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Efficacy of Therapeutic Listening Intervention on Auditory Processing/Attention in Children Ages 3-11

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EFFICACY OF THERAPEUTIC LISTENING INTERVENTION ON AUDITORY PROCESSING/ATTENTION IN CHILDREN AGES 3-11

by

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A study was conducted to determine the effect Therapeutic Listening® intervention has on auditory attention in children when used in conjunction with sensory integration therapy. Single subject experimentation took place with three participants over a ten week period of time. Pre-test and post-test results on standardized tests were compared as well as graphical representation of change during the intervention phase of this study to determine effect. Positive intervention results were concluded when graphical and test changes were compared. Therapeutic Listening® has noted positive change in auditory attention and completion of verbal tasks in children between the ages of 3 and 11 years.

This study concluded that there is positive change in attention to auditory information when using Therapeutic Listening® as a treatment tool along with sensory integration therapy. Additional studies need to be conducted to ensure effective intervention strategies to assist children with auditory processing and sensory integration.

TABLE OF CONTENTS

ACKNOWLEDGMENTS ii

LIST OF TABLES v

LIST OF FIGURES vi

CHAPTER

I. INTRODUCTION 1

Background of the Study 1

Statement of the Problem 1

Purpose of the Study 2

Definition of Terms 2

II. LITERATURE REVIEW 5

Introduction 5

Auditory Processing and Attention 5

Auditory Processing and Sensory Integration 10

Therapeutic Listening® for Treatment of Auditory Processing Difficulties 15

Therapeutic Listening® 16

Research Question 20

III. METHODOLOGY 21

Introduction 21

Review of the Research Question 22

Instruments 22

Table of Contents—continued

CHAPTER

Procedure of Instrument Application 24

Data Collection 25

Data Analysis 26

IV. FINDINGS 28

Intervention Results 28

V. DISCUSSION AND SUMMARY 33

Discussion of Findings 33

Limitations of the Study 35

Conclusions and Recommendations 36

Summary 37

APPENDICES

A. Command Check List 39

B. HSIRB Approval Letter 41

BIBLIOGRAPHY 43

LIST OF TABLES

1. Participant Standardized Test Scores 32

LIST OF FIGURES

1. Response to verbal directions: Participant #1 28

2. Response to verbal directions: Participant #2 29

3. Response to verbal directions: Participant #3 30

CHAPTER I

INTRODUCTION

Background of the Study

There is an ongoing need to determine best practices for treating children with sensory dysfunction. Auditory processing disorders are prevalent in children with sensory dysfunction, although there is minimal information on how to provide effective intervention for this problem. This study investigates the effect of an intervention that has not been widely tested, Therapeutic Listening®, on children with sensory dysfunction and auditory attentional difficulties.

Statement of the Problem

Occupational therapists working with children who present problems of sensory integration are constantly seeking more effective and valid treatment options for children they are assisting. Currently, there is a strong need for increasing the body of research to support the treatment outcomes that occupational therapists manifest during clinical treatment sessions. The need for further research, along with more scientific validity, is important to the field of occupational therapy. There appears to be a lack of evidence based research on treatment modalities and outcomes. Furthermore, increased numbers of outcome studies need to be conducted on modalities for the treatment of children with sensory integration dysfunction and how those modalities work. Evidence of effect or lack there of may give credibility to the modality being used in occupational therapy practice.

Purpose of the Study

To improve individuals current understanding of innovative modalities used to treat children who present with sensory integration problems, scientific inquiry must be conducted. The results from research will allow for better understanding of the efficacy of these tools and how better to address problems of auditory processing when encompassing the sensory system as a whole. The purpose of the present study was to examine the effectiveness of one auditory processing modality, Therapeutic Listening®, on the possible treatment implications for children with decreased attention to spoken language. The ability to process sounds and make correct assumptions and outcomes of that sound is a very complex process. If a child displays symptoms of sensory processing dysfunction, discriminating and attending to sound stimuli is very difficult. Attention to the correct auditory stimuli to appropriately respond to spoken language is a major dysfunction of these children often reported by parents, teachers, and caregivers. This study examined the use of Therapeutic Listening® to assist with increasing children's attention to spoken language and determine if auditory processing of language is increased when treated with a combination of sensory integration therapy and Therapeutic Listening® treatment modality.

Definition of Terms

Listening is a complex process that requires several integrated neurological responses to be effective. Listening is defined as paying attention to sound, to hear something with thoughtful intention and alertness (Mish and Morse, 2001).

"Through listening, we are able to connect our inner and outer worlds" (Frick, 2001). Listening is the most basic precursor to interactions such as speaking, reading,

and writing. Sound gives us information regarding time and space (Frick, 2001). Sound is the stimuli given off by objects or beings (Phillips,1999). Hearing and listening to sounds is different. Hearing is a less active process, not involving conscious thought. Listening requires active participation with sound to attend to the stimuli being emitted from a source and respond to it in some manner. Therapeutic Listening® is a term used to describe combined use of a number of electronically altered compact discs in a prescribed manner with specialized sound producing equipment (Frick, 2000).

Neurological responses to sounds within a listening environment are first activated through the tympanic membranes (ear drums) of both ears. Tympanic membranes are structures within the outer ear that respond to vibration. Vibration is mechanical energy emitted by external sources through the air that needs to be converted into electrical or sensory stimuli for the brain to respond and react to in an appropriate manner. This process takes place in the middle ear structures of the semicircular canals and cochlea. Grouping and discriminating neurological impulses of sound is completed within various lobes of the brain and the brain develops a map of sound to respond to from processed information (Feng and Rama, 2000). The sensation of sound is processed through these physiological structures within the body and integrated for listening. Sensory integration is the neurological process that organizes sensation from one's own body and from the environment, in turn making it possible to use the body effectively within the environment (Ayres, 1979). Through sensory integration processes, the body is able to function more appropriately when presented with external sensations. Often, numerous sensory interactions within the central nervous system are involved to create a functional response to stimuli within the body (Driver, 2001). Auditory processing is the finalized result of the neurological

processing of sound information. The brain must support the detection, discrimination, and localization of sound (Phillips, 2002). Auditory processing involves the use of all sensory input from the central auditory nervous system and arranging the input according to frequency (Phillips, 2002). Frequency plays an important role in the understanding of time, space, and location of sound. Within these constraints, attention must be paid to the context of the sound within the environment to process the importance of the sound being emitted. Proper attention and processing of the sound is critical for listening (Schroeder, et.al., 2003). Deficit in attention is characterized by persistent and developmentally inappropriate levels of inattention, impulsivity, and distractibility (NIH consensus development panel, 2000).

Although proper processing of auditory information is necessary for listening, there are many other components of the central nervous system that must be integrated to allow for correct response to sound. Auditory processing is necessary for retrieval of information within the auditory system and is closely connected to the vestibular system. In fact, the two biological processes of the vestibular and auditory systems are sometimes referred to as the vestibulo-cochlear system (Tomatis, 1996). Anatomically, the vestibular system is in close proximity to the inner ear. Neurologically, the vestibular system is the part of the body that detects head position and movement as well as gravity (Case-Smith, 2001). With the close proximity to the sound processing cochlea in the ear, the vestibulo-cochlear system is functionally named.

CHAPTER II

LITERATURE REVIEW

Introduction

A review of the current literature related to Therapeutic Listening® effectiveness on attention in children, as well as general scientific evidence to support the use of this modality has not been studied. The same can be said of research published on the efficacy outcomes of treatment tools used to assist children who present with auditory processing difficulties, in addition to inability to attend. In order to more practically treat the needs individuals of whom occupational therapists serve, there is a necessity for increased research on the outcomes of therapeutic interventions. Mauer (1999) stated that there is a lack of consensus concerning the definitions, assessment results, and efficacy of treatment interventions in the literature or in clinical practice of sensory integration theory. Occupational therapy, along with many other health fields, require evidence based research to support the use and continued acceptance of the theories and practices involved for the effective treatment of individuals.

Auditory Processing and Attention

Electronic auditory training has been in use since the mid- 1900's to allow individuals with decreased ability to process sounds the ability to develop more functional use of their hearing through the therapeutic effect of electronic auditory stimulation (Frick, 2000). Dr. Alfred Tomatis, a French Ear, Nose, and Throat specialist, was one of the first individuals to begin using auditory therapy to address

sensory processing disorders within the context of listening difficulties of the middle and inner ears (Thompson, 1991). Tomatis defined the role of the ear as an "integrator" causing neural organization at all levels of the nervous system. Using auditory intervention strategies, one can "exercise" the auditory processing ability of the ear and central nervous system to listen to and process auditory information from stimuli within the listening environment.

The purpose of the present study is to examine the effectiveness of one electronic auditory processing intervention, Therapeutic Listening®, on the possible treatment implications for children with decreased attention to spoken language. Attention deficit is now the most common neurobehavioral disorder of childhood (Shaywitz, Fletcher, Shaywitz, 1994). Estimates of 3%-5% of school-age children suffer from some attention deficit (NIH consensus development panel, 2000).

In a study conducted by Ludlow, Cudahy, Bassich, and Brown (1983) to determine the extent of auditory processing skills of hyperactive, language impaired and reading disabled boys, researchers found that auditory processing deficits are not dependent of attentional deficits. This study replicated an earlier study to determine the relationship between language impairments and auditory processing deficits in children. Control group samples were compared to experimental samples of children with and without language impairments and hyperactivity. Researchers found that children with hyperactivity and normal language skills had the greatest difficulty with temporal order perceptual capabilities of language. This suggested that auditory processing abilities might be independent of language functional abilities and possibly related to attention to auditory input (Ludlow, et al. 1983). Findings from this study suggest that language processing difficulties might not directly contribute to decreased attention of children, but to the decreased auditory processing abilities of

these children. It could be argued though, that this study did not account for the developmental level of children within both the control and experimental groups and further research needs to be conducted to determine if there is a correlation between language development and the response to verbal language processing in children with hyperactivity.

In addition to the findings by Ludlow et al., Gomez and Condon (1999) determined that there are no consistent testing criteria to rule out differences in children with central auditory processing problems diagnosed with attention deficit hyperactivity disorders (ADHD) presented with and without learning disabilities. Therefore, it is very difficult to determine the necessity of attention on auditory processing. Central auditory processing disorders and ADHD have similar characteristics of inattentiveness when scored on standardized tests. This creates difficulty for testers to determine the extent of disability for children with auditory processing problems and learning disabilities. The above study concluded that central auditory processing deficits are more often associated with learning disabilities than ADHD (Gomez and Condon, 1999).

Conversely, a study conducted by Tillery, Katz, and Keller (2000) found that attention plays a major role in auditory processing. This study attempted to determine the effects of ADHD medication, Ritalin, on auditory processing performance in children who presented with both ADHD and auditory processing disorders. For auditory processing, researchers found that sustained auditory attention is necessary, but not directly related to the ability of central auditory processing on test measures. A stumbling block of this study is the variables being measured and the testing measurements did not match. The use of Ritalin for increasing attention and auditory processing was measured by central auditory processing tests which were not

designed to assess the effects of medication on auditory processing. Positive conclusions were made that attention does play a role in auditory processing in children with auditory processing disorders.

Attention requires neural activity for processing of sounds. It is important to understand that the central nervous system is activated to attend when sensations are presented. Jon Driver (2001) found that when physiologists studied single cells with the brains in alert cats and monkeys, external stimulus of sound and light were able to be modulated by the animal's attentional state. This displayed that the animal has the ability to selectively attend to stimuli and the single cell brain mapping displayed attention in not only the visual auditory cortexes of the brain, but many other cortexes. A possible correlation to humans may be inferred that humans need to attend to sensations to correctly process them. When the sensations are being processed, multiple areas of the brain incorporates stimulus information to attention and draw conclusions about the stimuli being presented to respond correctly to it. Therefore, to attend, one must also have neural activation and the ability to process multiple neural stimuli. Each sensory system displays its own ability to attend and is directly related to the stimuli being presented (Bedi and Sharma, 1994). Distractibility is often seen in conjunction with decreased attention. For correct attention to occur to the proper stimuli, one must integrate the proper sensory system to the stimuli being presented. Bedi and Sharma (1994) found that a sequence of processing tasks were necessary for perception of stimuli. Any deficit in focus on the presented stimuli resulted in distractibility of that specific sensory system's ability to process the given stimuli (ie., sound for auditory processing and light for visual processing).

When the environment that a listener is in is compromised by competing frequencies or volumes, it is critical to have keen auditory processing ability to attend

to the appropriate sound stimuli. Attention with multi-stimulatory environments is often difficult for individuals with sensory processing dysfunctions. The environment in which children are involved imposes many sensations to their nervous systems. Auditory input can cause children with decreased ability to process environmental stimuli to have inappropriate levels of inattention, impulsivity, and distractibility. Children displaying difficulty attending within these environments are also at risk for unrecognized communication, attentional, and language disorders (Purvis and Tannock, 1997). Processing of lingual directions is often very difficult for these children. With the possible added disorganization of their sensory systems and the environment in which the lingual directions are being given, one can easily understand why some children display inattention to directions when given verbally.

Auditory processing problems can often be a factor in functional abilities related to reading, language, and attentional disorders often observed in school-aged children (Cacae & McFarland, 1998). Functional sensory processing of auditory information is critical for individuals to use the information for positive functional outcomes. If an individual displays difficulty attending to auditory stimuli from his/her environment, this may be associated with lack of attention or focus. Cacae and McFarland (1998) found that groups of children could have auditory-specific attentional deficits and display attentional deficits only related to auditory information while displaying functional attention to all other sensory inputs. From this information it can be better understood why within the classroom environment, listening is critical for academic success in children.

Ludlow, Cudahy, Bassich, and Brown (1983) found through controlled studies of children with auditory processing disorders, that differences between experimental group children and control group children in processing sound within a given

environment is most likely due to processing problems and not attention deficits. Further, findings by the same authors suggested that most auditory processing dysfunctions are independent of language functioning and more related to the processing of sound. Sound must be detected by the ear through vibrator stimuli then processed into electrical neurological stimuli for cortical processing and functional activation.

In some children, sound that is degraded in a high volume or low volume is more difficult to process and respond to. Research has indicated that children with attention deficits require quieter levels of sounds to accurately process and attend to that sound (Luker, Geffner, Koch, 1996). These findings could suggest that children who have a predisposition for decreased ability to process loud sounds could have even greater difficulties attending and processing sounds within environments that do not meet their needs for appropriate sound levels.

Maintaining proper arousal states during times of auditory processing is necessary to maintain attention and respond to given auditory information. Ayres (1976) termed this ability to maintain arousal as "sensory modulation". Sensory modulation refers to the capacity of the central nervous system to regulate its response to sensory input for proper response to the given input (Spitzer et al., 1996). Ayres work led to better understanding that the central nervous systems response and maintenance of arousal states for arousal control, activation, and control of attention is an important aspect of sensory integration.

Auditory Processing and Sensory Integration

Many occupational therapists address various sensory system dysfunctions through the treatment technique of sensory integration therapy. Kamhi (2004) stated

that improving auditory processing and sensory integration abilities will have a direct impact on language and learning abilities. To integrate the sensory systems, people use mulitmodal senses of touch, taste, smell, motion, pressure, and hearing. To correctly integrate these senses, all environmental sensations must be incorporated effectively and efficiently, then interpreted, associated, and unified to be processed. Individuals with difficulty processing any of these senses are said to have sensory processing dysfunction. A. Jean Ayres was able to correlate that all sensory systems work integrally together, and a concept of inter-sensory integration was formed. Brainstem level processing often develops foundational support for neural functions such as processing of auditory information at higher levels of processing within the central nervous system (Spitzer, et. al., 1996). This is important to account for when treating various central nervous system problems, due to the fact that all senses are linked and processed within context of each other. Ayres went further to describe the functioning of neural connections to be more than just neurological perceptions, but organization for the body to "use" sensation functionally as a whole (Spitzer, et. al., 1996). If the neurological processes are all connected and are dependent on one another as Ayres proposes, then one can understand why the integration of our senses is critical for the correct interpretation of sensory stimuli. The power of the central nervous system to organize sensory information for functional outcomes is great. In part, the auditory system as an individual system can contribute to the over all sensory organization and integration of information entering the central nervous system as a whole.

Ayres and Mailloux (1981) conducted single-case experimental studies with four children who had language difficulties to support their findings that vestibular sensory inputs developed increased processing of auditory-language and speech-

language abilities. Griffer (1999) reviewed sensory integration outcomes and found research by Schaffer (1984) that critiqued Ayres and Mailloux's (1981) study. Schaffer found that errors compromised the validity of the findings by Ayres and Mailloux. Schaffer found that measurements of language development were not properly measured and no synchrony of control groups existed. Although research findings were possibly flawed, one could conclude that Ayres and Mailloux did have sound foundational findings that sensory stimulation did have positive results on the language ability of children, but the research requires further development and better instrumentation.

In a study conducted by Fallon, Mauer, and Neukirch (1994), researchers concluded that sensory integration intervention provided greater increases in language development than with control groups. Increased opportunity for focus and organization during sensory integration treatment was also found to be positive. The clinical implications of this study indicate that there is positive change in children with language impairments when actively engaged in sensory integration activities prior to language learning tasks. Some limitations of these findings are that there was a very small sample size of participants. Also, it is almost impossible to correlate what type of sensory integrative treatment worked best for language learning with the participants in the study that displayed positive change because there was no single relationship between a specific modality of sensory integration therapy and language learning tasks. A variety of factors could have contributed to change in language functioning and no standardized tests were sensitive enough to measure the potential for change or change that occurred. Finally, it would be difficult to find if children within the study were only learning impaired or also had symptoms of both sensory integration dysfunction and language learning impairments.

The vestibulo-cochlear system is thought to help with sound vocalization and movement to enable one to perform many activities of daily living (Frick, 1994). Ayres (1972) defined processing of sound as "one of the primal forms of sensory integration" (p71). The auditory system is able to process sound intensity, volume, and pitch and give us spatial recognition. The vestibular system gives spatial orientation to the body. When these two systems combine, one can understand the importance of listening to maintain attention and awareness within our environment.

Listening is an active process that requires both hearing and processing sound. To be able to listen, one must be able to attend to sound within his or her environment. Research has shown that children with language learning impairment have greater difficulty separating sounds due to sensory processing (Marler, 2005). In a study conducted by Marler (2005), he found that children who presented with delayed sensory system responses were more likely to have detection error of auditory stimuli when compared to a normative control sample. This indicated that when children have an auditory processing deficit, neurological selectivity of sound signals are degraded and neural activation of sound does not occur. In other words, if a child exhibits signs of decreased ability to detect sound stimuli, then sensory processing of that sound does not occur and an active response is not elicited. This response could mirror attention deficits. One problem with the research conducted by Marler is there was little account for the matched control group possibly having much higher neurological processing abilities as well as cognitive function than did the experimental group. Change was greater in the experimental group in response to auditory stimulation than the control group. Also, multiple trials of measuring response to sound stimuli could have created a practice effect for the experimental group in this study.

To learn, all sensory systems must be working together without dysfunction. Montgomery (2004) speculated that language comprehension can be related to general sensory processing abilities. In his study, to determine sentence comprehension in children with language impairments, Montgomery found that sentence comprehension difficulties could be caused by inferior processing abilities. Decreasing the rate of language presentation was shown to increase the comprehension of sentence phrases in children with language impairments. Allowing for increased processing time between words permitted these children to better attend and comprehend verbal cues being given in spoken language and respond more effectively to the spoken words. This study was only conducted on 12 children and would need to be replicated on a much larger sample size to correlate any result to a specific population of language impaired children. None the less, positive findings by Montgomery indicated that allowing for increased processing of spoken language produced more effective responses to verbal input in children with language impairments.

Swanson (2003) found that learning disabilities are closely related to the ability of the student to process language and become aware of auditory cues. If a student is unable to process verbal information at appropriate times during speech, they will not take all the spoken words into context and possibly become confused by the given verbal cueing within the spoken information. This study indicated a positive effect that general verbal memory difficulties are caused by memory processing problems within the context of language. Verbal working memory and language comprehension are necessary for effective processing of spoken information. With correct attention and processing of verbal language, working memory was shown to increase and better recall of directions was developed.

Occupational therapists working with individuals with sensory integration

dysfunction have found many modalities to address individual sensory systems. Some modalities display positive results for treatment of sensory integration dysfunction, while others still require further research to construct validity of use for treatment. Until recently the use of auditory modalities for sensory integration treatment were non-existent. Occupational therapists were unable to attempt to address auditory system dysfunctions affecting individuals with sensory integration dysfunction with positive results. Very few treatment modalities have been used with proper validity research to support the claims that many auditory treatment modalities are making. Most reports of positive outcomes are anecdotal in nature and have very little sound theoretical base (Creaghead, 1999). There is very little research on the effectiveness of auditory treatment modalities for auditory processing difficulties. The need for viable research for auditory treatment modalities within therapeutic context is critical.

Therapeutic Listening® for Treatment of Auditory Processing Difficulties

Therapeutic Listening ® is a treatment tool resulting from several methods of treatment interventions attempting to use sound to integrate the central nervous system. Derived from earlier works by Tomatis (1996), Berard (1993), Madaule (1994), and Steinbach (1997), assessing auditory training techniques, Frick (1994) began to develop Therapeutic Listening® to assist with sensory integration and auditory processing difficulties. Therapeutic Listening® and other forms of auditory training are considered an unconventional treatment by some professionals with little degree of face validity (Tharpe, 1999). Tharpe suggested that auditory training has lack of empirical evidence and the lack of published studies that claim to have little or no positive change in auditory processing after the use of auditory training are few.

Due to the lack of research to support effectiveness, Therapeutic Listening®

relies heavily on anecdotal reports and individual case study outcomes similar to previous auditory modalities. Although the theories used to derive the process of Therapeutic Listening® are anatomical, neurological, and physiological, there is no evidence for professionals to use to determine best practice. Spitzer et al. (1996) suggested more research to comprehensively address treatment effectiveness in sensory integration therapy modalities is needed.

Therapeutic Listening®

Therapeutic Listening® may be helpful by providing stimulation to the auditory system necessary for arousal control and modulation. This stimulation is provided through electronically altered music with greatly varying frequency patterns. Musical sound of varying complexity is reproduced to digital quality compact disks and delivered over high quality and wide frequency range headphones played over a portable compact disk player (Frick, 2001). Therapeutic Listening® is thought to assist individuals with attention to auditory input by increasing the individual's ability to process sound and attend or discriminate sounds within the listening environment. Organization of the auditory input from the environment increases the listener's ability to focus on the proper auditory stimuli. This could allow the listener to better attend and process directions, requests, questions, and warning sounds.

Through the use of sound for stimulation to the auditory system, attention and comprehension of auditory information can be increased (Montgomery, 2004). Sound plays a major role in our temporal-spatial, visual-motor, and social responses within context of our listening environment. By allowing for more effective listening, an individual theoretically has the opportunity for better auditory processing and concurrently their general sensory processing and modulation. Cool (2004) stated that

music plays an important role in the brainstem to combine limbic system integration through sequencing, timing, and rhythmicity of the central nervous system for organization, which can result in more functional behavioral outcomes.

Having the ability to hear sound then localize and process the stimuli producing the sound, and assessing if the sound is a threat is very biological behavior. This primitive response is sometimes compromised in individuals with auditory processing dysfunctions. When this response is compromised, an individual will often display difficulty with sensory modulation from sound and may over or under respond to sounds. Over response to sounds can cause a listener to have difficulty discriminating what sound to attend to and what sound to filter out as background noise. With the inability to filter out unimportant sounds, it is not difficult to understand why listening to a selective source might be difficult and attention to that source observed as non-existent.

Individuals with auditory processing dysfunction appear to be at particular risk when listening in degraded or noisy multi-sound emitting environments (Marler & Champlin, 2005). This could be assumed because of decreased ability to process auditory stimuli from varied informational sources within one listening area. Auditory attention is often difficult from multiple competing sources that require processing by one individual (Broadbendt, 1954). When multiple noise sources are of the same frequency and volume, there is even more difficulty processing what, when, and where the stimuli is coming from. Classrooms and family homes all contain this type of degraded listening environment.

A study conducted by Musiek, Shinn, and Hare (2002) indicated that auditory training used for the treatment of auditory processing disorders is targeting the brain as the main site of mediation. This is important to understand because the brain has

plasticity. Plasticity refers to the brains ability to change nerve cells to conform to environmental influences. Auditory functioning can be improved though plasticity changes. When sound is temporally processed for auditory processing, increased identification of sound stimuli is possible and better auditory discrimination is the end result. In their study, Musiek, Shinn, and Hare found that auditory discrimination is critical for auditory processing. They found that auditory training can assist with a person's ability to discriminate sound of speech stimuli. Researchers suggested that the effect auditory training has on a person's ability to discriminate sound might also have positive results in evolving plasticity for improved auditory functioning. One account that the authors make is attention and motivation plays a major role in the effectiveness of any treatment program. When a child is not directly involved in the auditory training, they suggested that results will not have positive outcomes for triggering plasticity. Therapeutic use of auditory training methods must be done in a habilitative approach for proper effect to occur.

Frick (2004) believes that Therapeutic Listening® should always be used in conjunction with sensory integration therapy to allow all sensory systems to integrate from the environment. Occupational therapists seeking more progressive modalities can use Therapeutic Listening® to better assist with a sensory integration therapy program, including auditory intervention to assist individuals with auditory processing difficulties. When the nervous system is actively engaged to respond to several different treatment approaches, neural plasticity is more likely to occur. Through this premise, one can understand why direct correlative studies have not yielded positive results when measuring few independent variables. Multiple variables must be considered when attempting to change a response in children who display delays in sensory processing within the central nervous system.

For the nervous system to integrate its response to environmental stimuli, several complex processes must be incorporated to support a single sensory system's response, such as auditory processing. Therapeutic Listening®, was developed to be used as a treatment tool for incorporating sensory system responses through auditory stimuli. Auditory attention, discrimination, and correct neurological processing are also necessary for neurological adaptations to occur and a functional response to stimuli as an outcome.

The purpose of the present study was to examine the effectiveness of one auditory processing modality, Therapeutic Listening® on the possible treatment implications from children with decreased attention to spoken language. The ability to process sounds and make correct assumptions and outcomes of that sound is a very complex process. If a child displays symptoms of sensory processing dysfunction, the difficulty to discriminate sound and attend to other sound stimuli is very difficult. Dunn and Bennett (2002) suggested that there is growing evidence that sensory processing difficulties occur in children with attention problems. Through their research and data collection for the Sensory Profile (Dunn, 1999), they found that children who have sensory processing differences often display similar difficulties with attention as children who are diagnosed with Attention Deficit Disorder. Attention to the correct auditory stimuli to appropriately respond to spoken language is a major dysfunction children with sensory processing difficulties have as reported by parents, teachers, and caregivers.

Research Question

This study examined the use of Therapeutic Listening® to assist with improving children's attention to spoken language and determine if auditory processing of language is increased when treated with a combination of sensory integration therapy and Therapeutic Listening® treatment modality. This study was conducted to answer the research question, "What is the effect on attention to spoken language when using Therapeutic Listening® intervention with children between the ages of 3 and 11?"

CHAPTER III

METHODOLOGY

Introduction

A total of three children participated in this study. The participants ranged in age from 3 to 11 years. They were all of white ethnicity. Two children were female and one was male. All participants were from the same region in western Michigan. They all carried the same diagnosis of central nervous system disorder not otherwise specified (CND N.O.S.). This diagnosis was characteristic of sensory processing dysfunction criteria.

Selection of the participants was done through a convenience sample of patients attending a small, private pediatric occupational therapy clinic within the town that they lived. All children had been referred from their primary care physicians for treatment of CND N.O.S. and similar sensory dysfunction. All subjects and caregivers were briefed on the study at the appropriate academic levels and given informed consent/assent information and forms as per Human Subject Review Board of Western Michigan University policy to sign and consent/assent to. The explanation of potential benefits and risks were explained to each subject and caregiver for pre-screening and information. Each caregiver was allowed a copy of the explained information and consent/assent forms. All caregivers and subjects were informed of the right to end their participation within the study at any time without negative consequences. Seven children were initially selected for the study through convenience sample of the currently attending population. The seven potential

candidates caregivers were given letters of invitation for participation in a research study before their first treatment at the clinic.

Inclusionary criteria were established for the potential candidates. The criteria were established to include children who had a diagnosis of sensory processing dysfunction or similar diagnostic code, were able to follow through with listening programming at home seven times per week for ten weeks under caregiver supervision, the caregiver agreeing to fill out weekly reports of observation, had no other physiological or neurological condition that would inhibit their ability to listen to music over headphones, and were between the ages of 3 and 11 years. Informed consent/assent documents must also have been understood and signed for inclusion in the study. From the seven potential candidates, three met all inclusionary criteria. All participants were informed within the letter of invitation that all materials needed for research and treatment would be provided during the testing period free of charge to prevent against coercion and financial bias within the study.

Review of the Research Question

This study was designed to increase the amount of information on the application of Therapeutic Listening® as a treatment tool for increasing attention to verbal directions in children diagnosed with sensory integration dysfunction. Determining if Therapeutic Listening® intervention has effective results in changing children's ability to attend to verbal directions is what is being tested in this study.

Instruments

The instruments used for data collection and testing were standardized tests, parent observation forms, and informal tests. The Quick Neurological Screening Test

II (Mutti, Sterling, and Spalding, 1978), the Miller Assessment for Preschoolers (Miller, 1982), and the Sensory Profile (Dunn, 1999) were standardized tests used for pre-testing, as well as post-testing of participants. Informal testing materials used for measurement were caregiver observation weekly input forms and verbal direction scripts to measure change within the participants during the experimental phase of the research. All tests matched the chronological ages of the participants and were administered accordingly by an occupational therapist experienced in each measurement method.

The Quick Neurological Screening Test is a standardized developmental test designed for children as young as five years, but is demonstrated to be effective with adolescents and adults, according to the authors (Mutti, Sterling, Spalding, 1978). The test is used to measure a variety of motor, perceptual, and other functions to determine the degree of neurological integration as it relates to learning.

The Miller Assessment for Preschoolers is a standardized developmental test for children aged 2 years, 9 months to 5 years, 8 months. The instrument provides a comprehensive screening to determine developmental status and to identify moderate delays (Miller, 1982).

The Sensory Profile is an inventory checklist designed for parents and caregivers to rate their child's sensory response using a five-point Likert scale. Reports are scored and five areas of sensory behaviors are scaled and rated. Sensory system areas with high scores are reported to have dysfunction (Dunn, 1999).

Non-standardized instruments were used to measure the change within the participants by caregiver report and weekly testing of attention to verbally given directions. The caregiver report form was intended to give subjective measurements

collected weekly and analyzed by the occupational therapist researcher. Verbal instruction testing was conducted weekly during each therapy visit to measure capacity to attend to auditory directions and complete requested tasks.

Procedure of Instrument Application

In accordance with Therapeutic Listening® basic protocol (Frick, 2001), each subject listened to modulated music played by portable compact disc units, delivered through Sennheiser 500A headphones worn during everyday activities. Music was listened to for thirty minutes, two times per day, with at least four hours in-between listening sessions and two hours before bed time, seven days per week, for ten weeks. The volume output was measured by the caregiver prior to placing the headphones on the child to assure "conversation level" listening volume. Each compact disk player was programmed to have electronic "bass boost" equalization turned off and play track randomization activated. Track randomization was activated to ensure active listening by the subject and decrease the potential for extinction to listening due to song habituation by the listener. During the ten week listening period, the modulated compact discs were exchanged every two weeks to allow for increases in listening intensity due to the electronic modulation of each successive disc in the listening protocol. Progressively each disc becomes more demanding for the listener to process due to auditory modulation within the disc. The modulation was done electronically to alter the frequency patterns within the given compact disc's music. Alteration of the frequencies were gated to allow for filtering of high frequencies then low frequencies and vise-versa in a random fashion within each track of the compact disc. This alteration was done through an electronic process and recorded on the compact disc by the manufacturers. The compact disc's were chosen from a selected list of compact

discs for *Initial listening protocol* within Therapeutic Listening's® training manual, Listening with the Whole Body, page 3-4 (Frick, 2001). The compact discs selected in successive order were; *EASe, Rhythm&Rhyme, Kidz Jamz, Baroque, and Mozart for Modulation-Modified.* All music was listened to for thirty minutes per day except for *Baroque*, which was listened to for twenty minutes per day due to very complex filtering that is sometimes difficult for children to stay engaged with for longer periods of time. Within the listening time constraints given to each parent, it was at their discretion when and where to apply the headphones for listening. The only outlined constraint to individual discretion was that the listening should take place in an environment free from "screen based" activities (i.e. computer, video games, and television). This was due to most children's ability to block out all external stimuli to attend to highly stimulating screen based activities. Auditory stimulation through the applied headphones could potentially be discriminated against during such activity and make that listening session ineffective.

The listening sessions were to take place off-site from weekly scheduled occupational therapy treatment. Each participant was given forty-five minutes of occupational therapy treatment in addition to home listening programming to address their clinical diagnoses of central nervous system dysfunction N.O.S. The treatment modality primarily used during individual treatment sessions was within a sensory integration frame of reference.

Data Collection

During the beginning of weekly individual treatment sessions, participants were given a series of six verbal commands to complete. The verbal commands were given while seated face-to-face with the subject and occupational therapist providing the treatment, and verbalized at a normal conversation volume and rate of speed to

each participant. The participant was then requested to complete the six commands after the last command was stated. Measurement of the participant's attention to the verbal instruction and ability to complete the requested tasks were tabulated. The series of six commands were verbal requests for the subject to complete within the therapy room. Each task within the series of six was read from a list of twelve potential requests. The tasks were selected randomly from the list and read out loud for the participants. For example, "Walk over to the swing, then put the red ball in the basket, after that, say your name and climb on top of the red ramp, next jump up and down 5 times, finally, step over the yellow foam square." A measurement of how many of the six commands were completed without verbal reminders or prompts was taken each treatment session during the listening protocol time period of ten weeks. After the measurements were taken, the traditional occupational therapy session would begin. At the end of the ten week period a post-test was given in the same manner that the pre-test was given.

Measurements were scored for the standardized tests and compared to the pre-test measurements. Weekly parent report forms were analyzed to determine any significant subjective information regarding change during the home listening phase of the study. Finally, the command completion activity measurements were tabulated to determine the change in number of commands completed during the ten week testing phase.

Data Analysis

Because of the small sample size and lack of randomization, a quasi-experimental methodology was employed. Pre-test, followed by experimental treatment, and a post-test was completed for each subject. A period of time equal to the experimental treatment time was allowed to elapse prior to post-testing for each

participant. During the treatment periods, the participants in the group composed an experimental group, and during the non-treatment periods, the participants of non-treatment acted as their own controls.

Significance of the results from the variables were plotted in graphical format to give visual analysis of experimental effect. Each participant's change was represented by plot points within the graph to display change over time (Wolery and Harris, 1982). Graphical representation of change can be visually examined to determine significance of Therapeutic Listening® on attention in children aged 3-11 years in a sample size of three children over a 10 week period of time.

CHAPTER IV

FINDINGS

Intervention Results

Intervention results yielded varied responses to Therapeutic Listening® when measuring completion of verbal tasks over a ten week period of time. All three participants displayed gains in the number of responses completed compared to initial measurements. Each participant displayed different gains during different periods of measurement. When each subject was compared to another, there was positive evidence that most change occurred over weeks six, seven, and eight within the ten week protocol of this study (See Figure 1-3).

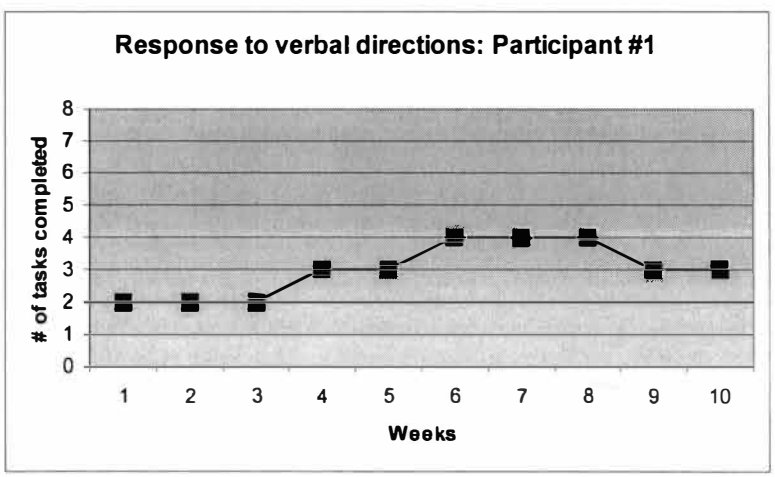

Figure 1. Response to verbal directions: Participant #1

Participant one was a three year old white female from a local town. She was referred for treatment of hypersensitivity to sound and touch by her pediatrician. She had high scores on the Sensory Profile for auditory, movement, body position, touch,

and activity level. This indicated signs of sensory dysfunction. When tested with the Miller Assessment for Preschoolers, she had definitive scores indicative of sensory motor difficulties. She was often startled by noise, touch, and unexpected movements. She would often overreact to sensation and have behavioral outbursts. When engaged in play, participant one would often become very overactive and require frequent reminders by caregivers to calm herself. Her mother reported great difficulty gaining her attention when giving verbal directives.

Visual examination of Figure 1 indicates slight change in completion of verbal tasks over the ten week testing period. Participant one displayed the greatest change during weeks six, seven, and eight of the protocol. Negative change occurred over weeks nine and ten. Little significance in change is made over the ten week protocol, but change did occur when compared to initial baseline measurements. Therefore, a positive change in response to verbal directions was noted during the ten week listening protocol.

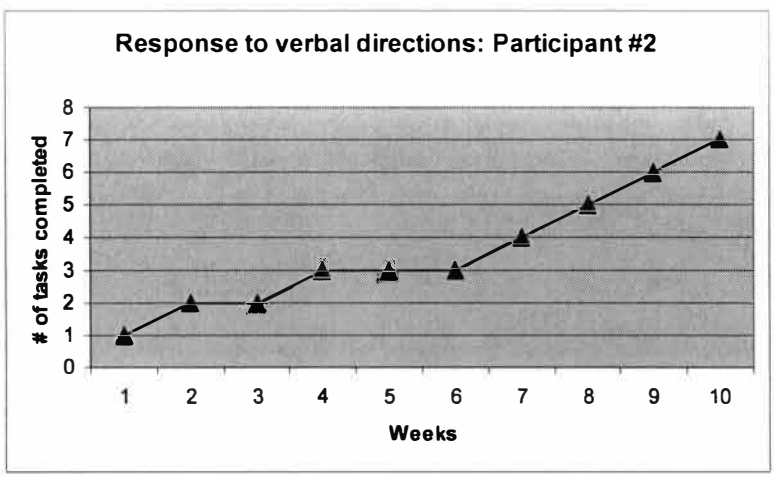

Figure 2. Response to verbal directions: Participant #2

Participant two was a white, eleven year old female from a local town. She was referred from her pediatrician for difficulty calming and organizing during school, problems accepting textures of clothing on the skin and food within the mouth. She was also reported to have difficulty attending to verbally given directions by children, teachers, and caregivers. Often several requests were required to gain participant two's attention. When her mother completed the Sensory Profile, her reports displayed that participant two had moderate difficulties with sensory processing in the areas of touch, movement, body position, auditory, and emotional/social. Scores on the Quick Neurological Screening Test indicated areas of auditory processing and tactile processing to be high risk areas for decreased neurological processing.

Visual examination of Figure 2 indicates a positive change over time in completion of verbal tasks. Participant two displayed a positive change in the number of tasks completed each week for the ten week protocol. The greatest amount of change was seen over weeks 6-10. Parent report of behaviors and attention to verbal directives at home also corresponded with the positive change over weeks 6-10.

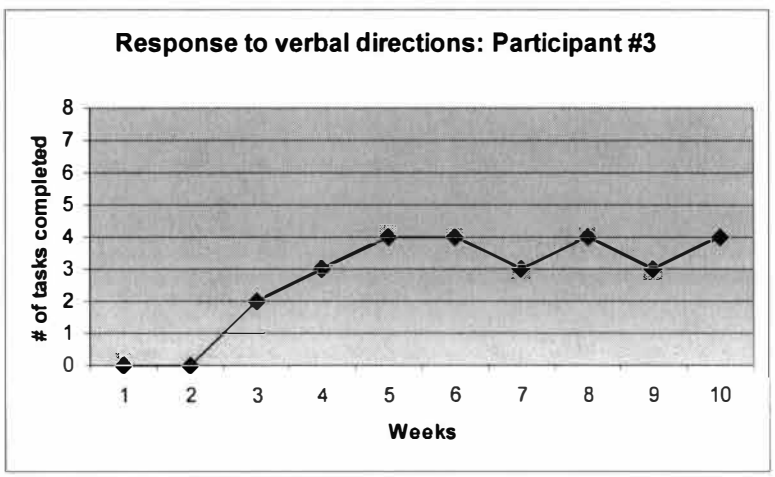

Figure 3. Response to verbal directions: Participant #3

Participant three was a white, seven year old male from a local town. He was referred by his pediatrician for difficulty with attention and behavioral outbursts. He also had difficulty accepting textures of clothing on his feet and would seek spinning for calming throughout the day within the classroom. When his caregiver completed the Sensory Profile, the areas of auditory, touch, and behavior were scored very high for sensory processing difficulty. The Quick Neurological Screening Test indicated severe dysfunction in sensory processing and fine motor manipulation skills.

Visual examination of Figure 3 indicates a positive change in task completion of verbally given directions over the ten week protocol period. At baseline, there was zero completion of tasks over a two week period of time. Participant 3 had a very difficult time attending to verbal directives and would often avoid any requested task. Starting with week three, participant 3 began to have positive change in response to verbal directions and completed two tasks. A positive trend developed over the next three weeks of testing and a plateau effect was established. During weeks 7-10 varied numbers of tasks completed were recorded. Positive change was seen from baseline though, indicating change in response to verbal directions over the listening protocol time period of ten weeks.

Table 1. Participant Standardized Test Scores

	Pre-test	Post-test	Change
Participant #1 (Miller Assessment for Preschoolers)	54th Percentile Moderate dysfunction	60th Percentile Moderate Dysfunction	6 Percentiles Positive change
Participant #2 (Quick Neurological Screening Test)	36 Moderate dysfunction	27 Slight dysfunction	9 Positive change
Participant #3 (Quick Neurological Screening Test)	41 Moderate dysfunction	22 Normal functioning	19 Positive change

Changes within standardized test scores indicate a positive change in all three participants. Participant three indicated the most positive change in comparison to the two other participants (Table 1). Indication of change is also noted to be high in participant one. A change of 6 percent is very high on the Miller Assessment for Preschoolers (Miller, 1982). Post-test results indicated encouraging outcomes for the three participants involved in this study. Results are indicative of increased sensory processing skills.

CHAPTER V

DISCUSSION AND SUMMARY

Discussion of Findings

From the current study, evidence has been displayed that Therapeutic Listening® has positive results in increasing verbal task completion and attention to verbal directions in children. However, there are limits to the effectiveness as displayed by results found during this study. Results displayed varied increases over time in completion of verbal directions throughout the ten week experimentation phase of this study. All participants within this study displayed positive results, but few displayed substantial increases over time. Measurements of the three participants change was graphed and graphical representation of change indicated increases in response to verbal directions in the three participants. One participant did display consistent positive change over time with six positive deviations from baseline over the ten week experimentation period. The results of the other two participants were more difficult to summate consistent change.

Participant one and three both had three commands as the mean number of tasks completed during the study. This would indicate that three verbal directions was the most frequent number of directions that were able to be completed by the given participants. Also, participants one and three both had the maximum number of tasks completed as four, while participant number two was able to complete a total of seven tasks. Although participant three was able to average four tasks completed, he displayed three changes in completion of tasks over time that were inconsistent with

each other. Participant three changed from four tasks completed to three, then to four, then to three, and back to four. Variance in change over half of the testing duration indicated inconsistent, at best, change. When compared to initial baseline change, participant three did display four positive deviations of change in number of correct responses to verbal directions. Positive change did occur and was visually indicated by graphical representation from initial baseline.

Participant one displayed similar results in relation to inconsistent change. She maintained four tasks completed for three weeks during weeks six, seven, and eight. Then, on week nine she displayed a one task decrease and maintained this decrease for two weeks. Over the duration of the study, participant one was able to make two positive deviations from baseline.

Participant two was able to display the most consistent and positive change over the duration of the study. She was able to make six positive deviations from baseline. She also displayed the most consistent change with one positive deviation change in the number of tasks completed each week over the last five weeks of the study. This would indicate distinctive positive results from Therapeutic Listening® during the study. Participant two's initial number of tasks completed was one. Over the next nine weeks, she was able to increase to seven tasks completed. This displayed that positive intervention results were established during the testing period of the study.

Given visual representation of change in graphical format, the ability to see change over time is much easier. Each of the three participants within the study did have positive change. To account for deviations within given weeks is very difficult and extraneous circumstance can not be measured. Therapeutic effect did take place and positive correlations are represented when using Therapeutic Listening® as a

treatment modality to increase verbal attention and processing in children with sensory integration dysfunction.

The findings from this study support previously published literature on the need for effective sensory processing and attention to auditory input to correctly respond and react to auditory stimuli. The findings also demonstrate that when used in conjunction with sensory integration therapy, Therapeutic Listening® can display positive complimentary results on auditory processing and attention. Conclusions derived from this study can not discount previous findings that auditory training modalities require stronger testing criteria to determine the full extent of their effect. Arguments have been published within scholarly literature that attentional difficulties are often seen in children with auditory processing difficulties (Gomez and Condon, 1994; Montgomery, 2004; Mauer and Neukirch, 1994). Summating what type of auditory information children with attentional issues are not attending to and what extent sensory processing difficulties contribute to attentional issues is very difficult. The lack of research on the role that Therapeutic Listening® has as a therapeutic modality for treating children with auditory attentional issues contributes to decreased acceptance by health professionals for its use (Creaghead, 1999). Findings from this research will allow for better acceptance and use of Therapeutic Listening® as a treatment modality for children with auditory attentional difficulties.

Limitations of the Study

Increased research is needed to improve our understanding of the effect treatments have on positive functional outcomes. This study was able to display positive results in attention can occur when using Therapeutic Listening as a treatment modality for children diagnosed with Sensory Integration Dysfunction

within a small sample size.

Several limitations were found with this study. One of the main limitations is sample size. To attempt to make inferences to a larger population, further studies with larger sample sizes need to be conducted. Measurement of change in attention to verbal directions was not standardized and therefore can not be generalized to a large population. More sophisticated testing criteria and tools are needed to measure definitive change by a given treatment within this study. Control groups are also absent within this study, so comparative measurements of change were not conducted. There are no previous studies on the effect of Therapeutic Listening® on attention published, therefore many findings within this study are theoretical assumptions that require further testing.

Conclusions and Recommendations

There is an ongoing need to determine best practices for treating children with sensory dysfunction. This need has resulted in the completion of the current study to better determine the effectiveness of Therapeutic Listening® for treating children with poor auditory attention and sensory processing abilities. The absence of research determining efficacy of Therapeutic Listening® is concerning. Due to the lack of research, there is difficultly in discerning if the effects of this modality of treatment have been successful by other practitioners. Findings from this study indicate a positive effect on the treatment of sensory processing of auditory input and attentional difficulties of children with sensory processing dysfunction. Conclusions can be made that in this small sample study, Therapeutic Listening® was an effective treatment modality. Three participants between the ages of 3 and 11 years displayed positive change in completion of verbal requests over a ten week period of time while using

Therapeutic Listening® as part of a sensory integration treatment program.

Further research is necessary to determine if the same results would be displayed in a larger sample size. Also, it is recommended that more detailed testing instruments be developed to analyze if positive change was the direct result of Therapeutic Listening® or other forms of sensory integration treatment. The development of a control group and experimental group would allow for better direct correlation of results to be concluded within the parameters of the current study. Because so many different changes can occur as a result of this intervention, research into specific changes is difficult to administer. This is one of the reasons that qualitative research, using individual case studies, could be important to develop better evaluation of the intervention results case by case. Further quantitative and qualitative research should be conducted on the treatment outcomes and effectiveness of Therapeutic Listening®. This study should be used as a foundation for future research on the effectiveness of Therapeutic Listening® when used as a treatment modality. Increased evidence-based findings are necessary for the professional acceptance of this specific treatment tool and application as a treatment modality for children with sensory integration dysfunction.

Summary

The implementation of this study has displayed the potential for positive outcomes when using Therapeutic Listening® as part of a sensory integration therapy modality for children with sensory dysfunction and auditory attentional difficulties. This research should influence others to further investigate the effect of Therapeutic Listening® and warrant its use as a treatment tool. The consistent pattern of marked ability to complete verbal directions within the participants of this study is an

important consideration when selecting tools for treatment.

Clearly, more research and case studies need to be completed and published to clarify the functional changes that can take place with Therapeutic Listening®. The changes that were found within this study are important and further research could display more effective intervention strategies to assist children with auditory processing difficulties, sensory integration dysfunction, and decreased attention to verbal language.

APPENDIX A

COMMAND CHECK LIST

Command Check List

Subject #_____ Week #_____ Total Completed_____

Command Completed without prompt:

1. Walk over to the swing.	Yes No
2. Put the red ball in the basket.	Yes No
3. Carry the orange tube to the table.	Yes No
4. Put the balloon in the sink.	Yes No
5. Jump up and down 5 times.	Yes No
6. Stand inside of the hula hoop.	Yes No

* *Commands should be varied from week to week.*

Additional commands to add variance:

-Step over the yellow foam square.	Yes No
-Swing on the tire swing three swings.	Yes No
-Put the green ball on the chair.	Yes No
-Say your name.	Yes No
-Pick up the flashlight and turn it on.	Yes No
-Climb on top of the red ramp.	Yes No

APPENDIX B

HSIRB APPROVAL LETTER

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Date: February 15, 2005

To: Cindee Quake-Rapp, Principal Investigator
Casey Pawill, Student Investigator for thesis

From: Mary Lagerwey, Ph.D., Chair Mary Lagerwey

Re: HSIRB Project Number: 05-01-05

This letter will serve as confirmation that your research project entitled "Efficacy of Therapeutic Listening Intervention on Auditory Processing in Children Ages 3-11" has been **approved** under the **full** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: January 19, 2006

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