804-727-5537 Work 804-930-2755 Home
---	---

Dr. John Lavach, Supervisor School of Education College of William and Mary Williamsburg, VA 23185	Phone: 804-221-2337
---	---------------------

Results of the study may be obtained from the above individuals.

Informed and Voluntary Consent to Participate

I have read the Parent Information Form and understand the nature of the research.

(Parent Signature)

I have been informed and agree to allow my child, _____, to participate in the study outlined above. My child does NOT have a history of or tendency toward seizures or migraine headaches. If your child is on medication, please check with your physician. It is understood that the researcher or sponsoring agency are in no way liable for any unforeseen side effects from the use of this technology. A demonstration of the technology is available on request. The right to decline to participate or to withdraw my child from this study in part or in whole at any time is guaranteed without penalty. The child may also refuse to participate by verbally or physically refusing to wear the technology.

Please check (✓) the following statement of assurance:

MY CHILD DOES NOT HAVE A HISTORY OF MIGRAINE HEADACHES OR SEIZURES.

Date: _____ Signature _____

Parent Information Form

This study will investigate the effectiveness of light/sound technology to promote sensory integration which may facilitate the learning capacity of autistic children by reducing their high state of arousal, increasing time on task and decreasing acting-out behaviors.

The definitions of a majority of researchers agree that the condition of autism is neurologically based. A group of psychiatrists and pediatric neurologists from U.C.L.A. describe autism as a neurological disorder or sensory integrative disorder.

Classifying the proposed research as sensory integration is an extension of the present definition of the term and techniques that provide a foundation for complex learning and behavior. The concept comes from a body of work developed by A. Jean Ayres, Ph.D., OTR., and expanded by Lorna Jean King, OTR, FAOTA, during the past thirty years.

According to Ayres, the limbic system of the brain decides which sensory input is registered and whether the information received is attended to and acted on. The autistic individual's brain does not register, modulate or integrate many sensations that normal people notice: in particular, auditory and visual inputs are ignored more than other types of sensory stimuli. They may over-register or under-register sounds and seemingly ignore their visual environment, avoiding or staring through people or objects.

A child is neurologically immature at birth with innate drives to receive, organize, and integrate incoming sensory stimuli. This is a natural, maturational process for the developing nervous system. After birth, the nervous system develops in response to incoming stimulation. The autistic child seems unable to process and organize these sensations or coordinate them with hearing and vision. The ability to learn any task depends on predictable and stable perceptions. The approach that helps the autistic person make sense of the sensory world is facilitating their ability to process sensory input into meaningful information.

Physiological research indicates many autistic children operate routinely in a high state of arousal believed to be due to extreme sensitivity to and modulation of sensory stimulation. The theory of the use of sensory integration techniques pioneered by Ayres and further developed and utilized by King will be extended by this research to investigate the use of light/sound technology to desensitize autistic students to light and sound sensory inputs which may facilitate their capacity to learn.

The light/sound technology consists of a brain-wave synchronizer computer, earphones, "eye-stim" glasses fitted with gently flickering light/color patterns that duplicate the patterns and frequencies of the brain. Through a process called "entrainment" (the brain's tendency to mimic the patterns of the frequencies) the computer duplicates the frequencies of the brain, using gentle light and sound to stimulate the production of alpha and theta brain waves. The lights in the eye-stim glasses flicker over closed eyes, in harmony with a variable tone or soft white noise: the subject may

begin to experience changing colors and patterns. As the whole brain responds, the hemispheres begin to synchronize in the slower rhythms of the alpha state. The four brain-wave states that may be experienced are:

- Beta: 13-30 Hz.: waking state
- Alpha : 8-12 Hz.: calm, relaxed but mentally alert
- Theta: 4-7 Hz.: meditative or hypnogogic state
- Delta: .5-4 Hz.: deep sleep, unconscious

The light/sound machines that will be used are furnished by researcher Harold Russell, Ph.D. and John Carter, Ph.D., who have conducted three studies with the Learning Disabled and Attention Deficit Hyperactivity Disorder (ADHD) populations. Results have been statistically significant for improvement in learning, behavior, self esteem, and handwriting. These articles will be furnished upon request.

We will utilize the same protocol that is programmed with a microchip that has been used in his work. Please see the attached letter of support from Dr. Russell.

The researcher has also contacted Dr. William Deering, a pediatric neurologist at the University of South Dakota, to review the proposal and possibly oversee the research. Dr. Deering is familiar with the technology and has observed its use with autistic individuals, although not under controlled conditions. He has indicated his interest and support in the attached letter.

There is a great deal of literature on the autistic population but most of it is based on clinical studies with small samples or individual case studies. The literature reports few long lasting results from any of the current methods in practice (behavioral techniques being the most frequently endorsed). Very little generalization of gains as a result of these techniques is documented or observed. It is important to explore methods and combinations of approaches in order to help these students function optimally.

Since the Individuals with Disabilities Education Act (1990) has made autism a handicapping condition and the identification criteria have allowed for a greater number with this syndrome to be identified, it is incumbent upon the educational system to utilize "cutting edge" technology and methods that will allow more of this population to optimize their potential. It is important that innovative techniques such as the light/sound technology be tested under controlled conditions to produce responsible and publishable research.

This study will add to the literature additional empirical data on the efficacy of alternative and innovative techniques in dealing with the varied characteristics of autism. In particular, it will address the sensory integration deficits reported in the literature by Ayres and King.

I have read the above and understand the nature of this research.

(Parent Signature)

DATE	START TIME	BEHAVIORS (before, during & after)	ENDING TIME	GENERAL COMMENTS
24				

APPENDIX B

Harold L. Russell, Ph.D.
Clinical Psychology
115 22nd Street, Suite 409
Galveston, Texas 77550

April 24, 1995

Phone Number
(409) 763-6831

*Please note
Mrs Woodbury
immediately. Thanks*

226

Mailing Address

P. O. Box 240

Galveston, Texas 77553

Mrs. Patricia Woodbury
47 Indian Springs Drive
Newport News, VA 23606

Dear Mrs. Woodbury:

It was a pleasure to talk to you about your proposed research with auditory and photic stimulation and children with autism problems. From my reading of the literature and from almost three years work using these procedures with a high functioning adult with autism problems, I think your approach may be of value.

Your concern with the possibilities of seizures being triggered by the flashing lights is one that we have had from the start of our research nearly five years ago. We are continuing to search the medical and scientific literature to be able to assess that risk as accurately as possible. I am including some of that information for your review.

What we have done in our research is to exclude children with a history of seizure activity from participation. The result has been that in over 8,000 training sessions with children, adolescents and adults, we have not as yet encountered any problems whatever related to the stimulation.

There may be several possible reasons for our not having encountered any problems: 1. The incidence of children who are vulnerable to photo-sensitive triggering of seizure activity may be, as the enclosed literature suggests, quite low particularly when children with a seizure history are excluded. 2. The light intensity of the LED's used in our devices is far less than that of the strobes used in EEG examination in attempts to provoke seizures. 3. The sound stimulation as well as the lights are set to a "comfort" level for the children and may not be as stressful and fatiguing as the powerful strobes are to the brain. 4. The stimulation frequencies used, 10 Hz and 18 Hz with a rest pause interval between the stimulation times, may not be within the range at which seizures occur in those people with whom we have worked.

The potential benefits to the children in terms of their life functioning now and in the future as adults, if the proposed treatment turns out to be useful, would appear to be far greater than what appears to be a very small risk of seizures.

I am enclosing some literature for you and please feel free to use it and this letter as input to your committee. Please assure them that I am as concerned about the safety of the stimulation procedures as I am about their efficacy.

Mrs. Patricia Woodbury

2

April 24, 1995

Approval by the Human Subjects Committee at the University of Houston-Clear Lake has been granted. I have been informed that the Human Subjects Committee at the University of Texas Medical Branch is considering a request for approval in connection with a moderately large grant request. According to my sources, there does not appear to be any difficulty at this point with the risk of stimulation.

Good luck with your research. I will be glad to be helpful in any way that I can.

Sincerely,

A handwritten signature in black ink, appearing to read "Harold L. Russell". The signature is fluid and cursive, with a large initial "H" and "R".

Harold L. Russell, Ph.D.

Enclosure



THE UNIVERSITY OF SOUTH DAKOTA
SCHOOL OF MEDICINE
DEPARTMENT OF PEDIATRICS & ADOLESCENT MEDICINE
1100 SOUTH EUCLED AVENUE
SIOUX FALLS, SOUTH DAKOTA 57117-5039

228

*"... providing medical education, service
and research for South Dakotans"*

March 13, 1995

Ms. Patricia Powell-Woodbury
- School of Education
College of William and Mary
Williamsburg, VA 23185

Dear Ms. Woodbury:

It has been a pleasure talking to you recently. I have had a chance to read your papers dating from 1991 as well as your thesis proposal *The Use of Light/Sound Technology with Autistic Students: A New Frontier*. It is my further understanding from our discussion that in a recent review of the proposed project that concern was expressed about the use of flickering lights in autistic children who do have an increased risk of seizures over the general population. The risk in all autistic children appears to be on the order of 10%, most of these children being identified relatively early in life. To my knowledge, however, seizures are spontaneous in onset, that is to say, not induced by photic stimulation. I suspect that many of these children will already have in their possession copies of EEGs performed in the past for one reason or another. A standard portion of each EEG is the performance of the very same photic stimulation, and it should be obvious from review of the reports whether, in fact, these individuals are susceptible to flashing lights. If one saw, for instance, only the simple driving response that is typical, I think there need be no great concern about making matters worse in these subjects, even if other parts of the records show changes suggestive of greater risk than average for clinical seizure activity. In those individuals who have had clinical seizures, a case could be made to explain to the parents that the proposed technology does have a chance of helping with activity level and attention span, that there may be a small increased risk of seizures, that those providing the training have knowledge in the treatment of acute seizure activity. In the case of photic stimulation, typically this activity is brief and rarely long outlasts the stimulation itself. There are rare exceptions to this and first aid techniques, again, must be well understood by those involved, particularly in the early phases of study.

It should be pointed out further that there is no evidence that brief seizures, convulsive or non-convulsive, cause any harm to the brain or any risk of death. Prolonged seizures, those lasting an hour or more, are a different matter, but certainly one would not expect that in this situation.

Ms. Patricia Powell-Woodbury
March 13, 1995
Page 2

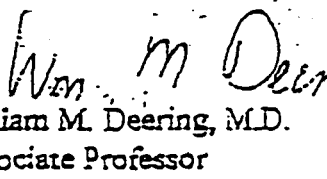
There is a small percentage of the normal population that has an epileptiform response to photic stimulation. Even in this situation, only a percentage actually ever have clinical seizure activity. A useful text for review of the matter is the book *Electroencephalography*, Third Edition, by Niedermeyer and Lopes Da Silva, published by Williams and Williams, the Third Edition being published in 1993. The section regarding photic stimulation begins on page 242.

To my knowledge, photic stimulation poses no risk to those with migraine. I think there is confusion with the common report from migraine sufferers that they are photo sensitive or photophobic, but again, this is a result, not a cause, of their migraine.

I believe that this study is medically safe, given the above caution, and it is of really great importance. As you have so nicely pointed out in your studies, there is abundant anecdotal information regarding the use of this equipment, but not a single controlled study. You will do the larger community a great service by demonstrating, even in a small group of subjects, the potential usefulness or its lack. If additional subjects who have had seizures or migraine were included, that certainly would increase the power of the study as well.

I have enclosed a copy of my curriculum vitae. I have been interested over the last 10 to 15 years in the use of EEG in the study of reading disability and as a normal part of my practice treat children with epilepsy and read EEGs on a daily basis. I believe that the statements that I have made above would be acceptable to the large majority of neurologists in the United States at this time and would be glad to discuss this matter further with you or with others on your thesis review team.

Sincerely,


William M. Deering, M.D.
Associate Professor
Pediatrics and Neurosciences

Medical Director
Health Center for Children
University of South Dakota
1100 South Euclid Ave.
Sioux Falls, SD 57117-5039

APPENDIX C

**UNIVERSITY OF ARKANSAS AT LITTLE ROCK**2801 SOUTH UNIVERSITY • LITTLE ROCK, ARKANSAS 72204 • (501) 569-8000
FAX (501) 569-8020

Department of Electronics and Instrumentation

February 28, 1991

Jessee Lucas, General Manager
8707 Kanis Road
Little Rock, AR 72204-2323
501-224-1855

Dear Mr. Lucas,

I have completed the evaluation you requested concerning the light emitting diodes in the IQ-JR equipment. You will find a copy of my evaluation enclosed. Mr. Tom Rimmer will review this report and communicate with you independently.

It is my opinion that the Threshold Limit Values for light and near-infrared radiation are not exceeded and that there is a considerable margin of safety.

If you or any reviewer would like to discuss my findings please call me at 501-569-8044.

Sincerely,

A handwritten signature in cursive script that reads "Doug Wilson".

Doug Wilson, Research Associate

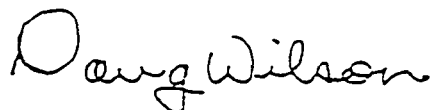
March 7, 1991

Jessee Lucas, General Manager
PR Manufacturing
8707 Kanis Road
Little Rock, AR 72204-2523
501-224-1855

Dear Mr. Lucas,

This letter is a follow up of the letter I sent to you dated February 26, 1991 concerning the IQ-JR glasses. I have reviewed the circuitry for the model IQ-I, IQ-II, and IQ-III. Since each model has the same output circuitry as the IQ-JR and the glasses are the same for all models, the measurements concerning the Threshold Limit Values apply equally to all models. Further, as long as the same output circuitry and the same LEDs (HILMP-4101) are used in future products, there should be no reason to repeat the measurements concerning the radiant output of the LEDs in your products.

Sincerely,



Doug Wilson, Research Associate



UNIVERSITY OF ARKANSAS AT LITTLE ROCK

2801 SOUTH UNIVERSITY • LITTLE ROCK, ARKANSAS 72204 • (501) 568-4000
FAX (501) 568-4020

Department of Electronics and Instrumentation

March 4, 1991

Mr. Jesse Lucas, General Manager
PR Manufacturing
8707 Kanis Road
Little Rock, Arkansas 72204-2323

Dear Mr. Lucas:

Mr. Doug Wilson has asked me to review the evaluation that he did for the IQ-JR equipment relative to any possible hazard to the eyes for users. My comments on his evaluation dated February 26, 1991 follow.

First, I should point out that I was not involved in the actual measurements of the light output or other physical parameters. I am confident that Mr. Wilson, as a qualified and competent scientist, made accurate measurements. However, I have reviewed the underlying assumptions and conclusions in Mr. Wilson's report, and I have repeated the calculations. These calculations appear to be correct, and I agree with his conclusion that the applicable Threshold Limit Values (TLVs) are not exceeded. In fact, the limits to protect against both thermal and photochemical injury to the retina are over 100 times greater than the actual exposure measured by Mr. Wilson. There is an additional margin of safety under normal use since he calculated exposure with the eyes open and normal use is with eyes closed.

As an industrial hygienist, I would also like to comment on the use of the Threshold Limit Values for the purpose of safety evaluation in this case. First, it should be kept in mind that TLVs are intended for the evaluation of occupational exposures to potentially harmful chemical and physical hazards. This means that they are to be applied to workers who are exposed on the job, and not necessarily the general public. This is primarily because the general public includes the very young and the very old and people who are in poorer health than workers in general. Also, off-the-job exposure may be of a longer duration (though not to be expected in this case) or under less controlled conditions than exposure in the typical workplace. Therefore the use

of the TLVs for non-occupational exposures should be done with caution and only when no other relevant standard for the general public applies.

Another point about the use of TLVs for hazard evaluation is that some people may have such a high degree of sensitivity to a particular hazard that they are not adequately protected by exposure at or near the TLV. In other words, minimal compliance with the TLV exposure limits may not be adequate to protect all individuals. To quote from the TLV book, the TLVs "represent conditions under which it is believed that nearly all workers may be exposed without adverse effect." However, as the actual exposure falls further and further below the TLV, it may be assumed that a larger and larger fraction of the population will suffer no harm. In this case, exposures that are less than one percent of the TLV increase the expectation that no one should be harmed.

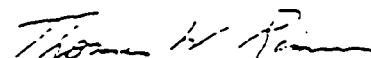
One last cautionary point is that the TLV for light and near-infrared radiation is a new one and is subject to change over time as new information is learned about possible adverse health effects. Because of this, a regular review of the appropriate TLV is recommended.

To summarize:

1. Mr. Wilson's calculations and conclusions that light exposure from the IQ-JR is substantially less than the appropriate TLV appear to be correct.
2. Although the TLV has limitations when used for evaluation of a consumer product, if it is the only available criterion and if it is complied with in a very conservative manner, then compliance with the TLV is a reasonable indication of user safety.

If you have any questions about my review or need more information about any of the matters that I have commented on, please feel free to call me at 501-569-8018.

Sincerely,



Thomas W. Rimmer

Certified Industrial Hygienist

Evaluation of the Light Exposure Hazard From the Light Emitting Diodes in the Glasses of the IQ-JR

Introduction

P. R. Manufacturing produces a device which provides light and sound stimuli for individuals. The light stimulus comes from four light emitting diodes (LED's) mounted in a set of opaque glasses worn by the user. The LEDs are positioned directly in front of the user's eyes and are flashed at a preprogrammed rate. Since the LED's are in close proximity to the user's eyes and since the exposure could be as long as an hour per day in normal usage, it is important to insure that the exposure to light from the LEDs is within acceptable guide lines.

The acceptable level of exposure was taken to be the Threshold Limit Values for Light and Near-infrared Radiation as set forth in the American Conference of Governmental Industrial Hygienists' booklet on Threshold Limit Values And Biological Exposure Indices. The three Threshold Limit Values specified protect the retina from thermal injury, photochemical injury, and cataractogenesis. Two measurements were made to determine whether the Threshold Limit Values are being exceeded. First, the spectral output of the LEDs was determined, and second, their radiance was measured.

Methods

A Perkin-Elmer 139 UV-VIS spectrophotometer was used to measure the spectral output of two sample LEDs. Two LEDs were placed in the lamp position of the instrument and the

monochromometer was swept through its full range recording the relative intensity vs. wavelength from 200 nm to 1000 nm.

The radiance (sterance) of the LEDs was determined by measuring the incident radiation falling on a calibrated one centimeter diameter detector (an EG&G model 550-1 radiometer/photometer) placed at distance of 10 cm from one LED operating at maximum output. The LED was made to operate continuously during the radiance measurement rather than in a pulsed mode.

The flux P in watts received by the detector is given by

$$(1) \quad P = \iint L \cdot dA_e d\theta$$

where dA_e is an element of the luminous surface of the LED,

$d\theta$ is the solid angle subtended by the detector, and

L is the radiance.

The LEDs used in the IQ-JR glasses are modified by mechanical means to render the emitting surface flat but optically rough. When observed, the light emitted from one of the modified LEDs appears to come from a small circular area on the rough surface of the LED. The luminous area is roughly the same size as the AlGaAs/GaAs diode imbedded in the plastic approximately 0.1 cm behind the rough surface. Therefore, it will be assumed that the LED emits uniformly from a small circular area on its roughened surface. This assumption is in part justified by the fact that the LEDs are located very close to the eye during use and the eye cannot clearly focus the image of the LED on the retina. Since the luminous area of the LED in this arrangement is both small and uniform, the solid angle is essentially constant over the integration of equation (1) and the integration can be simplified so that the desired parameter L can be extracted. Further, the power P

can be expressed as $P = I_d \Lambda_d$, with Λ_d being the area of the detector and I_d being the irradiance measured by the detector. Hence,

$$(2) \quad L = I_d \Lambda_d / \Lambda_e \cdot \theta.$$

The Threshold Limit Values are specified three ways. First, to protect against retinal thermal injury, the spectral radiance of the lamp weighted against the function R_λ (given in a table) should not exceed:

$$(3) \quad \sum_{400}^{1400} L_\lambda R_\lambda \Delta\lambda < 1 / (a \cdot t^{1/2})$$

Since L_λ is zero for all values outside the range 600 nm to 700 nm only one value of R_λ need be considered. The time, t , in equation (3) is limited to 10 second. For the case in question $R_\lambda = 1$ and L_λ is computed from equation (2). The viewing angle is given by $a = l/r$ where r is the viewing distance and l is the largest dimension of the observed source. For the case in question, $l = 0.2$ cm and it is assumed that $r = 0.2$ cm. The viewing distance is rather difficult to determine in this case because of variability between users. Worst case is assumed for r and t .

To protect against retinal photochemical injury from chronic blue-light exposure the integrated spectral radiance of a light source weighted against the blue-light hazard function B_λ (specified in tabular form) should not exceed

$$(4) \quad \sum_{400}^{700} L_\lambda \cdot t \cdot B_\lambda \Delta\lambda \leq 100 \text{ for } (t < 10^4 \text{ s}) \text{ or}$$

$$(5) \quad \sum_{400}^{700} L_\lambda \cdot B_\lambda \cdot \Delta\lambda \leq 10^{-2} \text{ for } (t > 10^4 \text{ s}).$$

For the system under evaluation, $B_\lambda = 0.001$ since the LEDs emit only red light. The Aphake Hazard Function A_λ must be used to evaluate the exposure to persons who have had a lens removed (cataract surgery). Because of the emission wavelength of the LEDs, $A_\lambda = 0.001$ and is the same as B_λ .

To avoid possible delayed effects upon the lens of the eye (cataractogenesis), the infrared radiation as viewed by the eye should be limited to:

$$(6) \quad \sum_{710}^{1400} I_\lambda \cdot \Delta\lambda < 0.6/a$$

Results

The measured spectrum of the LEDs matched the published data sheet for the Hewlett Packard HLMP-4101 LED which indicates a peak output at 650 nm with all radiant output falling between 600 nm to 700 nm. Although the Perkin-Elmer 139 spectrophotometer does not measure radiation in the range of 1000 nm to 1400 nm, there is no indication from the data sheets that the device will emit radiation in this wavelength.

Since the LEDs emit only over a narrow range of wavelengths, it is appropriate to drop the summations of equations (3) through (6) and in each case express $L_\lambda \cdot \Delta\lambda = L$ of equation (2).

The measured values of the parameters of equation (2) are

$$A_d = 0.785 \text{ cm}^2,$$

$$A_e = 0.0314 \text{ cm}^2,$$

$$\theta = 7.85 \cdot 10^{-3} \text{ ster, and}$$

$$I_d = 9.68 \cdot 10^{-6} \text{ watts.}$$

The radiance of four LEDs were measured and the values of I_d ranged from $6.9 \cdot 10^{-6}$ W/cm² to $9.68 \cdot 10^{-6}$ W/cm². The worst case was chosen for the calculations herein. Therefore $L_\lambda \cdot \Delta\lambda = 3.08 \cdot 10^{-2}$ W/cm²-ster

The left hand side of equation (3) is $3.08 \cdot 10^{-2}$ and is less than the right hand side of equation (3) which is 0.316 assuming the maximum time of 10 seconds. All assumptions are worst case.

Equation (4) was evaluated assuming a one hour exposure which is the maximum exposure time that may be selected by the user. The left hand side of the equation is then 0.11 and is less than the right hand side. If the exposure is greater than $1 \cdot 10^4$ seconds, then equation (5) is to be used. The left side of equation (5) is $3.08 \cdot 10^{-5}$ and the equation is satisfied for an indefinite exposure time.

The left side of equation (6) is zero since there is no infrared radiation emitted and the equation is satisfied.

Discussion

Equation (3) is the Threshold Limit Value for thermal injury. Aside from lasers and nuclear fireballs, the retina is seldom exposed to irradiances that elevate the retinal temperature sufficiently to cause thermal injury. The value of the left hand side of equation (3) is conservative for the following reasons. The LEDs are pulse with a 50% duty cycle during normal use but the calculations were made assuming continuous operation. The calculation assumes that the distance to any LED is 0.2 cm so that the viewing angle (α) is 1.0 radian. This distance is much too close for the eye to focus a clear image on the retina. An out of focus image will always act to reduce the incidence (watts/cm²) falling on an area of the retina. Therefore, the value used is an over estimate.

If the LEDs are held at a 10 cm distance, the lens of the eye can clearly focus the image of the LED on the retina, but then the viewing angle would be reduced by a factor of 50 and the right hand side of equation (3) would increase by 50. Even with the most pessimistic interpretation of equation (3), it is satisfied by an order of magnitude and there should be no danger of retinal thermal injury.

Equations (4) and (5) are both satisfied by three orders of magnitude. Photochemical injury is not indicated even for exposures of several hours.

There is no indication of emissions from the LEDs in the range of 770 nm to 1400 nm either measured or published. Consequently, there should be no infrared hazard.

All of the Threshold Limit Values calculations presented herein assume that the user has his eyes open. However, the users manual supplied with the equipment clearly states that the user should close his eyes. In that instance, the light will be attenuated and diffused thereby adding a significant margin for safety.

The circuitry was analyzed for possible fault conditions that would increase the radiance of the LEDs. The design is considered reliable because the current supplied to the LEDs is limited by a 51 ohm resistor.

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