THE EFFECT OF SOUND-BASED TREATMENT AS A HOME PROGRAM ON 10 CHILDREN WITH SENSORY PROCESSING DEFICITS AND VISUAL MOTOR DELAYS

A Thesis

Presented in Partial Fulfillment of the Requirements for

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By

Leah Jean Hall, BS, OTR/L

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Master's Examination Committee:

Jane Case-Smith, EdD, OTR/L, FAOTA
Professor, Chair of Graduate Studies

Larry Sachs, PhD
Associate Professor Emeritus

Mary Margaret Gottesman, PhD, RN, CPNP
Assistant Professor

Approved by

Jane Case-Smith
Advisor
Graduate Program in Allied Health Professions
Objective: This study investigated the effects of implementing therapeutic listening in a therapist directed, 8-week home program on children between the ages of 5 and 11 years.

Method: A convenience sample of 10 subjects with sensory processing deficits and delays in visual motor integration participated in this study. Each participant acted as his own control by measuring changes during the first four weeks using traditional sensory diet and comparing those changes to changes made following 8 weeks of therapeutic listening program. The Sensory Profile, Draw a Person test (DAP), Development test of Visual Motor Integration (VMI), and Evaluation Tool for Children’s Handwriting (ETCH) were the outcome measures. Visual motor integration and handwriting legibility were measured three times, before and after each treatment. Sensory processing behaviors were measured during the initial visit and the final visit following the 8-week treatment period. The researcher met with the families at 4 week intervals to update and monitor program. Parents responded to a questionnaire at the end of the study.

Results: Over the twelve week period, all ten subjects showed improvement in their scores on the Sensory Profile, averaging 71 points per child indicating a decrease in behaviors indicative of sensory processing dysfunction.
Total score and nine of the 14 subtests showed significant improvements on the Sensory Profile. Scheffe’s Compound Contrast analysis determined that visual subscale of the VMI and overall handwriting legibility significantly improved as a result of therapeutic listening. The DAP, VMI and Motor subscale of the VMI did not demonstrate significant effects.

Conclusion: Therapeutic listening when used with a sensory diet is an effective treatment approach for reducing behaviors indicative of sensory processing dysfunction. Therapeutic listening can facilitate the visual aspect of visual motor integration and handwriting legibility. The motor aspect of visual motor integration and overall visuomotor performance is not affected by this treatment.
DEDICATION

I would like to dedicate this work to my husband and son for their love, patience, and support. They allowed me to dedicate many evenings and weekends to work on this project.
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I would like to thank my advisor, Dr. Jane Case-Smith, OTR/L for her intellectual support, guidance, and encouragement throughout the course of my studies and especially with the research project. I would also like to thank Dr. Mary Margaret Gottesman for her comments and editorial help. I am very grateful to Dr. Larry Sachs for his patience and assistance in the analysis of data.

To all of the children and families who dedicated 12 weeks to this project, I hope this study will offer therapists another tool to use when treating children with sensory integration dysfunction. I wish you continued success on your journey to wellness.

I would like to thank my colleagues in the Occupational Therapy Department at Children’s Hospital, Ann Cain-Sheban and Kristi Reed for the many hours they spent scoring multiple assessments.

I am grateful to the director of the offsite clinics at Children’s Hospital, Larry Long, who allowed me to purchase the equipment needed for this research project.

I am appreciative of Mike Jewell, OTR/L, clinical leader, for supporting the project and allowing me the flexibility in my schedule to see the influx of patients.
VITA

March 28, 1964..................Born – Toledo, Ohio

1984.............................Assoc. Occupational Therapy Assistant
                             Lourdes College, Toledo, Ohio

1985.............................Certified Occupational Therapy Assistant
                             Buckingham Community Services, Waterford, MI

1987.............................Program Director
                             Buckingham Community Services, Waterford, MI

1994.............................B.S. in Occupational Therapy
                             Eastern Michigan University, Ypsilanti, MI

1994.............................Occupational Therapist Consultant
                             Buckingham Community Services, Waterford, MI

1998 to present..................Occupational Therapist
                             Children’s Hospital, Columbus, Ohio

FIELDS OF STUDY

Major Field:  Allied Medical Professions

Tract:       Advanced Professional Tract

Focus:       Pediatrics

Specialization:  Early Intervention
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CHAPTER 1

INTRODUCTION

Background of the Problem

Music has long been known to have therapeutic value. The use of music and sounds as therapy is growing ever more popular in recent years as a result of a variety of auditory intervention techniques becoming available. Many occupational therapists, speech therapists and psychologists are using sound-based interventions to treat adults and children with a variety of diagnoses. The benefits of this form of treatment have been reported to include improvement in behavior, attention, communication, motor performance and learning (Frick, 2001; Steinbach 1998).

The originator of sound based treatment is a French physician by the name of Alfred Tomatis, who in the mid 1900’s, developed the use of electronically altered music as a treatment modality for adults and children with differing diagnoses, including attention deficits, developmental delays, autism, head injury, multiple sensory system disorder, and learning disabilities. Tomatis believes that the main role of the ear is to function as the “integrator” facilitating organization at all level of the nervous system (Thompson, 1991). He understood that there are direct links between sound, the ear and the body. Because
the ear is neurologically aligned with the optic, oculomotor, troclear, abducens and spinal accessory cranial nerves, the ear is a major mechanism of reception and the integration of perception (Thompson & Andrews, 2000). Tomatis also recognized the intimate relationship between the auditory and the vestibular systems by the nature of their anatomical structure. He viewed them as having the same function – the perception of movement. He described the vestibular system as the “ear of the body” perceiving the slower movements, which are the lower frequency vibrations and the cochlea perceiving the faster oscillatory movements of sound, which are the higher frequency vibrations (Frick & Shirley, 1994). By stimulating the ear, you are not only affecting the voice but you are shaping the whole body including posture, coordination, balance, and movement (Madaule, 1994).

Tomatis developed a method specifically to stimulate the vast interconnections between the ear and the nervous system. He preferred using the music of Mozart, which is rich in high frequencies provided by the violin and piano, as well as Gregorian chants and the mother’s voice. Tomatis treats his patients using a machine called the Electronic Ear. This device is intended to simulate the stages of listening development. The child listens to the music through special headphones equipped with a bone conduction sensor that delivers the sound through a sophisticated stereo system. A minimal program typically involves two to three intensive treatment sessions which consists of listening for up to 2 ½ hours per day for about 15 days per session and three to six weeks between sessions. Treatments are done in the clinic under the guidance of practitioners who are specifically trained in the Tomatis approach (Thompson & Andrews, 1999).
Studies on the Tomatis method have yielded mixed results. Neysmith-Roy (2001) found that three out of six severely autistic boys experienced significant improvements in behavior as measured by the Children’s Autism Rating Scale (CARS). One boy was no longer considered autistic, two boys showed only mild symptoms of autism, and three boys remained within the severely autistic range following the Tomatis treatment. Positive changes were also seen in the pre-linguistic areas for five of the six boys. These included adaptation to change, listening response, non-verbal communication, emotional response, and activity level. Kershner, Cummings, Clarke, Hadfield, and Kershner (1990) found that there were no differences in longitudinal achievement gains between a group of learning-disabled children receiving the Tomatis approach in school and a control group of learning-disabled children receiving direct instruction only.

Another physician who is well known for his use of sound-based therapy is a French otolaryngologist named Guy Berard. In the early 1960’s, Berard, who worked with Tomatis, developed another method of sound treatment, called Auditory Integration Training (AIT) based on some of the Tomatis principles. This form of treatment gained international attention following the publication of the book, *The Sound of a Miracle*, written by Annabel Stahli, who poignantly describes her autistic daughter’s recovery following AIT treatment with Berard.

AIT uses electronically enhanced pop music that distorts or modulates sound frequencies at random intervals for random periods of time. AIT is typically used to correct hypersensitive or distorted hearing. This clinic-based treatment consists of 10
hours of listening to modulated music in twenty ½ hour intervals over a period of ten consecutive days (Thompson, 1999).

Research on AIT has produced mixed results as well. Some studies have shown that children with autism treated with AIT had improved behavior (Brown, 1999; Rimland & Edelson, 1994,1995). Gillberg (1997) found that sensory problems decreased slightly. Brown (1999) reported general improvements in a variety of domains including functional behavior, attention and speech. Bettison’s (1996) research comparing groups receiving filtered/modulated music and unprocessed music found that both groups made significant but equal improvement on all measures including sensory processing, sound sensitivity, IQ, language and audiometric tests. Two subjects had adverse effects. Mudford, Cross, Breen and Cullen (2000) reported that the group receiving a placebo (wearing headphones with no music) showed slightly less aberrant behavior.

Advanced technology has made it possible for similar tools to be developed that allow individuals to participate in sound-based treatment at home. Although less intensive than the Tomatis method or AIT, these compact discs have made sound based treatment more accessible to clinicians in a variety of settings and are easier for families to afford.

One such tool was developed by Bill Mueller, an American sound engineer, who created a compact disc program called EASc, which is used in the home and in school under the direction of a knowledgeable clinician. These discs provide various styles of music and sounds that have been modulated similar to the Berard AIT method, but without the capacity to individually select a specific filter (Frick & Hatcher, 2001).
The SAMONAS method is another model of sound-based treatment developed by Ingo Steinbach, a German sound engineer with a broad background in music, physics and electronics. One of many characteristics that sets SAMONAS apart from AIT or the Tomatis approach is that the music is processed through a sophisticated device called the envelope shape modulator that enhances the frequencies and activates the recordings. This allows the music to be modified while maintaining the quality of the music. This process is referred to as SAMONAS, which in an acronym for spectrally activated music of optimal natural structure.

SAMONAS uses a variety of mainly classical music selections. Steinbach also utilized sounds of nature including water, wind, and birds. There are several CDs available with different levels of spectral activation and filtering. Listening sessions and protocols are highly individualized based on clinical reasoning which considers the individual’s age, diagnosis, symptoms, and history. Listening times can last anywhere from a few minutes up to 30 minutes per session for one to two sessions daily. Therapists are required to receive special training to be able to purchase these CDs for use in therapy.

Significance of the Problem

The use of sound-based therapy as part of an overall sensory integrative approach to treatment is becoming more widespread among occupational therapists. In their book *Listening with the Whole Body*, Frick and Hatcher (2001) explain that this method of treatment has been shown to facilitate improvement in the following areas:

- Attention
• Language
• Balance and coordination
• Self regulation
• Motor planning
• Affect
• Bilateral coordination
• Gravitational insecurity

In addition, clinical outcomes have shown improvements in task attention, temporal-spatial organization as demonstrated in handwriting, social interaction, timing of motor movement, and discrimination of dimensionality and directionality of spatial concepts (Frick, 2001). However, research and case studies are needed to document and clarify the functional changes occurring with sound-based treatments. The changes seen clinically are important and appear to have therapeutic implications for children with sensory integrative dysfunction (Frick & Lawton-Shirley, 1994).

The purpose of this study was to investigate the effects of incorporating sound-based intervention strategies in a therapist directed, 8-week home program on children between the ages of 5 and 11 years.

Research Hypotheses

Following 8 weeks of sound based intervention when compared to standard intervention only, children will:

1) demonstrate increased visual motor integration as measured by the Beery Test of Visual Motor Integration.

2) demonstrate fewer behaviors indicative of sensory processing problems as measured by the Sensory Profile.
3) demonstrate improved handwriting legibility as measured by the Evaluation Tool of Children’s Handwriting.

4) demonstrate improved visual motor integration as measured by the Goodenough Draw-a-Person Test.

**Research Approach**

A quasi-experimental design was used. Ten subjects between the ages of 5 and 11 years, were recruited. All subjects were assessed by an occupational therapist and have been determined to have sensory processing dysfunction and visual motor integration delays. Each of the subjects acted as his or her own control. They received the traditional treatment in the form of a sensory diet home program for the first four weeks, then received the sound based treatment, which was added to their home program, for the next 8 weeks. All subjects received two pretests, one at the initial 4 week period and another at the end of the 4 week period to measure the effects of the traditional treatment only and to establish a baseline of performance. All subjects received a posttest at the end of the final eight week period to measure the effects of the sound based treatment. The Developmental Test of Visual Motor Integration, the Evaluation of Children’s Handwriting, The Sensory Profile, and the Draw-a-Person test were used to measure changes in the subjects in the areas of visual motor integration, handwriting, sensory processing and conceptual maturity. Data analysis compared the test scores of each time period with one another.
Limitations

The outcomes of this study are valid for children of a limited age range between 5 and 11 years. This age group was selected because the standardized assessments used in this study are known to be sensitive to changes for this range.

There was no specific diagnosis being studied. All of the subjects that were included in this group showed evidence of sensory integration dysfunction, and visual motor integration delays as indicated by their scores on standardized assessments, but were referred with a variety of diagnoses such as ADHD, Autism, Coordination Disorder, Asperger Syndrome. The outcomes are externally valid for children with symptoms of sensory integration dysfunction and delays in visual motor dysfunction.

The subjects were not randomly assigned to the treatment. A convenience sample of subjects, referred to occupational therapy for sound-based treatment, were used. However multiple pretests were conducted to establish a baseline of performance and to allow the subjects to act as their own control.

The treatment was administered by the parent as a home program. Therefore the researcher was not able to closely monitor how well the parents followed through with the treatment. However, the researcher asked the parents to document the duration and frequency of each session in order to track compliance with the treatment protocol.

There was a possibility that other therapeutic interventions may have caused a change in the subjects’ functional skill development. Subjects were required to maintain all current therapies or refrain from starting new therapies during the duration of the study. Parents reported that no major medication changes occurred during the time of the study.
Most children receiving sound-based treatment typically continue with this treatment for 6 months duration. This study examined the effects of a short duration of this treatment. Therefore, the full effects of this intervention may not have been revealed given the 8-week duration.
CHAPTER 2
REVIEW OF LITERATURE

Introduction

This chapter will discuss the difference between hearing and listening, the potential physiological effects that listening to music can have on our nervous system and how listening affects our ability to process sensory information. Outcomes of previous studies of sound-based treatments and instrument reliability and validity will also be reviewed in this chapter.

Hearing versus Listening

Alfred Tomatis, the originator of sound-based treatments distinguished the critical difference between hearing and listening. He believes that the listening function is a major process affecting voice, language, rhythm and coordination, motivation and learning abilities. Tomatis distinguished hearing as a passive reception of sound from listening, which is an active process that involves the whole brain and requires tuning into what one hears and blocking out irrelevant information (Thompson & Andrews, 2000). Webster’s Dictionary defines hearing as the perception of sounds through the ear and listening as the ability to closely attend to what one hears. One can have good hearing but poor listening.
Frick and Hatcher (2001) further describe the importance of listening as a means to connecting inner and outer worlds. It requires focus, attention and concentration. Sounds help in understanding temporal and spatial information about our environment as well as in categorizing and organizing perceptions. Listening difficulties (i.e. the ability to accurately perceive, process, and respond to sounds) are often part of other perceptual, motor, attention and learning difficulties that affect a large number of children and adults with sensory processing problems.

The Effect of Music on the Brain

In 1993, Rauscher, Shaw, and Ky gained a lot of attention with their claim that after listening to Mozart music for 10 minutes, a group college students showed significantly better spatial reasoning skills than they did after periods of listening to relaxation instructions or silence. The enhanced effect lasted only 10 to 15 minutes. Some studies were unable to reproduce the findings (Chabris, 1999), but others confirmed the conclusion that Mozart’s Sonata K488 produces a small increase in spatial-temporal performance, (Rideout and Laubach 1996;1998). Rauscher et al theorizes that listening to music helps to organize the cortical firing patterns so that they do not wash out for other pattern development functions, in particular, the right hemisphere process of spatial-temporal task performance. They also believed that music acts as an exercise for exciting and priming the common repertoire of sequenced flow of the cortical firing patterns responsible for higher brain functions.

In an attempt to explain this “Mozart Effect”, subsequent studies have been done using techniques such as positron emission tomography and functional magnetic
resonance scanning. They have shown that music activates a wide distribution of brain areas (Chauvel, 1998; Jenkins, 2001; Platel et al., 1997; Warren, 1999). These areas range from the prefrontal cortex and superior temporal gyrus to the precuneus of the parietal lobe, with interconnection of the different networks activated (Jenkins, 2001). Mellet et al. (1996) analyzed brain areas concerned with spatial temporal tasks (such as the building of three dimensional cube designs in sequence) by mapping brain activity using PET scanning while subjects performed such tasks. The results show that the areas activated include the prefrontal, temporal and precuneus regions which overlap with those areas involved in music processing. Another study showed that listening to music caused a significant increase in EEG Beta power, particularly in the area of the precuneus bilaterally. Beta rhythm is a measure of cortical integrity, because it is diminished in the presence of cortical injury. This may reflect the interaction of the music with cognitive processes, such as music evoked memory recall or visual imagery (Nakamura et al. 1999).

Rauscher, Robinson and Jens (1998) conducted animal studies that supported the claims that complex music, such as Mozart, enhances spatial learning and cognition. One such study exposed rats in utero, plus 60 days post partum to either complex music (Mozart Sonata K448), minimalist music (a Philip Glass composition), white noise, or silence. The rats were then tested for five days, three trials per day, in a multiple T-maze. By day three, the rats exposed to the Mozart work completed the maze more rapidly and with fewer errors than the rats assigned to the other groups. The difference increased in magnitude through day five. Panksepp (1999) replicated a study three times with similar results, exposed four separate groups of chicks to four auditory conditions. Two groups
received musical treatment, one with the CD of AIT-type modulated music, and the other to the same unmodulated music for 10 consecutive days. One control group received no music, and the other was exposed to an audio tape of human voices (both male and female). Two days following termination of the treatment, the two groups of chicks that received the music treatments showed that their levels of brain norepinephrine (NE) and its principle metabolite (MHPG) were dramatically elevated. Similar effects, but not to the same degree, were seen for brain dopamine and its main metabolite HVA, with no clear effect on brain serotonin and epinephrine. The NE effects were unexpectedly large and it is known that NE activity promotes attentional processes in the brain. It is also the type of brain change that is thought to mediate the antidepressant effects of tricyclic drugs such as desipramine. It is noteworthy to mention that both the modulated music and unmodulated music had similar effects with the unmodulated music being slightly more effective.

Another significant study that demonstrated the potential power of listening to music was done on patients who suffered from epileptic seizures. In 23 of 29 patients with focal discharges or bursts of generalized spike and wave complexes, who listened to Mozart piano sonata K448, there was a significant decrease in epileptiform activity as shown by the electroencephalogram (EEG). In one patient, ictal patterns were present 62% of the time; during exposure to Mozart’s music this value fell to 21%. In two other patients with status epilepticus continuous bilateral spike and wave complexes recorded 90 to 100% of the time before listening to the music, dropped to 50% five minutes after the music began. This took place in one comatose patient, which shows that music appreciation was not necessary to induce such an effect. (Hughes, Daaboul, & Fino,
1998) This study was later confirmed by an experiment conducted on an eight-year-old
girl diagnosed with intractable childhood epilepsy with many drop attacks. The subject
was exposed to 10 minutes of Mozart music every waking hour over a 24-hour period.
The results showed that her clinical seizures dropped from 9 to 7 to 1 over three periods
of wakefulness. The number of attacks the next day was 2 in contrast to 9 on the
previous day (Hughes & Fino, 1999).

In an attempt to explain why Mozart had this affect of reducing seizure
activity, Hughes and Fino (2000) analyzed Mozart’s Sonata and compared the
characteristics of this music to that of other composers. What they found is that the
music of Mozart and the two Bachs is distinctive in that it demonstrates a long-term
periodicity significantly greater than that of other composers. Also, Mozart and the two
Bachs mainly used very similar notes in their musical selections, notably, G3 (196Hz),
C5 (523 Hz) and B5 (987 Hz). It is suggested that music with a high degree of long-term
periodicity, whether Mozart or other composers, would resonate within the brain to
decrease seizure activity and to enhance spatial-temporal performance.

The Relationship of Listening to Sensory Integration

Sensory integration is the brain’s ability to organize the information that we
take in through our senses for our use. Jean Ayres (1989) used the analogy of directing
traffic. She writes:

“The brain must organize all of these sensations if a person is to
move and learn and behave normally. The brain locates, sorts, and
orders sensations—somewhat as a traffic policeman directs moving
cars. When sensations flow in a well-organized or integrated manner, the brain can use those sensations to form perceptions, behaviors, and learning. When the flow of sensations is disorganized, life can be like a rush-hour traffic jam.” p.5.

Ayres (1972) understood that similar to listening, sensory integration affects changes at the level of the brainstem. Listening is related to arousal, self-regulation, emotion, respiration, postural adaptation, visual motor skills, and oral motor skills through the interconnected neuroanatomy of both portions of the vestibulocochlear system (Frick & Hatcher, 2001). The auditory and the vestibular systems function together to provide us with the perception of time and space and is the reference point from which all sensations are organized (Frick & Hatcher, 2001; Tomatis, 1991). Auditory and vestibular pathways in the brain are extensive, possibly found in 85 to 90 percent of the brain. (Thompson & Andrews, 2000)

Tomatis understood the ear to be neurologically aligned with the optic (2nd), oculomotor (3rd), trochlear (4th), abducens (6th), and spinal-accessory (11th) cranial nerves integrating with the acoustic nerve. The vestibulocochlear system is a major mechanism of reception and integration of perception (Thompson & Andrews, 2000). Ayres classified the brain’s processing of sound as “one of the primal forms of sensory integration”. She understood the auditory portion as having “primal significance to survival” and thus having influence over “several integrating neurons at the brain stem and other subcortical locations” (Ayres, 1972; Frick & Hatcher 2001).

Research has shown that there is a powerful connection of the auditory system to the autonomic nervous system. Sideorenko’s (2000) study of sixty children suffering
from hypertension due to autonomic nervous system disturbance, showed normalized
healthy blood pressure after being treated with music. A meta-analysis of the efficacy of
music for premature infants showed statistically and clinically significant benefits from
music therapy in the neonatal intensive care unit. The results were consistent across all
variables measured and included improvements in behavioral state, heart rate, respiratory
rate, oxygen saturation level, weight gain, days in the hospital, feeding rate, and
nonnutritive sucking rate (Standley, 2002).

**Efficacy of Sound-Based Treatment**

To date, there have been no empirical studies published regarding efficacy of
using using modulated or spectrally enhanced music as a home program. However,
anecdotal evidence supports its use as part of an overall sensory integration treatment.
Frick and Hatcher (2001) have listed several case studies in their book *Listening with the
Whole Body* where several therapists report seeing their clients improve spatial
awareness, motor-planning, visual motor integration, social skills, auditory processing,
expressive language, and more normalized responses to sensory input.

Empirical studies about clinical-based sound therapy treatments have produced
mixed results. Grace Baranek (2002) summarized the results of nine of these studies
done on children with autism. Eight studies utilized Berard AIT method (Bettison, 1996;
Brown, 1999; Gillberg, Johansson, Steffenburg, & Berlin, 1977; Mudford et al., 2000;
Rimland & Edelson, 1994; 1995; Zollweg, Palm, & Vance 1997) and one study used the
Tomatis sound therapy approach (Neysmith-Roy, 2001). Of the nine studies reviewed in
total, three used randomized, controlled methods with either no treatment or an
alternative treatment placebo control group, (Bettison, 1996; Rimland & Edelson, 1995; Zollweg, et al., 1997), two utilized other methodological designs with various levels of control (Mudford et al., 2000; Neysmith-Roy, 2001), one was a pre-post open trial (Gillberg, et al., 1997), two were descriptive case reports (Brown, 1999; Link, 1997) and one compared various types of AIT devices (Rimland & Edelson, 1994).

Baranek found that the methodologically stronger studies (Bettison, 1996; Mudford, et al., 2000; Zollweg, et al., 1997) demonstrated that improvements in behavior were not significantly different between the AIT treatment and control (unmodulated/unfiltered music) conditions. In two studies (Mudford, et al., 2002; Zollweg, et al., 1997) the control group showed a subtle advantage in reduction of aberrant behaviors at least at one point in time. Similar improvements for subjects in both treatment and control conditions suggest that outcomes may have been influenced by factors that are peripheral to the treatment (i.e. behavioral and educational interventions). The one study that investigated the Tomatis method, showed reductions in autistic symptoms overall including an improvement in prelinguistic behaviors noted in three of the six boys (50%), who also happened to be the youngest subjects (Baranek, 2002).

One study that was not included in Baranek’s review was done by Edelson, Bauman, Rudy, and Rimland (1999) evaluating the effect of AIT treatment on 19 people ranging in age from 4 to 39 with the diagnosis of autism. The control group listened to unprocessed music for the same length of time as the AIT treatment group. Results showed that at one month post treatment, the treatment group scored worse on the behavioral questionnaires than the control group. However, at three months post
treatment, the experimental group overall showed a significant decrease in aberrant behaviors. The experimental group also showed significant increases in P300 brain wave activity, including the distribution over the scalp was more focused as evaluated by the Event-Related brain Potential (ERP), which is an electrophysiological technique used to evaluate stimulus processing. The P300 brain wave is low when the subject is not paying attention. The P300 brain waves typically are generally low in people with autism indicating impaired stimulus processing. There was no improvement in brain wave activity in the control group. The number of participants that were able to respond to the audiometric assessment was so small that this assessment was not used for statistical analysis.

**Instrument Reliability and Validity**

Frick and Hatcher (2001) explain in their book *Listening with the Whole Body* that sound is a very powerful way to stimulate both the vestibular and auditory structures. The vestibular portion perceives and coordinates the temporal or timing aspects of movement while the auditory system perceives the temporal aspects of sound. Therefore, the vestibulocochlear system plays a significant role in the perception of time and space that underlies the organization of sensory motor functions and forms the basis for perceptual organization. This system helps the individual with focus, attention and facilitates meaningful behavior and interaction with the environment.

Three assessments were used in this study to examine the functional outcomes of perception and motor integration skills. They include the Beery-Buktenica Developmental Test of Visual-Motor Integration (VMI), the Evaluation Tool of
Children’s Handwriting (ETCH), and Draw-a-Person Test. The Sensory Profile was also used to measure the effect of sound intervention on overall sensory processing and behavior.

The VMI is a popular assessment tool used by occupational therapists to evaluate visual-motor integration skills in children ages two to fifteen. The VMI is designed to assess the extent to which individuals can integrate their visual and motor abilities. If the child performs poorly on the VMI, it could be because he or she has adequate visual perceptual and/or motor coordination abilities, but has not yet learned to integrate, or coordinate, these two domains. Alternatively, it is possible that the child’s visual and/or motor abilities are deficient. Therefore the examiner will follow the VMI with the supplemental Visual Perception and Motor Coordination standardized tests. The child receives one raw score point for each response that meets the specified criteria. The raw scores are converted into standard scores, scaled scores, percentile ranks and age equivalents, using normalized data. The standardized scores for all three tests were used for statistical analysis in this study.

For the 1994 norming study, two individuals independently scored 100 VMI, Visual, and Motor tests of a random sample of the norming group. The resulting interscorer reliabilities were .94 for the VMI, .98 for the Visual, and .95 for the Motor. The average interscorer, internal consistency, and test-retest reliability provide the best indications of overall reliability (Anastasi, 1988). The VMI and its supplemental Visual and Motor tests had overall average reliabilities of .92, .91, and .89 respectively.

The ETCH is designed to evaluate manuscript and cursive handwriting skills of children in grades 1 through 6 who are experiencing difficulty with written
communication. The test items were chosen based on counsel from occupational therapists, special educators, the literature pertaining to handwriting assessment, and the author’s own pediatric experience (Amundson, 1995).

Reliability for total letters and numbers range from ICC = .82 to ICC = .84. For total letter legibility, test-retest reliability was \( r = .77 \), and for total number legibility, it was \( r = .63 \) (Diekema, Deitz, & Amundson, 1998).

The Draw-a-Person (DAP) task is often used in routine educational and psychological assessments of children and adults with various learning, behavioral, and developmental problems (Dykens, 1995). Occupational Therapists have typically used the DAP as a developmental measure to assess visuomotor skills and body awareness. Research has shown that the DAP is highly correlated with measures of perceptual motor skill (Short-DeGraff & Holan, 1992). Mortensen (1984) provided a summary of research for the DAP and found that test re-test reliability is \( .68 - .69 \) (1 week to 3 months); inter-rater reliability is \( .68 \) to \( .96 \) (most found \( .80-.90 \)). Concurrent validity with the Goodenough-Harris Draw-A-Person is \( (n=32, r=.64) \) (Short-DeGraff & Holan, 1992).

The Sensory Profile (Dunn, 1999) provides professionals with a standard method to measure a child’s sensory processing abilities and to profile the effect of sensory processing on functional performance in daily life. The Sensory Profile is a judgment-based caregiver questionnaire consisting of 125 items grouped into three main sections: Sensory Processing, Modulation, and Behavioral and Emotional Responses. Items on the Sensory Profile are also grouped into nine factors that characterize children by their responsiveness to sensory input (i.e., overly responsive or under responsive): Sensory Seeking, Emotionally Reactive, Low Endurance/Tone, Oral Sensory Sensitivity,
Inattention/Distractibility, Poor Registration, Sensory Sensitivity, Sedentary, and Fine Motor/Perceptual. The test items characterize unusual responses to various sensory experiences in children’s daily lives and were developed by literature review of sensory histories. Each item is written as a behavioral statement (e.g., “Prefers to be in the dark”).

The research on the Sensory Profile took place from 1993 to 1999, and included more than 1,200 children with and without disabilities between the ages of 3 to 14. The examiners included 166 occupational therapists randomly selected from the roster of the Sensory Integration Special Interest Section of the AOTA. The examiners provided a sample of 1,037 children without disabilities between the ages of 3 and 10 years, which included 524 girls and 510 boys (gender not reported on 3 children). Researchers scored and analyzed all Caregiver Questionnaires from the research sample (i.e., descriptive statistics, multivariate analysis of variance, principal component factor analysis) to formulate a scoring structure and provide validity evidence.

Internal reliability of the test total score and subscale score was estimated by calculating Cronbach Alphas with reliabilities ranging from .70 to .90.

Construct validity of the Sensory Profile was measured using electrodermal responses (EDR) which is a physiological measure. Researchers used skin conductance to gauge the child’s physiological responses using the Sensory Challenge Protocol. This protocol was designed to gauge the child’s physiological responses to repeated sensory stimulation (i.e., a light flash, a sound, etc) and is well established to capture physiological responses and to differentiate among groups. Both hyperresponsivity and hyporesponsivity are considered atypical physiological responses. The EDR testing was
conducted with children with sensory modulation dysfunction and typically developing children. The results showed that the children with atypical EDR (either hyporesponsive or hyperresponsive) scored significantly lower (i.e., had more frequency of SSP behaviors) on all sections of the *Short Sensory Profile*. 
CHAPTER 3

METHODOLOGY

Introduction

This research project was designed to measure the effect of therapeutic listening on the functional development of children. This chapter identifies the research design, describes the sample, instruments and procedures. The independent variable, therapeutic listening, is described in depth.

Research Design

A pre-test, post-test design with two initial baseline measures was selected. The subjects acted as their own control by measuring changes during the first four weeks using traditional sensory diet strategies. The treatment was therapeutic listening and was tailored to the individual needs of each subject as prescribed by the researcher. The treatment, or independent variable, was implemented at home (while continuing the sensory diet) and monitored by the child’s parents or caregivers. The time interval between the first two measurements, O1 and O2 was four weeks and between the second and third measures, O2 and O3, was eight weeks. X, the therapeutic listening treatment, was implemented for an eight week period between O2 and O3. The researcher met with
the families at 4 week intervals but to prevent the threat of a testing effect, the subjects did not receive a post-test until after the full 8 weeks of treatment.

\[
\begin{array}{cccc}
O1 & O2 & X & O3 \\
\end{array}
\]

FIGURE 1. Pre-test 1 and 2, Post-test design.

**Hypothesis**

Following 8 weeks of therapeutic listening, when compared to standard intervention only, children will demonstrate increased visual motor integration, improved handwriting ability, and fewer behaviors indicative of sensory responsivity problems. The null hypothesis is that there will be no difference in children’s visual motor integration, handwriting and sensory responsivity before and after therapeutic listening.

**Subject Selection**

A convenience sample of 10 subjects between the ages of 5 and 11 years old was used in this study. Using an effect size of 1.0 (based on previous results with the VMI), a sample size of 10 subjects yields a power of .76. Based on an effect size of 1.4 (expected effect size with the Sensory Profile) 10 subjects yield a power of .92, which is more than sufficient for the purposes of this study. The age range of 5 to 11 years old is
required because this range is appropriate for the instruments that were used in this study to measure change.

All of the subjects were referred to occupational therapy for therapeutic listening and had a prescription from their primary physician for occupational therapy treatment. Although the IQs of the subjects were not known, they had the cognitive skills to participate in the testing. Exclusion criteria for the participant were severe mental retardation or significant motor impairments due to a central nervous system lesion. Excluded diagnoses were cerebral palsy, Down Syndrome and other genetic disorders, visual impairment, hearing impairment and severe autism. A participant’s diagnosis could include any of the following: attention deficit hyperactivity disorder (ADHD), sensory integration dysfunction, mild autism or pervasive developmental disorder (PDD), Asperger’s Syndrome, developmental delay, coordination disorder, or motor delays. Children on medication and whose dosage was anticipated to change during the course of the study were excluded. Subjects who were receiving other therapies were asked to continue in these therapies during the course of this study. Subjects had to display behaviors that indicated delays with visual motor integration and problems with sensory processing as indicated by a score of at least one standard deviation below norm on the Beery test of Visual Motor Integration and a score of definite difference (or 2 standard deviations below norm) on at least three subtests on the Sensory Profile.
**Instrumentation**

Four standardized instruments were used to measure change, the Developmental Test of Visual Motor Integration (VMI), The Evaluation Tool of Children’s Handwriting (ETCH), the Goodenough Draw-a-Person test, and The Sensory Profile.

The VMI (Beery, 1997) is a norm-referenced, evaluative measure of visual motor integration for children ages 2 to 15 years old. There are supplemental, standardized, visual perception and motor coordination tests with this instrument that provides a means to assess relative visual and motor contributions to VMI performance. The “Full” VMI booklet is designed for ages 3 to adult and contains 24 forms to be copied. The test booklet was placed in front of the child and the child was asked to copy the forms in order, without erasing. There was a specific order in which the tests were administered. The VMI was given first, then the Visual, then the Motor sections. The VMI and the supplemental Motor and Visual tests were administered to the subjects by the researcher following the administration guidelines and criteria for scoring test items as written in the VMI Administration, Scoring, and Teaching Manual. The standard scores for the VMI and supplemental tests were used for data analysis.

The ETCH (Amundson, 1995) is designed to evaluate manuscript and cursive handwriting skills of children in Grades 1 through 6 who are experiencing difficulty with handwriting. The primary focus of the ETCH is to assess a child’s legibility and speed of handwriting in writing tasks which are similar to those required in the classroom. The ETCH examines specific legibility components of the child’s handwriting, such as letter formation, spacing size and alignment, as well as a variety of sensorimotor skills related to the child’s handling of the writing tool and paper. The ETCH contains six cursive
writing tasks and six manuscript writing tasks which include the following: Writing Alphabet from Memory, Writing Numerals from Memory, Near-Point Copying, Far-Point Copying, Manuscript-to-Cursive Transition, Dictation and Sentence Composition. The ETCH-manuscript consists of the same tasks except the Manuscript-to-Cursive Transition task. In this assessment, the child is given a response booklet and a pencil and asked to write letters and numbers from memory; copy two simple sentences, one from a visual model placed next to them and another from a visual model placed at a distance; write nonsense words by dictation; and write a 5 word sentence that they have made up. Only the first three subtests for both manuscript and cursive were administered for purposes of this study. These subtests included writing upper-case letters, lower case letters, and numbers from memory. The researcher administered the test according to the ETCH Examiners Manual. Legibility raw scores and percentiles were used for statistical analysis.

The Draw-a-Person Test (DAP) was used to measure integration of visuomotor skills (Short-Degraff & Holan, 1992; Vane, 1967). This test assesses the mental age of the child by analyzing the detail of the child’s drawing of a person. The subjects were given a blank sheet of paper and asked to make the very best drawing of a person that he or she could. There was no time limit to this test. The test was scored by giving credit to each of the details in the drawing according to specified criteria. The total raw score was then correlated with a mental age based on IQ. The mental age scores were used in statistical analysis.

The Sensory Profile (Dunn, 1999) is a 125-item questionnaire which evaluates the following areas: sensory processing as part of daily life, modulation of sensory input
for use in life, and behavioral and emotional responses that might be indicative of a child’s processing abilities. The parent or caregiver who has daily contact with the child completed the questionnaire by reporting the frequency with which these behaviors occurred (Always, Frequently, Occasionally, Seldom, or Never). The questionnaire was scored by an occupational therapist. Certain patterns of performance on the Sensory Profile are indicative of difficulties with sensory processing and performance. Scores fall in one of the following categories:

- **Typical Performance** – indicates scores at or above 1 standard deviation (SD) below the mean score, indicating typical sensory processing abilities. This range indicates the child performed better than the lowest 16% of the research sample of children (N=1,037).

- **Probable Difference** – indicates scores at or above 2 SD below the mean but lower than 1 SD below the mean. Section raw scores in this range indicate questionable areas of sensory processing abilities. This range indicates that the child’s performance was between the 2nd and 16th percentile of the research sample.

- **Definite Difference** – indicates scores less than 2 SD below the mean, indicating sensory processing problems. This range indicates that the child is performing like a child in the lowest 2% of the research sample when compared to the research sample of children without disabilities.

The Sensory Profile was given twice, once at the initial visit and again at the last visit following the completion of the 8-week treatment period. Raw scores calculated from the sensory profile were used for statistical analysis.
Data Collection

Each subject was assessed three times using the VMI, ETCH, and Draw-a-Person test. The Sensory Profile was completed by the caregiver during the initial visit and the final visit following the 8-week treatment period. All of the tests were administered by the researcher, but were scored by another occupational therapist, who was blinded to the subjects and to whether the tests were pretests or posttests.

Pre-Intervention Phase

During the initial visit, the researcher explained the study to the parents. Parents were asked to sign a consent form for treatment prior to their child beginning the pretests. The treatment did not begin until the next visit which occurred 4 weeks from the time of the initial visit. The initial 4 weeks were used for gathering baseline data. The parents were asked to fill out a daily checklist that recorded the type and frequency of the child’s target behaviors and their use of a sensory diet that was given to them at their initial visit. The parents selected target behaviors that reflected their goals for their children, such as, improving eye contact or decreasing outbursts, wetting accidents, etc.

The subjects were tested at the clinic by the researcher during the initial visit. Information about therapeutic listening was given and explained to the parents. Because therapeutic listening treatment is most effective when it is a part of an overall comprehensive sensory diet, the researcher also develop a sensory diet according to the needs of the child as indicated by the results of the testing for the parents to use as a home program. The sensory diet contained activities for the child to do at home which included sensory experiences such as movement, heavy work or tactile stimulation. See
appendix C for a sample of sensory diet activities. The sensory diet is considered a traditional treatment for children with symptoms of sensory processing deficits, developed by occupational therapists, to meet the sensory needs of the child. The purpose of starting the sensory diet home program at the time of the initial visit was to measure potential changes in the child as a result of the sensory diet alone without the auditory treatment.

**Intervention Phase**

The subjects were scheduled for a second visit 4 weeks following the first visit. At this time, the therapeutic listening home program was further explained to the parents and any questions they had were answered. The therapeutic listening protocol was developed at that time according to the needs and goals of the child and his or her response to listening to the CDs. The parents were provided with the equipment they needed to implement the treatment as an intensive home program. The equipment included a set of good quality headphones with a high resistance or impedance of at least 150 Ohms and a frequency sensitivity to 23,000 Hz, and two to three CDs as prescribed by the researcher, who is formally trained in the advanced use of therapeutic listening treatment. The subjects had to purchase or use their own portable CD player.

The group of CDs used in this study are identified as Modified CDs and are altered by processing the music through an alternating high pass low pass filter. This causes the high and low frequencies to pass through in the music at different intervals which creates a disruption in the sound of the music. Frick and Hatcher (2001) further
explain the clinical significance of this type of modification in their manual entitled

*Listening with the Whole Body*:

"What appears to be created with the use of modulated music is an ‘exercising’ effect of the muscles in the middle ear. Flexibility of these muscles is necessary to transmit sensory information to primary sensory processing centers that support sensory modulation....Biomechanically, it is the function of the middle ear muscles to contract or focus on sounds and relax to monitor ambient environment." p.3-13

The parents and subjects were instructed to listen to the music at a decibel reading of 45 to 55 dB, which is equivalent to listening to soft background music and is well within OSHA standards for safety. The parents and subjects were advised that they should be able to carry on a conversation while the subject is listening with the headphones on and the subject should not have to raise his or her voice above typical conversational level.

The therapeutic listening protocol required the subjects to listen to the prescribed music for two sessions daily with at least three hours in between sessions. Each session should last 20 to 30 minutes depending on the type of music prescribed. No one CD was used for a period of longer than 3 weeks to prevent habituation. Subjects were instructed to avoid activities that make them seem unavailable, such as watching TV or videos, and playing computer games or video games. Subjects were allowed to play with their favorite games or toys, go for a walk, or engage in any activity that was not too mentally demanding.

Parents were instructed to keep a listening log on their child to record the frequency of treatment and their child’s response to the prescribed music. They were also be asked to continue to document their use of a sensory diet and the frequency and
severity of target behaviors throughout the treatment period. This was done in a checklist format to make it convenient and less time consuming for the parents in order to promote compliance.

The researcher was available to the parents via email or telephone to answer questions or concerns at anytime during the treatment phase. The subjects were scheduled for a third visit 4 weeks into their treatment to assess their response to the prescribed CDs, monitor progress, review the listening logs and to update their listening schedule or CDs as needed. No testing was done at that time.

**Post-Intervention Phase**

During the week following the end of the 8 week treatment period, the subjects were scheduled for an appointment for the O3 posttest. The O3 posttest included the VMI, ETCH, Draw-A-Person test administered by the researcher. The parents were asked to fill out a Sensory Profile at the time of this visit. The daily checklist logs were collected from the parents.

To examine the confounding variables, the parents were asked the types and frequencies of other interventions that occurred between O2 and O3.

Subjects who continued to need the treatment were allowed to continue with the therapeutic listening beyond the termination of this study and were followed by the researcher until their treatment was completed.

**Statistical Procedures**
Means and standard deviations of the dependent variable were summarized to demonstrate the group’s performance at each observation interval. A comparison across time periods was analyzed using repeated measures analysis of variance. When results were significant, post hoc multiple comparisons (Tukey’s and Scheffé’s) were performed to determine which time periods were most significant. Significance level was set p<.10 a priori.
CHAPTER 4

THE EFFECT OF SOUND-BASED TREATMENT AS A HOME PROGRAM ON CHILDREN WITH SENSORY PROCESSING DEFICITS AND VISUAL MOTOR DELAYS

Music has long been known to have therapeutic value. The use of music and sounds as therapy is growing ever more popular in recent years as a result of a variety of auditory intervention techniques becoming available. Many occupational therapists, speech therapists and psychologists are using sound-based interventions to treat adults and children with a variety of diagnoses. The benefits of this form of treatment have been reported to include improvement in behavior, attention, communication, motor performance and learning (Frick, 2001; Steinbach 1998).

Sound-Based Interventions and Research

The originator of sound-based treatment is a French physician, Alfred Tomatis, who in the mid 1900’s, developed the use of electronically altered music as a treatment modality for adults and children with differing diagnoses, including attention deficits, developmental delays, autism, head injury, multiple sensory system disorder, and learning disabilities. Tomatis believed that the main role of the ear is to function as the “integrator” facilitating organization at all levels of the nervous system (Thompson, 1991). He believed that by stimulating the ear, you are not only affecting the voice but
also the whole body including posture, coordination, balance, and movement (Madaule, 1994). He understood that there are direct links between sound, the ear and the body. Tomatis treats his patients using a machine called the Electronic Ear. This device is intended to simulate the stages of listening development. The child listens to the music through special headphones equipped with a bone conduction sensor that delivers the sound through a sophisticated stereo system. A minimal program typically involves two to three intensive treatment sessions that consist of listening for up to 2 1/2 hours per day for about 15 days per session with three to six weeks between sessions. Treatments are done in the clinic under the guidance of practitioners who are specifically trained in the Tomatis approach (Thompson & Andrews, 1999).

Studies on the Tomatis method have yielded mixed results. Neysmith-Roy (2001) found that 3 out of 6 severely boys with autism experienced significant improvements in behavior as measured by the Children’s Autism Rating Scale (CARS). One boy was no longer considered autistic, two boys showed only mild symptoms of autism, and three boys remained within the severely autistic range following the Tomatis treatment. Positive changes were also seen in the pre-linguistic areas for five of the six boys. These included adaptation to change, listening response, non-verbal communication, emotional response, and activity level. Kershner, Cummings, Clarke, Hadfield, and Kershner (1990) found that there were no differences in longitudinal achievement gains between a group of children with learning disabilities receiving the Tomatis approach in school and a control group of children with learning disabilities receiving direct instruction only.

Another physician who is well known for his use of sound-based therapy is a French otolaryngologist named Guy Berard. In the early 1960’s, Berard, who worked
with Tomatis, developed another method of sound treatment, called Auditory Integration Training (AIT) based on some of the Tomatis principles. This form of treatment gained international attention following the publication of the book *The Sound of a Miracle*, written by Annabel Stahli, who poignantly describes the recovery of her daughter with autism following AIT treatment with Dr. Berard.

AIT uses electronically enhanced popular or classical music that distorts or modulates sound frequencies at random intervals for random periods of time. The music is also filtered according to the individual’s sensitivities, with respect to their audiogram. AIT is typically used to correct hypersensitive or distorted hearing. This clinic-based treatment consists of 19 hours of listening to modulated music in twenty ½ hour intervals over a period of ten consecutive days (Thompson, 1999).

Research on AIT has produced mixed results as well. Some studies have shown that children treated with AIT had improved behavior (Brown, 1999; Rimland & Edelson, 1994, 1995). Gillberg (1997) found that sensory problems decreased slightly. Brown (1999) reported general improvements in a variety of domains including functional behavior, attention and speech. Bettison’s (1996) research comparing groups receiving filtered/modulated music and unprocessed music found that both groups made significant but equal improvement on all measures including sensory processing, sound sensitivity, IQ, language and audiometric tests. Two subjects had adverse affects. Mudford et al. (2000) reported that the group receiving a placebo (wearing headphones with no music) showed slightly less aberrant behavior.

Advanced technology has made it possible for similar tools to be developed that allow individuals to participate in sound-based treatment at home. Although less
intensive than the Tomatis method or AIT, these compact discs have made treatment more accessible to clinicians in a variety of settings and are easier for families to afford. Therapeutic listening is a form of treatment that uses electronically altered music on compact discs. Treatment requires that the individual listen to the music using high quality headphones for two sessions per day for up to 30 minutes per session. The selection of music is prescribed by a trained therapist to meet the needs of the individual. The music varies in style, types of filtering and level of complexity. Treatment is typically implemented as a home program for an average duration of 3 to 6 months. The use of therapeutic listening as part of an overall sensory integrative approach to treatment is becoming more widespread among occupational therapists. Therapist reports that therapeutic listening programs result in improvements in task attention, temporal-spatial organization, handwriting, social interaction, and timing of motor movement (Frick, 2001). To date, no research has been published on the efficacy of using therapeutic listening programs.

**Purpose**

The purpose of this study was to investigate the effects of incorporating therapeutic listening in a therapist-directed, 8-week home program on children between the ages of 5 and 10 years. We hypothesized that children would demonstrate increased visual motor integration, improved handwriting ability, and fewer behaviors indicative of sensory processing deficits following 8 weeks of therapeutic listening, when compared to use of sensory diet. The null hypothesis was that there will be no difference in children’s
visual motor integration, handwriting and behavior when therapeutic listening was compared to standard treatment.

**Methods**

**Participants**

A convenience sample of 10 subjects between the ages of 5 and 11 years old was used in this study. All of the subjects were referred to occupational therapy for therapeutic listening and had a prescription from their primary physician for occupational therapy treatment. Although the IQs of the subjects were not known, they had the cognitive skills to participate in the testing. Exclusion criteria for the participants in this study included severe mental retardation or significant motor impairments due to a central nervous system lesion. Excluded diagnoses were cerebral palsy, Down Syndrome, visual impairment, hearing impairment and severe autism. A participant’s diagnosis could include any of the following: attention deficit hyperactivity disorder (ADHD), sensory integration dysfunction (DSI), mild autism or pervasive developmental disorder (PDD), Asperger Syndrome, developmental delay, coordination disorder, or motor delays. Children on medication and whose dosage was anticipated to change during the course of the study were excluded. Subjects who were currently receiving other therapies were asked to continue in these therapies during the course of this study. All subjects had to display behaviors that demonstrate delays with visual motor integration and problems with sensory processing as indicated by a score of at least one standard deviation below norm on the Beery Test of Visual Motor Integration and a score of definite difference (or 2 standard deviations below norm) on at least three subtests on the Sensory Profile.
Research Design

Each participant acted as his or her own control by measuring changes during the first four weeks using traditional sensory diet and comparing those changes to changes made during a therapeutic listening program combined with the sensory diet. The sensory diet program comprised a four-week home program of strategies to help the child modulate his/her sensory responses, arousal and alertness throughout the day. The program was designed either by an occupational therapist or the researcher at the time of the initial interview. Then each participant initiated a therapeutic listening program (while continuing the sensory diet) tailored to individual needs of each subject as prescribed by the researcher. The therapeutic listening program was implemented for eight weeks at home and monitored by the child’s parents or caregivers. The child’s sensory diet program continued during the therapeutic listening program. The researcher met the families at 4 week intervals to update and monitor the program.

Instrumentation

Four standardized instruments were used to measure sensory motor behaviors and performance: the Sensory Profile, the Draw-a-Person test (DAP), the Developmental Test of Visual Motor Integration (VMI), the Evaluation Tool of Children’s Handwriting (ETCH). The Sensory Profile was completed by the caregiver during the initial visit and the final visit following the 8-week treatment period. The other tests were administered three times before and after each treatment. All of the tests were administered by the
researcher who is an occupational therapist and were scored by other occupational therapists, blinded to the subjects and to whether the tests were pretests or posttests.

The Sensory Profile (Dunn, 1999) is a 125-item questionnaire which evaluates the following areas: sensory processing as part of daily life, modulation of sensory input for use in life, and behavioral and emotional responses that might be indicative of a child’s processing abilities. The parent or caregiver who has daily contact with the child completes the questionnaire by reporting the frequency with which these behaviors occur (Always, Frequently, Occasionally, Seldom, or Never). Internal reliability of the test total and sections was estimated by calculating Cronbach alphas. Reliabilities range from .70 to .90. The questionnaire was scored by an occupational therapist. Certain patterns of performance on the Sensory Profile are indicative of difficulties with sensory processing and performance. The Sensory Profile was given twice, once at the initial visit and again at the last visit following the completion of the 8-week treatment period. Raw Scores of the sensory profile sections were used for statistical analysis.

The Draw-a-Person Test (DAP) was used to measure integration of visuomotor skills (Short-Degraff & Holan, 1992, Vane, 1967). DAP assesses the mental age of the child by analyzing the detail of the child’s drawing of a person. Mortensen (1984) provided a summary of research for the DAP and found that test re-test reliability is .68 - .69 (1 week to 3 months); inter-rater reliability is .68 to .96 (most found .80-.90). Concurrent validity with the Goodenough-Harris Draw-A-Person is (n=32, r=.64) (Short-DeGraff & Holan, 1992). The subjects were given a blank sheet of paper and asked to make the very best drawing of a person that she or he could. There is no time limit to this test. The test was scored by giving credit to each of the details in the drawing according to specified
criteria. The total raw score was then correlated into a mental age. The raw scores and mental ages were used in statistical analysis.

The VMI (Beery, 2004) is a norm-referenced, evaluative measure of visual motor integration for children ages two to fifteen years old. There are supplemental, standardized, visual perception and motor coordination tests with this instrument that provides a means to assess relative visual and motor contributions to VMI performance. The “Full” VMI booklet is designed for ages 3 to adult and contains 24 forms to be copied. For the 1994 norming study, two individuals independently scored 100 VMI, Visual, and Motor tests of a random sample of the norming group. The resulting interscorer reliabilities were .94 for the VMI, .98 for the Visual, and .95 for the Motor. The average interscorer, internal consistency, and test-retest reliability provides the best indications of overall reliability (Anastasi, 1988). The VMI and its supplemental Visual and Motor tests had overall average reliabilities of .92, .91, and .89 respectively. In our study, the standard scores for the VMI and supplemental tests were used for data analysis.

The ETCH (Amundson, 1995) is designed to evaluate manuscript and cursive handwriting skills of children in Grades 1 through 6 who are experiencing difficulty with handwriting. Interrater reliability for total letters and numbers range from ICC = .82 to ICC = .84. For total letter legibility, test-retest reliability was $r=.77$, and for total number legibility, it was $r = .63$ (Diekema, Deitz, & Amundson, 1998). In our study, the child was given a response booklet and a pencil and asked to write letters and numbers from memory. Only the first three subtests for manuscript were administered for purposes of this study. These subtests included writing upper-case letters, lower case letters, and numbers from memory. The researcher administered the test according to the ETCH
Examiners Manual. Tests were scored by another occupational therapist. Legibility raw scores were used for statistical analysis.

**Pre-Intervention Phase**

The initial 4 weeks were used for gathering baseline data. If one was not already developed by their treating therapist, the researcher developed a sensory diet according to the needs of the child as indicated by the results of the testing for the parents to use as a home program. The sensory diet contained activities for the child to do at home that provide sensory input, such as movement, heavy work or tactile stimulation. For purposes of this study, the sensory diet is considered a traditional treatment for children with symptoms of sensory processing deficits. The purpose of starting the sensory diet home program at the time of the initial visit is to measure potential changes in the child as a result of the sensory diet without the auditory treatment. The parents were asked to fill out a daily checklist that recorded the type and frequency of the child’s target behaviors as well as to track their use of sensory diet that was given to them at their initial visit.

**Intervention Phase**

The subjects were scheduled for a second visit 4 weeks following the first visit. At that time, the therapeutic listening protocol was developed by the researcher. The parent was provided with the equipment they needed to implement this treatment as an intensive home program. The equipment included a set of high quality Sennheiser 500 headphones with a high resistance or impedance of at least 150 Ohms and a frequency
sensitivity to 23,000 Hz, and two to three CDs as prescribed by the researcher, who was formally trained in the advanced use of therapeutic listening treatment. The subjects used their own portable CD player.

The group of CDs used in this study are identified as Modified CDs. This means that they are altered by processing the music through an alternating high pass, low pass filter. This causes the high and low frequencies to pass through in the music at different intervals which creates a disruption in the sound of the music. Frick and Hatcher (2001) further explain the clinical significance of this type of modification in their manual entitled *Listening with the Whole Body*:

"What appears to be created with the use of modulated music is an ‘exercising’ effect of the muscles in the middle ear. Flexibility of these muscles is necessary to transmit sensory information to primary sensory processing centers that support sensory modulation….Biomechanically, it is the function of the middle ear muscles to contract or focus on sounds and relax to monitor ambient environment." p.3-13

The therapeutic listening protocol required the subjects to listen to the prescribed music for two sessions daily with at least three hours in between sessions. Each session lasted from 20 minutes to 30 minutes depending on the type of music prescribed. No one CD was used for a period longer than 3 weeks to prevent habituation. Subjects were instructed to avoid activities that required intense focus and would distract them from listening, such as watching TV or videos, and playing computer games or video games during the listening sessions.

Parents were instructed to keep a listening log on their child to record the frequency of treatment and their child’s response to the prescribed music. They were asked to continue documenting their use of a sensory diet and the frequency and severity of target
behaviors throughout the treatment period. Target behaviors were selected by the parent which reflected their goals for their child, such as, eye contact, outbursts, wetting accidents. At the end of the study, parents were asked open ended questions in an interview by the researcher to gather information that could not be obtained by the standardized assessments used in the study.

**Statistical Analysis**

The SPSS computer program was used to analyze the scores of the instruments used in this study. Means and standard deviations of the dependent variable were summarized to demonstrate the group’s performance at each observation interval. A comparison across time periods was analyzed using repeated measures analysis of variance. When results were significant, post hoc multiple comparison (Tukey’s and Scheffe) were performed to determine which time periods were most significant. Level of significance was set .10 a priori.

**Results**

**Participants**

Twelve subjects with sensory processing dysfunction and visual motor delays were recruited in a convenience sample and were referred by an occupational therapist for therapeutic listening. Ten out of the 12 subjects completed the full 12 weeks of the study. One subject dropped out after two weeks of treatment because the parent was dealing with too many stressors at home including an ailing sibling. The other subject dropped out prior to completion of the study because the parent stated that she did not see any benefit. The age of the subjects ranged from 5 years, 8 months to 10 years, 11
months. All of the subjects had sensory processing deficits as defined by at least three areas of definite difference on the Sensory Profile and had scored at least one standard deviation below norm on the Developmental Test of Visual Motor Integration. All of the subjects had the cognitive skills to participate in the testing. However their diagnoses varied significantly. The subject demographics are presented in Table 1.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Gender</th>
<th>Age at baseline</th>
<th>Level and type of treatment during study</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>7y,2m</td>
<td>None - Discharged from OT treatment</td>
<td>Asperger Syndrome</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>7y,3m</td>
<td>Received 30 mins. of OT treatments 2 times per month</td>
<td>Developmental Delay, Hypotonia</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>7y,3m</td>
<td>None - Discharged from OT treatment</td>
<td>Sensory Integration Dysfunction</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>8y,4m</td>
<td>None - On waitlist for OT treatment</td>
<td>ADHD, Sensory Integration Dysfunction</td>
</tr>
<tr>
<td>5</td>
<td>F</td>
<td>5y,8m</td>
<td>Receives 20 mins per week of OT treatment at school</td>
<td>Developmental Delay</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>10y,11m</td>
<td>None - Discharged from OT treatments</td>
<td>High Functioning Autism</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>7y,0m</td>
<td>Received 45 mins of OT treatment 1 time per month</td>
<td>Coordination Disorder</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>6y,1m</td>
<td>OT consultation</td>
<td>Asperger, Anxiety Disorder</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>8y,6m</td>
<td>Discharged from OT treatment; PT 1 time per week.</td>
<td>ADHD, Mild CP</td>
</tr>
<tr>
<td>10</td>
<td>M</td>
<td>8y,7m</td>
<td>60 mins of OT treatment 1 time per week</td>
<td>Arnold Chiari Malformation</td>
</tr>
</tbody>
</table>

TABLE 1 The gender, age and diagnosis of each of the 10 subjects who completed the study.
Only four of the ten subjects listed in the above table were receiving occupational therapy at the time of the study. The frequency of and amount of treatment varied greatly. Four of the subjects had been discharged from OT treatment within the past year. One subject was on the waitlist for OT services and another only received OT consultation. Subject 9 had an additional diagnosis of CP which presented as mildly increased tone in his heel cords bilaterally. His upper extremities were not affected.

The subjects were asked to participate in two therapeutic listening treatment sessions per day for a total of 8 weeks. All but two parents were diligent in following through with this request. Subject 2 implemented the treatment 2×/day on an average of 4 to 6 times per week and one time per day on the other days. Subject 7 implemented the treatment on the average of 1× per day and occasionally 2×/day. Parents of all subjects reported that during the course of the 12 week study, there were no changes in medications or in frequency or types of therapies the subjects received.

Sensory Profile Results

Using a paired t-test, Sensory Profile means for 10 subscales improved significantly between pretest and posttest. See Table 2.
<table>
<thead>
<tr>
<th>Sensory Profile</th>
<th>Pre-Test Period</th>
<th>Post-Test Period</th>
<th>t</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SEM</td>
<td>Mean</td>
<td>SEM</td>
</tr>
<tr>
<td>Sensory Profile Total</td>
<td>367.1</td>
<td>10.6</td>
<td>438.7</td>
<td>15.1</td>
</tr>
<tr>
<td>A. Auditory Processing</td>
<td>18.4</td>
<td>0.9</td>
<td>27.1</td>
<td>1.1</td>
</tr>
<tr>
<td>B. Visual Processing</td>
<td>29.8</td>
<td>2.1</td>
<td>34.3</td>
<td>2.0</td>
</tr>
<tr>
<td>C. Vestibular Processing</td>
<td>40.1</td>
<td>1.2</td>
<td>43.0</td>
<td>2.4</td>
</tr>
<tr>
<td>D. Touch Processing</td>
<td>55.5</td>
<td>3.8</td>
<td>64.2</td>
<td>4.1</td>
</tr>
<tr>
<td>E. Multisensory Processing</td>
<td>19.9</td>
<td>1.4</td>
<td>23.4</td>
<td>0.9</td>
</tr>
<tr>
<td>F. Oral Sensory Processing</td>
<td>36.5</td>
<td>3.6</td>
<td>43.8</td>
<td>2.9</td>
</tr>
<tr>
<td>G. Endurance and Tone</td>
<td>28.8</td>
<td>2.9</td>
<td>31.6</td>
<td>2.8</td>
</tr>
<tr>
<td>H. Body Position and Movement</td>
<td>31.5</td>
<td>1.3</td>
<td>35.3</td>
<td>2.0</td>
</tr>
<tr>
<td>I. Movement Affecting Activity Level</td>
<td>19.4</td>
<td>1.2</td>
<td>21.3</td>
<td>1.3</td>
</tr>
<tr>
<td>J. Emotional Responses</td>
<td>10.1</td>
<td>1.0</td>
<td>12.7</td>
<td>0.7</td>
</tr>
<tr>
<td>K. Modulation of Visual Input Affecting Emotional Responses</td>
<td>11.9</td>
<td>0.7</td>
<td>13.9</td>
<td>0.8</td>
</tr>
<tr>
<td>L. Emotional/Social Responses</td>
<td>41.1</td>
<td>2.5</td>
<td>54.0</td>
<td>3.4</td>
</tr>
<tr>
<td>M. Behavioral Outcomes</td>
<td>13.6</td>
<td>0.7</td>
<td>17.7</td>
<td>0.9</td>
</tr>
<tr>
<td>N. Items Indication Threshold Response</td>
<td>10.5</td>
<td>0.6</td>
<td>11.2</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Table 2. Paired t-test Results of the Sensory Profile      * p < .10    ** p < .05   *** p < .01
Visual Motor Tests

One way analyses of variance (ANOVA) with repeated measures using the Greenhouse-Geisser adjustment were computed for the DAP and ETCH using raw scores and for the VMI using standard scores. See Table 3. ANOVA was used to test the difference between means; significance was set \textit{a priori} \( p < .10 \). The null hypothesis was rejected for visual and motor subscales of the VMI and the lower case, number and total legibility subscales of the ETCH.

<table>
<thead>
<tr>
<th>Assessment Tool</th>
<th>Pretest 01</th>
<th>Pretest 02</th>
<th>Posttest 03</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SEM</td>
<td>Mean</td>
<td>SEM</td>
</tr>
<tr>
<td>DAP-R</td>
<td>12.2</td>
<td>2.2</td>
<td>12.8</td>
<td>1.8</td>
</tr>
<tr>
<td>DAP-M</td>
<td>6.0</td>
<td>0.5</td>
<td>6.2</td>
<td>0.4</td>
</tr>
<tr>
<td>VMI</td>
<td>83.5</td>
<td>1.8</td>
<td>83.8</td>
<td>2.6</td>
</tr>
<tr>
<td>VMI-V</td>
<td>81.8</td>
<td>4.5</td>
<td>84.1</td>
<td>5.6</td>
</tr>
<tr>
<td>VMI-M</td>
<td>85.8</td>
<td>6.8</td>
<td>73.6</td>
<td>4.5</td>
</tr>
<tr>
<td>ETCH-LC</td>
<td>12.9</td>
<td>2.0</td>
<td>14.0</td>
<td>2.2</td>
</tr>
<tr>
<td>ETCH-UC</td>
<td>14.5</td>
<td>2.1</td>
<td>13.8</td>
<td>2.1</td>
</tr>
<tr>
<td>ETCH-N</td>
<td>8.0</td>
<td>.869</td>
<td>8.8</td>
<td>.998</td>
</tr>
<tr>
<td>ETCH-T</td>
<td>52.6</td>
<td>7.9</td>
<td>53.5</td>
<td>7.9</td>
</tr>
</tbody>
</table>

Table 3 DAP, VMI, and ETCH one way repeated measures ANOVA results. Test of within-subjects effects with Greenhouse-Geisser adjustment \(*p < .05\)

The rejection of the null hypothesis suggests that the sample means differ but does not tell where the differences lie. To identify the significance of the specific time periods and test the research hypothesis, post hoc multiple comparisons were done with Tukey’s test for honest significant difference (HSD). A Tukey’s HSD value was calculated using \textit{a priori} \( p < .05 \) for the VMI visual subscale, VMI motor subscale, ETCH lower case letter subscale, ETCH number subscale, and ETCH total legibility.
subscale. If the difference between the mean scores was greater than Tukey's HSD, then there was a statistical significance between the time periods analyzed. The results are as follows: Of the 3 pair-wise comparisons, The VMI visual subscale was significant from pretest 01 to posttest 03. The VMI motor subscale was significant for a decline in mean scores from pretest 01 to pretest 02. The ETCH lower case subscale was significant from pretest 01 to posttest 03. ETCH number subscale was significant from pretest 01 to pretest 02 and pretest 01 to posttest 03. ETCH total legibility subscale was not significant at p<.05, but significant at p<.10 from pretest 01 to posttest 03. See Table 4.

<table>
<thead>
<tr>
<th></th>
<th>01-02</th>
<th>02-03</th>
<th>01-03</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMI - V</td>
<td>NS</td>
<td>NS</td>
<td>S**</td>
</tr>
<tr>
<td>VMI - M</td>
<td>S (d)**</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>VMI - LC</td>
<td>NS</td>
<td>NS</td>
<td>S**</td>
</tr>
<tr>
<td>ETCH - N</td>
<td>S**</td>
<td>NS</td>
<td>S**</td>
</tr>
<tr>
<td>ETCH - T</td>
<td>NS</td>
<td>NS</td>
<td>S*</td>
</tr>
</tbody>
</table>

Table 4. Results of Tukey's test for post hoc multiple comparisons. NS denotes not significant. S denotes significance. (d) denotes decrease of mean scores. * p < .10 **p < .05

Further analysis was done on the VMI visual subscale and the ETCH total legibility subscale because there was a sharp increase in mean scores from pretest 02 to posttest 03. Using Scheffe Compound Contrast, the mean scores for posttest 03 were compared to the average of the mean scores for pretests 01 and 02. The results were
significant for both the VMI visual subscale and the ETCH total legibility subscale at p<.05, thus supporting the treatment effect.

A third analysis examined differences in the rate of change between pretest 01 and 02 and between pretest 02 and posttest 03. A paired t-test calculated the rates of change on the DAP, ETCH and VMI. To accept the research hypothesis, the scores during 02-03 (treatment phase) would have to improve at more than twice the rate of the scores during 01-02 (pretreatment phase). Therefore the value entered into the t-test for mean rate of change for 02-03 was divided in half (.5). The t-test results indicated a significant difference for the rates of change of the VMI motor subscale and the ETCH number subscale. Results are presented in Table 5.

<table>
<thead>
<tr>
<th>ASSESSMENT TOOL</th>
<th>01 – 02</th>
<th>02 – 03</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MEAN</td>
<td>SEM</td>
<td>MEAN</td>
</tr>
<tr>
<td>DAP – R</td>
<td>.66</td>
<td>.70</td>
<td>1.6</td>
</tr>
<tr>
<td>DAP – M</td>
<td>.16</td>
<td>.17</td>
<td>0.4</td>
</tr>
<tr>
<td>VMI</td>
<td>.30</td>
<td>2.9</td>
<td>2.2</td>
</tr>
<tr>
<td>VMI – V</td>
<td>2.3</td>
<td>3.8</td>
<td>5.4</td>
</tr>
<tr>
<td>VMI – M</td>
<td>-12.22</td>
<td>4.4</td>
<td>5.1</td>
</tr>
<tr>
<td>ETCH – LC</td>
<td>1.1</td>
<td>1.1</td>
<td>0.9</td>
</tr>
<tr>
<td>ETCH – UC</td>
<td>-0.70</td>
<td>1.10</td>
<td>1.0</td>
</tr>
<tr>
<td>ETCH – N</td>
<td>.80</td>
<td>.29</td>
<td>0.2</td>
</tr>
<tr>
<td>ETCH – T</td>
<td>.90</td>
<td>1.9</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Table 5 DAP, VMI and ETCH paired t-test results for rates of change. Mean for 02-03 was multiplied times .5. * p < .05   ** p < .10

Discussion

Sensory integration is the brain's ability to organize the information that we take in through our senses for our use. Ayres believed that the processing of sound is one of
the primal forms of sensory integration having crucial significance to survival and thus having influence over “several integrating neurons at the brainstem and subcortical locations” (Ayres, 1972, pg 71). Tomatis understood the ear to be neurologically aligned with the optic (2nd), oculomotor (3rd), trochlear (4th), abducens (6th) and spinal-accessory (11th) cranial nerves, integrating with the acoustic nerve. This interaction of the cranial nerves is a major mechanism of reception and integration of perception (Thompson & Andrews, 2000). Therefore it is not surprising that therapeutic listening may have a positive effect on reducing behaviors indicative of sensory integration deficits.

Sensory responsivity, like temperament, appears to be an enduring characteristic of children (Case-Smith, 1997, Dunn & Brown, 1997). Because the Sensory Profile is completed by parents and represents their impressions of their child over time, impressions may not change, even when behaviors do. In our study, all ten subjects showed improvement in their scores on the Sensory Profile on the average of 71 points per child showing a decrease in behaviors indicative of sensory processing dysfunction. Some parents noted significant changes in their child’s behaviors and performance, while others saw more subtle improvements. In ten of the fourteen subtests, as well as the total score, significant changes had occurred. The total score and two subscales, auditory processing and behavioral outcome showed improvement with a greater than .01 significance level. The other subscales that showed significant improvement included tactile processing, multisensory processing, oral processing, body position and movement, emotional responses, social responses, and modulation of visual input affecting emotional responses showed improvement (p < .05).
Comments that the parents made in response to an interview at the conclusion of the study support the findings seen on the sensory profile. Parents indicated marked improvement in noise tolerance for four of the five subjects reported to have hypersensitive hearing. Of the four subjects reported to tantrum on a daily or weekly basis, the parents indicated that tantrums had either stopped completely or decreased dramatically in frequency, duration, and intensity. Five of six parents who reported that their children were high energy or very active, reported that their children were calmer during the therapeutic listening program. Four parents of picky eaters reported that their children started trying new foods.

The subscales that did not show scores indicating significant improvement were vestibular processing, endurance and tone, and movement affecting activity level. This is surprising because of the interconnected neuroanatomy of both portions of the vestibulocochlear system. A closer look at these subscales showed that for vestibular processing, 7 subjects’ scores improved, 2 subjects’ scores remained the same, and one subject’s scores actually decreased at the end of the study. However, it is interesting to note, that only one of the 10 subjects was described as being gravitationally insecure. This subject did show some signs of improvement (increased 4 points on the vestibular subscale) and parents reported that the child was more willing to participate in some movement activities.

Visual motor skill and handwriting are functional outcomes that reflect spatial-temporal organization. In 1993, Rauscher, Shaw, and Ky gained great attention with their claim that after listening to Mozart music for 10 minutes, a group of college students showed significantly better spatial-temporal reasoning skills than they did after periods of
listening to relaxation instructions or silence. In an attempt to explain this “Mozart Effect”, subsequent studies have been done using techniques such as positron emission tomography and functional magnetic resonance scanning which have shown that music activates a wide distribution of brain areas (Chauvel, 1998; Jenkins, 2001; Platel et al., 1997; Warren, 1999). By mapping brain activity using PET scanning, researchers have found that areas of the brain that are activated when one is engaged in spatial-temporal tasks, overlap the areas of the brain activated when one is involved in processing music (Mellet et al. 1996). Rauscher et al. (1993) theorized that listening to music helps to organize the cortical firing patterns, in particular, the right hemisphere process of spatial-temporal task performance.

In our study, the evidence to support improvement in temporal-spatial skill as demonstrated in visual motor performance as a result of therapeutic listening was weak. The DAP mean scores did not support the treatment effect in this study. Nine of the 10 subjects participated in this assessment, because one subject was unable to complete his drawings due to his anxiety over trying to make his drawings perfect. Five of the nine subjects did show an increase of 6 months to 4 years calculated mental age comparing pretest 2 to posttest scores. This pattern of improvement was encouraging, although it was not significant.

The mean scores of the visual motor integration performance and the motor subscale did not support the treatment effect in this study as well. However, there was evidence to support treatment effect to account for the improvements seen on the visual subscale. This is consistent with the findings of the Sensory Profile showing improvements in the areas related to visual processing. Ayres (1979) understood
auditory and visual systems readily exchange information at the level of the brain stem due to the close anatomical proximity of the auditory organizing centers to the visual processing centers.

The ETCH analyzed changes occurring in the subject's handwriting over the course of the study. The skills were broken down in four areas: lower case letters, upper case letters, numbers and total legibility. Post hoc analysis showed that the subjects made significant improvement in writing their lower case letters over the entire 12-week period, but did not support the treatment effect. Number writing showed greater improvement during the base line phase, then gradual improvement over the treatment phase, thus not supporting a treatment effect. However, total legibility was significantly improved from the first pretest to posttest. Scheffé's compound contrast analysis showed that the majority of the improvement occurred during the treatment period, thus supporting the treatment effect.

It is important to note that only two of the 10 subjects were specifically working on their handwriting skills on a regular basis in their school or in their occupational therapy sessions during the course of the study. Both of these subjects showed greater improvement with handwriting during the time they received the therapeutic listening as demonstrated by their total legibility scores: Subject 5 scored 3% and 5% on the two pretests respectively and scored 17% on posttest. Subject 9 scored 40% and 48% on the two pretests respectively and scored 61% on the posttest. The parent of subject 5 noted that after her child started therapeutic listening, the child started becoming more interest in writing. She showed overall improvements in school as well as reported to the parent by the child's teacher. These findings may support the theory that therapeutic listening
primes the nervous system and prepares it for emerging skills (Frick and Hatcher, 2001; Rauscher et al, 1993). Other authors (e.g., Amundson, 2001; Chu, 1997) have recommended combining approaches based on the individual needs of the child. Sensory integrative interventions can help to improve attention, arousal, and motor planning (Cermak, 1991). Visual and kinesthetic cues reinforce the child’s perceptions of movements required for letter formation (Benbow, 1990). Emphasis on neuromotor and biomechanical aspects of handwriting can benefit children with low muscle tone, postural instability, and weakness (Amundson, 2001). Combining therapeutic listening along with other treatment strategies and opportunities to master the skill may be a powerful approach to treatment.

The parent interview at the end of the study gives us insight into some of the possible changes that were not addressed by the standardized assessments used in this study. Four parents reported that they received reports that their children were doing better in school. Three parents reported that their children’s eye contact improved. One child decreased his wetting accidents in school from one time per week to one time per month. Another child’s behavior and attention improved so dramatically that he was able to discontinue his afternoon dose of Adderall. Other comments included improved attention, more interaction with peers, decreased nightmares, improved transitions, better listening, greater self awareness, better communication, improved sleep patterns, and more consistency with following directions. One parent was so pleased with her child’s improvement that she wrote a detailed description of how her son improved after the therapeutic listening treatment. See Appendix F.
It is apparent by the diversity of the parents' responses to the follow-up interview that sensory integration dysfunction affects children differently and interferes with many aspects of life. Clinicians cannot accurately assess a child's reactivity to sensory input in one or two observations of his or her behavior (Case-Smith, 1997). Therefore it is important that the caregiver who has daily contact with the child provide the therapist with this information, not only for the purpose of assessment, but also for monitoring the effects of treatment.

Limitations

The outcomes of this study are valid for children of a limited age range between 5 and 11 years. This age group was selected because the standardized assessments that were used in this study are known to be sensitive to changes for this range.

There was no specific diagnosis being studied. All of the subjects that were included in this group showed evidence of sensory integration dysfunction and visual motor integration delays as indicated by their scores on standardized assessments, but were referred with a variety of diagnoses such as ADHD, Autism, Developmental Coordination Disorder, and Asperger Syndrome. The outcomes are externally valid for children with symptoms of sensory integration dysfunction and delays in visual motor dysfunction.

The subjects were not randomly selected. A convenience sample of subjects, referred to occupational therapy for sound-based treatment, was used. However multiple pretests were conducted to establish a baseline of performance and to allow the subjects to act as their own control.
The treatment was administered by the parent as a home program. Therefore the researcher was not able to closely monitor how well or consistently the parents followed through with the treatment. However, the researcher requested that parents document the duration and frequency of each session in order to track compliance with the treatment protocol.

There was a possibility that other therapeutic interventions may have caused a change in the subjects' functional skill development. Subjects were required to maintain all current therapies and refrain from starting new therapies during the duration of the study. All subjects reported that their medication they were taking remained consistent during the course of this study.

Most children receiving sound-based treatment typically continue with this treatment for an average of 6 months duration. This study examines the effect of a short duration of this treatment. Therefore, the full effects of this intervention may not be revealed given the 8-week duration.

Further Research

Because many of the subjects in this study were not receiving therapy services at the time they were engaging in therapeutic listening, opportunities to master emerging skills were limited. Therefore, further research is needed to analyze the effectiveness of therapeutic listening in conjunction with occupational therapy to address specific skill deficits. Because occupational therapists have reported clinical evidence that therapeutic listening has an effect on vestibular processing (Frick & Hatcher, 2001), studies using more sensitive instruments to measure vestibular processing changes would be useful.
Also, research is needed to look at long-term effects of therapeutic listening to see if the subjects were able to maintain their progress after treatment is discontinued.

Conclusion

The present study has produced some encouraging findings to support the use of therapeutic listening as part of an overall sensory integrative approach to occupational therapy in elementary aged children. Therapeutic listening, along with sensory diet strategies, can be effective in reducing many behaviors associated with sensory integration dysfunction. Although our study provides evidence that therapeutic listening facilitates visual processing and handwriting legibility, this author recommends that combining treatment approaches and providing plenty of opportunities to master these skills along with the therapeutic listening program would be its most effective use.
LIST OF REFERENCES


APPENDIX A

INFORMED CONSENT FORM
CONSENT TO PARTICIPATE IN A CLINICAL RESEARCH STUDY

STUDY TITLE: The effect of sound based intervention on 10 children with sensory integration dysfunction and visual motor integration delays.

STUDY INVESTIGATORS: Jacqueline Wynn, PhD, Jane Case-Smith, EdD, OTR/L, Leah Hall, OTR/L

CONTACT TELEPHONE NUMBER: (614) 839-2800 or (614) 776-5603 (24 hours a day, 7 days a week)

SUBJECT’S NAME: ______________________ DATE OF BIRTH: _____________

1) INTRODUCTION
We invite you to be in a clinical research study because your child has a diagnosis of sensory integration dysfunction and delays in visual motor integration. Clinical research is the study of diseases and treatments to improve health care. You will need to learn enough about this research study, along with its risks and benefits to decide whether you should agree to participate. This process is called “informed consent”. We must explain the study to you, and give you a chance to ask questions about anything you do not understand. It is up to you to choose if you want to be in this study. You may refuse to be in this study or quit this study at any time, and standard medical care will still be available here or at a doctor of your choice. It is important to understand that there may not be any benefit from being in this study, but we may learn something that could help others.

Before agreeing to be in this research study, it is important that you read and understand the study information in the consent form. By signing the consent form, you agree to be in this study. If your child is older than 9 years of age, he/she must also agree to be in the study by signing an Assent form. You will be given a signed copy of the consent and the assent form.

2) WHY ARE WE DOING THIS RESEARCH STUDY?
This is a study to see if listening to music on a daily basis will improve your child’s ability to concentrate, tolerate changes, process what is going on around him or her and improve visual-motor skills such as handwriting and drawing. Many occupational therapists use this treatment as a home program to along with their direct treatment and have found that children meet their therapeutic goals much quicker as a result. However, other than clinical observations, there is little written to support the use of this kind of treatment.

3) WHERE WILL THE STUDY BE DONE AND HOW MANY SUBJECTS WILL TAKE PART?
This study will be done at Children’s Hospital Westerville Close to Home Occupational Therapy Department. All of the testing will be done at this clinic. The sound therapy will be implemented as a home program. We hope to have at least 10 subjects between the ages of 6 to 10 participating in the study.
4) WHAT WILL HAPPEN DURING THE STUDY AND HOW LONG WILL IT LAST?

You and your child will meet with the occupational therapist (OT) to learn about the sound based treatment and to participate in the initial assessment process. Based on the assessment results, the therapist will determine if your child qualifies for the study. A sensory diet home program will be developed at this time to help you address any of the sensory issues your child is having difficulty with. The sensory diet could include activities such as exercises or games that require movement, resistance against muscles or various touch experiences. For the first four weeks, you will be asked to do some of the activities listed on the sensory diet at home. You will need to keep a record of your child’s response to the sensory diet by filling out a check list. When the four weeks is finished, you and your child will meet with the therapist again for a reevaluation. At that time, the sound therapy will be prescribed. You will be given the equipment you will need to start this treatment at home. You will be asked to have your child listen to the prescribed CDs for two sessions per day for a total of eight weeks. The music will be changed at least every two weeks. You will meet with the OT at least once every four weeks during the duration of the study.

This study will last for a total of 12 weeks.

During this study, we will compare the amount of improvement your child makes during the first four weeks using a sensory diet only to the improvement you child makes during the 8 weeks he/she is doing sound therapy.

This study is blinded. Blinded means that the occupational therapists scoring the assessments will not know which child they are scoring or if the tests were completed before or after treatment.

Visit 1 - Screening Visit
This visit will take about 1½ hours. Questions will be asked about medical history, past and present diseases, allergies and medications. It is important to tell the Study Occupational Therapist all the information you can. You will be asked to fill out a Sensory Profile which is a 125 item questionnaire that looks at how your child processes sensory experiences as part of daily life. You will complete the questionnaire by reporting the frequency with which these behaviors occur (Always, Frequently, Occasionally, Seldom, or Never). Your child will be asked to participate in the following assessments including the Test of Visual Motor Integration (VMI), The Evaluation Tool of Children’s Handwriting (ETCH), and the Goodenough Draw a Person test. The VMI requires your child to copy forms in order without erasing. There are a total of 24 forms in all and this assessment usually takes about 10 minutes to complete. There are two supplemental tests, visual perception and motor, which your child will be asked to complete. The visual perception test requires your child to choose the form that is identical to the example. This takes no more than 3 minutes. The motor tests require your child to draw the same 24 forms as the VMI by drawing within the lines. This test takes 5 minutes. The ETCH is designed to
evaluate handwriting skills. In this assessment, your child will be asked to write letters and numbers from memory. This should take about 15 minutes to complete. The Draw A Person test requires your child to draw a picture of a person. This is another test that can evaluate visual-motor skills.

During the initial visit, the Occupational therapist will recommend a home program that will consist of a sensory diet to address your child’s sensory processing deficits. You will be asked to keep track of how often your child does these activities by filling out a simple checklist.

During the course of this 12 week study, you will be asked to keep all your child’s therapies the same. Any changes in your child’s treatments including outside OT, Physical Therapy, Speech Therapy and even medications can affect the results of this study.

Visit 2 – Second Pretest
You will be asked to attend a follow up appointment 4 weeks after the first one. During this visit, your child will be tested again using the same tests as the first visit - the VMI, ETCH, and Draw a Person test. You will not be asked to fill out another Sensory Profile at this time. During this visit you will be provided with the equipment you will need to start the sound treatment home program. This equipment will consist of Sennheiser head phones, and prescribed CDs. You will need to purchase a portable CD player if you don’t already have one to use this equipment with. You will be given instructions on how to use the equipment. Home sound treatments usually require listening to the CDs with the Sennheiser head phones from 5 to 30 minutes per session, 2 times a day, depending on your child’s needs. The music will be changed at least every two to three weeks. Your commitment to doing this treatment daily is important to the outcome of this study. You will be asked to keep track of how often your child’s sound treatment as well as the sensory diet. Again, this will be done by completing a simple checklist.

Visit 3 – Follow Up
This appointment will be scheduled four weeks from the time of the second visit. The purpose of this visit is to check your child’s progress and to make any necessary changes in the music selections. No tests will be done during this visit.

Visit 4 – Positest
This will be the last visit of the study. It will be scheduled 4 weeks after visit 3. You will be asked to fill out the Sensory Profile once again. Your child will be retested with the VMI, ETCH and Draw a Person Test. The occupation therapist will collect your checklists and will ask you questions about your child’s progress over the last 12 weeks. If your child continues to need sound treatment beyond the end of this study, you will be able to continue with this therapy until your child’s goals are met. The occupational therapist will continue to monitor your child’s treatment. You will be asked to return the headphones and all CDs at the end of your child’s treatment.
5) **WHAT BAD THINGS CAN POSSIBLY HAPPEN DURING THIS STUDY?**

Your child will be told to listen to the music at a low volume like soft background music. Listening to the music softly through the headphones is well within the OSHA standards for safety. You should be able to carry on a conversation while your child is listening with the headphones without your child having to raise his or her voice.

Some children experience some irritability when first starting this treatment. This should go away after about two weeks. If your child starts losing sleep or losses his appetite, contact the occupational therapist and she will adjust or stop the treatment.

It is important for your child to use the Sennheiser headphones only for the sound treatments. All low frequencies in the music on the sound treatment CDs that could possibly cause harm to your child’s hearing have been filtered out. Listening to music of any kind very loudly could possibly damage your child’s hearing. If this occurs, please contact your child’s primary care physician immediately, stop the sound treatment, and contact the study occupational therapist. Please monitor the volume level at which your child is listening at each session.

6) **WHAT GOOD THINGS CAN POSSIBLY HAPPEN DURING THIS STUDY?**

The use of sound treatment as a home program could have many possible benefits. This could include improvement in the following areas:

- Attention
- Language
- Balance and coordination
- Ability to calm self
- Motor skills
- Over- sensitivity to sound or touch
- Ability to use both side of the body effectively

In addition to the benefits listed above, occupational therapists using sound therapy have seen children improve their sense of direction, timing of movements and handwriting skills.

There is also the possibility that this treatment could have no benefit for your child.

7) **WHAT HAPPENS IF BEING IN THIS STUDY CAUSES INJURIES?**

If being in the study causes any injury, Children’s Hospital will provide medical care. You may have to pay for the cost of this care. This does not mean that you give up any of your rights under state or federal laws to ask for this care to be paid by someone else.
8) **WHAT WILL HAPPEN IF NEW INFORMATION IS FOUND OUT ABOUT THE DRUG OR TREATMENT?**

If we find out any new information during this study that might make you change your mind about being in this study or might affect your health, a study staff member will call you.

9) **WHAT OTHER TREATMENTS ARE THERE?**

It is not necessary to be in this study to get care for this condition. Other treatments are available. If you decide not to be in this study, the study occupational therapist will talk to you about other treatments.

10) **WHAT WILL HAPPEN IF I DO NOT FINISH THIS STUDY?**

It is your choice to be in this study or to stop at any time. If you decide to stop being in this study, it is OK, but you must call the study coordinator.

If at any time the study therapist believes participating in this study is not the best choice of care, the study may be stopped and other care prescribed. If the study instructions are not followed, participation in the study may also be stopped. If unexpected medical problems come up, the study coordinator may decide to stop your participation in the study.

12) **WILL THERE BE ANY COSTS TO ME?**

Costs of being in this study will be billed to your insurance company or third party payer. Each session will be considered occupational therapy treatment or consultation and will be billed as such. You may have to pay any costs the insurance company or third party payer does not pay. You may also need to purchase a portable CD player in order to use the equipment if you do not already have one. A nonrefundable fee of $50.00 will need to be paid for the use of the equipment at the time it is issued. You will be asked to return the equipment when your child’s treatment completed. You will not be paid to be in this study.

13) **HOW WILL MY STUDY INFORMATION BE KEPT PRIVATE?**

Information collected for this study is confidential to the extent provided by law. Data collected and entered into the Case Report Forms are the property of the study sponsor. In the event of any publication regarding this study, your child's identity will not be revealed. Employees from the following organizations may receive copies of the study records and may review your child's medical records related to this study:

- PI and employees
  - Sponsor: OSU Occupational Therapy Graduate Department
  - The Office for Human Research Protections (OHRP)
  - The Institutional Review Board (IRB) of Children's Research Institute (a committee that reviews all research)
Information collected for this study will be kept confidential to the extent allowed by law. Information used and/or disclosed (shared with someone outside of Children’s Hospital) may include information that can identify you. This is called “protected health information” or PHI. By agreeing to be in this study, you are giving permission or authorizing the Study Director and study staff to collect, use, and disclose your PHI for this research study. Information collected is the property of Children’s Hospital. In the event of any publication regarding this study, your identity will not be revealed.

- **People or Companies authorized to use, disclose, and receive PHI collected or created by this research study:** Jaqueline Wynne; Leah Hall, OTR/L, Children's Hospital IRB, OSU Graduate Department. Because of the need to give information to these people, absolute confidentiality cannot be guaranteed. Information given to these people may no longer be protected by federal privacy rules.

- **Reason(s) why the use or disclosure is being made:**

  - If you have a bad outcome or adverse event from being in this study, the Study Director and staff or other health care providers may need to look at your entire medical records.

  - The PHI collected or created under this research study will be used/disclosed as needed until the end of the study. The records of this study will be kept for an indefinite period of time.

  - You may decide not to authorize the use and disclosure of your PHI, however, you may not be able to be in this study. If you agree to be in this study and later decide to withdraw, you may also withdraw your authorization to use your PHI. This request must be made in writing to the Study Director. If you withdraw your authorization, no new PHI may be collected and the PHI already collected may not be used unless it has already been used or is needed to complete the study analysis and reports.

15) **WHOM SHOULD I CALL IF I HAVE QUESTIONS OR PROBLEMS?**

If you have questions about anything while on this study, you have 24 hour access to talk to your Study Coordinator at 614-839-2800 or 614-776-5603.

If you have questions or are worried about your legal rights, contact Children’s Hospital Legal Services at (614) 722-3940. If you have questions or are worried about your rights as a research volunteer, please call (614) 722-2874, Children's Hospital, Institutional Review Board, (IRB, a committee that reviews all research).
Subject’s Name ___________________________ Date of Birth ___________________________

SUBJECT or SUBJECT'S LEGAL REPRESENTATIVE STATEMENT

I have read this consent form and have had a chance to ask questions about this research study. These questions have been answered to my satisfaction. If I have more questions about participation in this study or a research-related injury, I may contact the Study Coordinator. By signing this consent form, I certify that all health information I have given is true and correct to the best of my knowledge.

I have been given a copy of the Children's Hospital Notice of Privacy Practices. I understand that my right to my patient information that is created or collected by Children's Hospital in the course of this research can be temporarily suspended for as long as the research is in progress. I also understand that my right to access will be reinstated upon completion of this research.

I agree to participate in this study. I will be given a copy of this consent form with all the signatures for my own records.

CONSENT SIGNATURES

SUBJECT or SUBJECT'S LEGAL REPRESENTATIVE DATE SIGNED

SUBJECT or SUBJECT'S LEGAL REPRESENTATIVE DATE SIGNED

PERSON OBTAINING CONSENT DATE SIGNED
I certify that I have explained the research, its purposes, and the procedures to the subject or subject’s legal representative before requesting their signature.

STUDY INVESTIGATOR SIGNED DATE
APPENDIX B

INFORMED ASSENT FORM
THE PERSON IN CHARGE OF THIS STUDY: Jacqueline Wynn, PhD
Jane Case-Smith, EdD, OTR/L

Other Study Coordinators: Leah Hall, OTR/L

SUBJECT'S NAME: ___________________________ DATE OF BIRTH: __________

We invite you to be in a research study at Children’s Hospital. We want you to read and understand some things about being in this research study:

• It’s o.k. to say “no” if you don’t want to be in the study.
• You are allowed to quit being in the study any time.
• We have to explain the study to you so you can understand it. You can ask questions.

1. WHY ARE WE DOING THIS RESEARCH STUDY?
The purpose of this study is to find out how effective therapeutic listening treatment is in helping kids be successful in school and at home. We want to see if therapeutic listening will help kids write and draw better and to more successfully participate in daily life activities.

2. WHAT WILL HAPPEN DURING THE STUDY?
You will be asked to wear headphones and listen to music twice a day for up to 30 minutes each session. Your parents will keep track in writing of your listening schedule and report any problems or benefits that you experience. You will be asked to perform some simple handwriting and drawing tests. Your parent will fill out a questionnaire about how you perform at home and school. You may also be asked to participate in an exercise program at home in addition to listening to your music.

3. WHAT IF YOU DON'T WANT TO BE IN THE STUDY?
You can say “no” to being in the study if you want. If necessary, your occupational therapist can prescribe other treatment for you if you don’t want to be in this study. You can also drop out of the study anytime you want.

4. WHAT SHOULD I KNOW ABOUT THE SOUND THERAPY?
Initially, the sound treatment may make you feel irritable or cranky. However, these feeling should disappear after a couple weeks. After that, you should feel calm after listening to your music. While you are listening to the music, you can do any of your daily activities except watch TV, or play on the computer or with video games. You can eat, play games, make things, go for walks or just sit and read while listening to the music.

There may be no benefit for you to be in the study.

6. WHAT ELSE DO I NEED TO KNOW?

Sometimes therapists write papers about research studies when they are done. If a paper is written about this research study, your name won’t be used in it. We will keep your medical information private. People who work for the Clinical Study Center, Children’s Research Institute, the study sponsor, and government agencies will be able to look at your medical information.

I have read this form. I have had a chance to ask questions about things I don’t understand. I want to be in this research study and understand what will happen to me.

Signature of the Subject

Signature of the Person Obtaining Assent

Signature of the Principal Investigator

Date

Date

Date

If you have questions about the study, you can call Leah Hall at 839-2800.
APPENDIX C

SAMPLE OF SENSORY DIET ACTIVITIES
**PROPRIOCEPTIVE ACTIVITIES:**

**Carrying heavy loads:** a bag of groceries, a laundry basket, garbage can, a load of books, a bucket of blocks, a pail of water. Modify jobs to allow for lifting, carrying, stacking/unstacking, bending, stooping.

**Pushing and Pulling:** Push doors open, a stroller, chairs under the table, a library cart, a child in a wheelchair, heavy boxes on the floor, a wheelbarrow, a vacuum. Pull a loaded wagon, a child on a sled, or weeds from the ground. Modify jobs to allow for pushing/pulling/sliding.

**Elevate jobs** to promote reaching and stretching against gravity work at a vertical surface, such as a blackboard or easel.

**Add Weight:** Weighted vest, backpack, cuff weights, fanny pack, weighted blanket, add weight to a favorite stuffed animal.

**Allow for standing** at a table or workstation. People who have sensory processing defects do much better when they are standing or moving from place to place at times. They don’t do as well with desk or table tasks that require sustained sitting in one position.

**Provide a “helper dose”** of passive joint compressions or slow stretches to someone who is sitting or standing. Consult your therapist for specific instructions.

**Jumping and/or “crashing” activities**

**Hanging or climbing**

**VESTIBULAR ACTIVITIES:**

Playgrounds, gymnastic programs, backyard swing sets, and indoor play centers provide great opportunities. There are also ideas you can do at home:

**Rocking:** Rocking/gliding chair, rocking horse, seesaw, porch swing, rolling over a ball from hands to feet.

**Rolling:** Roll in a box with the top and bottom cut out, or in a barrel/tunnel, side to side, up a hill, from one side of the room to the other. Roll up inside a blanket and unroll. Roll over a ball and then under. Do somersaults forward and backward.

**Sliding:** There are many ways to go down a slide – forwards, backwards, on one’s stomach or back. Sled riding, water slides, riding a scooter or skateboard down an incline.
Bouncing/Jumping: Bounce on a Hippity-Hop or large ball, trampoline, jump-o-leen. Jump into a ball pit, on a pile of cushions or beanbags. Jump over, on, to the right or left of a rope. Play sack races.

Swinging: Swing on a traditional swing, rope swing, or hammock. Swing from a bar or trapeze. Swing on a chin-up bar by holding on with your arms or by your knees hanging upside down.

Spinning: Spinning in a rotational movement on a tire swing, merry-go-round, sit-n-spin. Let child direct the spinning.

Balancing: Walk along a low ledge, balance beam, or on top of a rope. Walk along unstable surfaces such as sand, planked bridges, ball pit, air mattress. Try to balance over a large ball sitting with feet up or lying on the stomach or back. Play Simon Says “stand on one foot” or Twister.

Running: Frontwards, backwards, sideways, or skip.

Riding Toys: The selection is endless – tricycles, push cycles, bigwheels. If the child cannot propel, they can be pushed in a stroller and wagons.

TACTILE ACTIVITIES:

Deep pressure massage, bear hugs

Sandwich activities: between mats, pillows, cushions, under beanbags.

Snuggling in bedding, wrapping in towels, blankets, clothing

Spandex clothing

Water play: use turkey basters, plastic cups, pitchers, suds, sponges, toys, bottles.

Rub-a-Dub-Dub: have the child rub various textures against his body, such as satin, sponges, feathers, brushes, foam, washcloths. Provide various types of soaps, shaving cream, lotions, etc.

Finger painting with pudding, finger paints, whipped cream, peanut butter, etc. Mix sand or rice into the goop to provide different textures.

Feely box: fill the box with various textures, fur, burlap, satin, sand paper, etc. Hide small objects inside and have the child find them without looking.
Vibrating toys, vibrating toothbrush.

Playing with playdough.

Hands-on cooking.

Finger drawing: draw on the back of the child’s hand and ask the child to guess or pass it on to another person.

Science activities: collecting leaves, acorns, pine cones, handling worms, planting seeds, catching fireflies, etc.

Playing dress up with furry mittens, hats, scarves, feathery boas.

Oral activities: sucking, chewing, licking, blowing, trying new flavors, textures.

Manipulatives: provide small toys for the child to handle, squeeze, feel, assemble, twist, pull, pinch.
APPENDIX D

DAILY ACTIVITY LOG
## ACTIVITY LOG

<table>
<thead>
<tr>
<th>DATE:</th>
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<table>
<thead>
<tr>
<th>SENSORY DIET:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Touch</td>
</tr>
<tr>
<td>2. Heavy Work</td>
</tr>
<tr>
<td>3. Movement</td>
</tr>
<tr>
<td>4. (other)</td>
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</table>

<table>
<thead>
<tr>
<th>TARGET BEHAVIORS:</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
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<tr>
<td>2.</td>
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<tr>
<td>3.</td>
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<tr>
<td>4.</td>
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<td>5.</td>
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<table>
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<tr>
<th>AM Listening Session</th>
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<table>
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<tr>
<th>PM Listening Session</th>
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APPENDIX E

THERAPEUTIC LISTENING
FOLLOW UP INTERVIEW
THERAPEUTIC LISTENING PROGRAM
FOLLOW UP

Childs Name: ________________________ Date: ________________________

Date Program was implements: __________________________________________

Current Prescribed Program (disc and time) __________________________________________

1. What is the current total listening time? __________________________________________

2. How consistent has this been? __________________________________________

3. How has the child responded in terms of following the program? __________________________________________

4. Please describe any changes in emotional tone (i.e., more excited, more irritable, more animated). __________________________________________

5. Please describe any changes in arousal (i.e., general energy level, sleep/wake patterns, transitions). __________________________________________

6. Please describe any changes in motor skills (i.e., participation in activity, gross motor coordination, handwriting). __________________________________________

7. Please describe any changes in self care routines (i.e., dressing, toileting, eating, follow through with directions, level of independence). __________________________________________

8. Please describe any changes in social behavior (i.e., language, interactions with peers and others, interactions with family). __________________________________________

9. Anything else? __________________________________________
APPENDIX F

ONE PARENT'S REPORT
Progress
That does not fit in the activity log
1/11/05 as observed by mom

Because the activity log does not tell the whole story, I felt compelled to write a few observations that I feel are absolutely significant:

Sleeping
Before: My child would not consciously go to his bed. He had to fall asleep in my bed and I would move him. He never slept through the night. He would wake up screaming in a panic. I would have to put him in bed with me. It took a lot to calm him or to even make him understand I was there. I don’t know what was happening.

Now: My child often will sleep through the night. If he wakes up, he calmly calls out for me. I just rub his back and kiss him and he will go back to sleep. Or I can lay down with him. No upset. He goes back to sleep. He even understands he will be waking up alone. He still calls out for me and does not get up by himself.

Eating
Before: My child wouldn’t sit at the table and eat. I would have to take a forkful to him after the meal. He just had no interest. Terrible meltdowns would happen if I tried to force it. It was especially traumatic if extended family members were trying to sit together. Eating out was never pleasant.

Now: He does sit at the table. He even sat at the table for Christmas. He is eating better.

Christmas
Before: Christmas was never fun. My child preferred to go into another room. I situated myself in the doorway, so he could see me. When everyone was done opening packages and cleaned up, he would then come in and I would help him open his gifts.

Now: He sat in the middle of everything and ripped open his packages. Paper was flying everywhere. He was actually in the middle of everything. Ryan, his sister and I did Christmas the day before because there were too many places to go on Christmas day. We had the best time, just the three of us and stayed in our PJs, played, opened gifts, and put things together. It was not too overwhelming for him, and he was good for the next day. It brought tears to his grandma’s eyes when she mentioned that this was the first Christmas my son had joined us.
Movies
Before: My son and his sister take turns picking out a bedtime movie for the night. He always had to have Care Bears or something really simple. He would get very upset if sister wanted something different. He was scared of everything.

Now: He watches Scooby Doo with ghosts and witches, Power Rangers, 101 Dalmatians with Cruella (in the past, he couldn’t even look at Cruella on the box without getting upset). One night, I told him that I was afraid he was going to have bad dreams if he watched a certain video. He responded, “My bad dreams have left me.”

It was hard to chart the amount of time he took to communicate after a tantrum. These tantrums were usually provoked by someone else. I had to recognize what the problem was and remove him from the situation. He used to melt down for no reason. It could last a long time. That is not the case anymore.

It was also hard to chart his response to unexpected touch. This was often occurred when I was not around. This past week, our whole town was w/o power. We went to grandmas and grandpa’s house. When my answering machine picked up, we all moved to our house. We doubled up in beds and couches. My son was great. He would leap into his grandparent’s laps unexpectedly and hug unexpectedly. This caught them off guard because this behavior is very out to character for him.

The tantrums are different now too. In the past, I could never see them coming. They usually occurred 2 to 3 times per day. Now we go several days without them. Now I can identify the reason for the tantrum. Not only are the meltdowns fewer, the reason is obvious.

Colors are more tolerable. My son would have a panic attack when the bus came down the road. He couldn’t tolerate that shade of yellow. Now he wears a bright yellow hat and sweatshirt.

He does not like buttons or collars. But now we do not have the daily confrontations about what he is wearing.

He is now more impulsive and tends to somehow flip his body into his sister and she ends up with a bloody lip. He usually gets upset and cries quite a bit if he hurts her. It just happens so much anymore. I do worry about him wanting to fly and jump.

He is now interacting with classmates. He has his friends he talks about. He does not like other kids calling Willy “fat”. He tells them “Willie is just wide.” The teacher said that my son used to walk on the timbers that enclosed the play area and would just keep
walking the circle with his head down. Now he is playing beside the other children. The other kids seem to like him.

My son never used to like to be lifted very high. I had to lift him and hold him close to me. Now he has let people lift him over their heads or on their shoulders a couple times. This is something that would absolutely have caused a panic in the past.

His eye contact improved. He now initiates conversations if he has something on his mind.

He used to get upset and shutdown before anybody would realize it. If someone talked to him, he would flap his hands, panic and melt down. Breathing became difficult, and a few times he turned blue. Now he can growl “Don’t talk to me.” That is an improvement. He can let us know that he is in this state and we need to back off and give him plenty of space.

There are other things that have changed. The family is amazed at the improvement. My little guy has been set free.