The Effect of Vestibular Stimulation on Expressive Language of Pre-Schoolers with Down Syndrome

Bergo

Follow this and additional works at: https://scholarworks.wmich.edu/masters_theses

Recommended Citation
https://scholarworks.wmich.edu/masters_theses/898
THE EFFECT OF VESTIBULAR STIMULATION ON EXPRESSIVE LANGUAGE OF PRE-SCHOOLERS WITH DOWN SYNDROME

by

Tiffany Bergo

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Master of Science
Department of Occupational Therapy

Western Michigan University
Kalamazoo, Michigan
December 1992
THE EFFECT OF VESTIBULAR STIMULATION ON EXPRESSIVE
LANGUAGE OF PRE-SCHOOLERS
WITH DOWN SYNDROME

Tiffany Bergo, M.S.
Western Michigan University, 1992

Effects of vestibular stimulation, when presented prior to language therapy, on expressive language abilities in pre-school children with Down syndrome were examined. Two subjects participated; one subject completed the study. Vestibular stimulation was therapist- and child-initiated and provided by various types of equipment. The subject's expressive language use (verbal and non-verbal) was videotaped during fifteen minutes of language therapy across a six-week, eleven-session period.

Results of this study indicate that expressive language use increased or improved across many parameters during the vestibular stimulation phase of the study. The subject displayed greatest gains in the use of multiple word utterances and gestures accompanied by vocal utterances and displayed a marked decrease in the use of unintelligible utterances.
ACKNOWLEDGEMENTS

First and foremost, I wish to express my sincere appreciation to the mem­bers of my committee, Sandra Edwards, MA, OTR, Karen Seelig, CCC-SLP, and Doris Smith, MEd, OTR, FAOTA, for their guidance, expertise, support, and encouragement. Indeed, the collaboration and teamwork demonstrated by these professionals provided an excellent model for future interdisciplinary endeavors.

I wish to extend my appreciation to the faculty and graduate students in the Department of Speech Pathology and Audiology at Western Michigan University for their help in coordinating this research project, their willingness to participate, and for the use of their facilities.

I also wish to thank the children who participated in this project, as well as their supportive families, whose interest and enthusiasm made this project successful.

Finally, I am indebted to my fiance and family for the support and encour­agement they provided throughout my graduate career.

Tiffany Bergo
INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps. Each original is also photographed in one exposure and is included in reduced form at the back of the book.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.
The effect of vestibular stimulation on expressive language of pre-schoolers with Down syndrome

Bergo, Tiffany Jean, M.S.
Western Michigan University, 1992
# TABLE OF CONTENTS

ACKNOWLEDGEMENTS ........................................................................................................ ii

LIST OF FIGURES ........................................................................................................ iv

CHAPTER

I. INTRODUCTION .......................................................................................................... 1
   Purpose of the Study .................................................................................................. 1

II. REVIEW OF RELATED LITERATURE ...................................................................... 3

III. HYPOTHESIS .......................................................................................................... 17

IV. DESIGN AND METHODOLOGY ............................................................................. 19
   Subjects .................................................................................................................... 19
   Apparatus ............................................................................................................... 22
   Procedure .............................................................................................................. 22
   Data Analysis ....................................................................................................... 25

V. RESULTS .................................................................................................................. 26

VI. DISCUSSION .......................................................................................................... 34

VII. SUMMARY ........................................................................................................... 41

APPENDICES

A. Description of Speech/Language Therapy .............................................................. 42

B. Human Subjects Institutional Review
   Board Letter of Approval .................................................................................... 44

BIBLIOGRAPHY ........................................................................................................... 46
**LIST OF FIGURES**

1. Total Communicative Attempts (Single and Multiple Word Utterances, Unintelligible Vocal Utterances, Gestures Accompanied by Vocal Utterances, and Gestures Not Accompanied by Vocal Utterances) During a Fifteen Minute Sample. 27

2. Total Gestures Accompanied by Vocal Utterances (Intelligible or Unintelligible) During a Fifteen Minute Sample. 28

3. Total Unintelligible Vocal Utterances (Single and Multiple Word) During a Fifteen Minute Sample. 29

4. Total Intelligible Single Word Utterances During a Fifteen Minute Sample. 30

5. Total Intelligible Multiple Word Utterances During a Fifteen Minute Sample. 31

6. Total Gestures (Not Paired With a Vocal Utterance) During a Fifteen Minute Sample. 32

7. Mean Percent Improvement Between Pre-Intervention and Intervention Phases. 33
CHAPTER I

INTRODUCTION

Vestibular stimulation is commonly used as a technique of sensory integrative treatment with clients known to have vestibular system dysfunction. Often, improvements in language abilities are seen in correlation with vestibular stimulation. As Ayres (1972b) reported, vestibular stimulation "usually elicits vocalizations" (p. 243). Ayres also states that in children with auditory-language problems, stimulation of the vestibular system may be effectively used for therapeutic purposes (1972b).

Previous research has found vestibular stimulation improves language abilities in persons with various language-limiting conditions. Significant gains across various parameters of language have been documented in persons with schizophrenia, mental retardation, autism, and learning disabilities. However, little research exists regarding the efficacy of these techniques when used with the Down syndrome population.

Purpose of the Study

The purpose of this study was to examine how one aspect of sensorimotor techniques, specifically vestibular stimulation, may be used as a therapeutic modality to facilitate language. More specifically, the study focused on how
vestibular stimulation, when presented prior to "traditional" speech/language therapy, affected expressive (verbal and non-verbal) language use in pre-school children with Down syndrome.

Although previous research using vestibular stimulation with Down syndrome individuals is limited, some authors have found improvements in language abilities following the use of vestibular stimulation with this population and recommend its use. However, additional research focusing on the effectiveness of vestibular stimulation on language development in individuals with Down syndrome is necessary to document the efficacy of this technique when used with this population. The present study attempted to demonstrate that vestibular stimulation improves expressive language abilities in pre-school children with Down syndrome.

Furthermore, due to the interdisciplinary nature of this study, it was anticipated that increased professional contact, as well as documentation of a relationship between specific occupational therapy techniques and speech/language therapy, would foster improved working relationships and increase interdisciplinary approaches to the remediation of speech/language delays and/or deficits in the future. Ultimately, this interdisciplinary and holistic approach will greatly benefit the consumer of occupational therapy and speech/language therapy services.
CHAPTER II

REVIEW OF RELATED LITERATURE

A connection exists between the vestibular system and the anatomical parts of the body concerned with speech and language, most specifically, the auditory system. The vestibular end organs are anatomically part of and share a continuous canal and duct system with the peripheral auditory system. The significance of this anatomical relationship as it relates to language is elementary: in order to develop language, a child must first hear it (Miller, 1988; Rosin & Swift, 1989). Additionally, phylogenetically, the vestibular system is correlated with the auditory system (Bailey, 1978). Bailey (1978) cited four evolutionary channels documenting the link between the vestibular and auditory systems: (1) the formation of cochlear (auditory) nuclei from the vestibular nuclei in the brain stem; (2) the development of the vestibulocochlear system for the perception of vibration, which eventually evolved into separate systems, vestibular and cochlear; (3) primitive cranial nerves for speech, language, and hearing related to and functioning with the vestibular nuclei and spinal cord; and, (4) finally, the development of the cochlea (human's auditory organ) from the vestibulocochlear system. Given the anatomic and phylogenetic correlation between the auditory and vestibular systems, it would appear that the two are functionally related and "it would seem logical that sensory input to one system might affect the other" (Weeks, 1979a,
Several studies have found vestibular system dysfunction to be associated with language disorders. As a result of his 1976 study of vestibular disorders in learning disabled children, DeQuiros concluded that "vestibular disorders (and postural disturbances) can produce learning disabilities associated with ... the acquisition of language" (p. 44). Decreased postrotary nystagmus is an indicator of the integrity of the vestibular system (Ayres, 1979), and researchers have demonstrated its correlation to language disorders (Ayres, 1976; Stilwell, Crowe & McCallum, 1978). Ayres and Mailloux (1981) observed expressive language improvements in aphasic children with shortened postrotary nystagmus following participation in activities involving controlled vestibular stimulation. Additionally, in their 1978 study of children diagnosed to have communication disorders (deficits in articulation, speech/language, language, or hearing), Stilwell et al. documented a depressed postrotary nystagmus in all categories of communication disorders when compared to a control group with no communication disorders. When compared to the speech/language disorders and articulation disorders groups, the language disorders group had a significantly lower duration of postrotary nystagmus. The authors concluded that "language acquisition is related to dysfunction in sensory integration and, in particular, depressed duration of postrotary nystagmus" (p. 226).

Additional evidence supporting the association between the vestibular system and language is provided by the presence of abnormal reflexes found in some
children with language impairments. Stilwell et al. (1978) described "decreased postural stability" (p. 226) as a characteristic present in their subjects with speech/language disabilities. In her 1974 study, Rider found an increased prevalence of abnormal postural reflexes in dysphasic children. Several studies (Montgomery & Richter, 1977a; Ottenbacher, 1983; Wolkowicz, Fish & Shaffer, 1977) have documented improved reflex integration following vestibular stimulation. Chee, Kruetzenberg, and Clark (1978) administered a program of horizontal and vertical semicircular canal stimulation to a group of children with cerebral palsy and found a significant degree of improvement in reflex integration, as well as in fine motor control and social/emotional behavior, when compared to a control group of children with cerebral palsy who received no vestibular stimulation.

Although central nervous system dysfunction in the individual with Down syndrome is caused by neurophysiological anomaly (Cowie, 1970; Kurnit & Neve, 1987) and not sensory integrative dysfunction, sensory integrative theory may help to explain some behaviors observed in the Down syndrome population. For example, sensory processing problems such as hyporesponsiveness to tactile stimuli and proprioceptive input have been observed in children with Down syndrome (Pueschel, 1984). Additionally, children with Down syndrome exhibit many vestibular-related disorders (Ottenbacher, 1983). In addition to hypotonia already present in children with Down syndrome, vestibular system dysfunction manifests its effects in the form of low muscle tone, the presence of primitive postural reflexes, abnormal protective and equilibrium reactions, and gravitational
insecurity (Niman-Reed & Sleight, 1988). Abnormal measures of postrotary nystagmus, an indicator of vestibular system dysfunction, have been documented in children with Down syndrome. Prolonged postrotary nystagmus was documented in four children with Down syndrome between the ages of six months and twenty-four months in a study by Kantner, Clark, Allen, and Chase (1976). However, decreased duration of postrotary nystagmus was observed in thirty-five children with Down syndrome between the ages of five and nine years by Zee-Chen and Hardman (1983). Edwards and Yuen (in press) reported similar findings of decreased postrotary nystagmus in their subjects with Down syndrome, between the ages of twelve months and fifty-two months.

In addition to vestibular system dysfunction, delays in sensorimotor development, along with hypotonia and muscle weakness, also have been documented in children with Down syndrome (Niman-Reed & Sleight, 1988). This observation is important to note, because delays in sensorimotor development may contribute to delays in language development. Several studies have suggested the importance of sensorimotor development as a precursor to language acquisition in children with Down syndrome (Greenwald & Leonard, 1979; Mahoney & Snow, 1983; Strominger, Winkler & Cohen, 1984).

Language disabilities are characteristic in children with Down syndrome. Although they have the ability to communicate their wants, needs, and emotions, when compared to other aspects of their development, language is severely delayed. Based on their study of eighteen pre-schoolers with Down syndrome,
Mahoney, Glover, and Finger (1981) concluded "that Down syndrome children are more delayed in their rate of language acquisition than might be predicted from general indices of their intellectual functioning" (p. 25).

Generally, studies indicate that when matched with non-retarded peers of the same chronological age, children with Down syndrome display significant delays in the acquisition of language (Cardoso-Martins, Mervis & Mervis, 1985; Leifer & Lewis, 1984; Mahoney et al., 1981; Pruess, Vadasv & Fewell, 1987; Smith & vonTetzchner, 1986). However, when compared to younger non-retarded children of the same mental age and level of cognitive development, the children with Down syndrome do not appear to be any different in regards to the sequence of language development (Cardoso-Martins et al., 1985; Leifer & Lewis, 1984).

The language delays observed in children with Down syndrome do not appear to be due to abnormal development but rather to a lag in development (Cardoso-Martins et al., 1985; Leifer & Lewis, 1984). As a result of their review of research on language development in young children with Down syndrome, Pruess et al. (1987) concluded that the "studies offer evidence that the language of children with Down syndrome develops in the same manner and sequence as does the language of non-retarded children" (p. 44).

Miller (1988) supports the proposition of a developmental lag in language this by stating that language abilities in children with Down syndrome develop at a rate comparable with intellectual abilities until approximately age three or four
years. After this age, he adds, language development continues, but not at a rate consistent with other cognitive abilities.

Other differences in language abilities of children with Down syndrome have been documented. Chapman, Schwartz, and Bird (1991) reported vocabulary comprehension to be more advanced than syntax comprehension. Also, when compared to non-retarded peers of the same sensorimotor stage, children with Down syndrome relied more heavily on gestures to express communicative intents (Greenwald & Leonard, 1979).

A number of factors contribute to language disabilities and delays in children with Down syndrome. Miller (1987, 1988) cited four major contributing factors. First, children with Down syndrome tend to experience increased frequency of otitis media (middle ear infections) in early childhood. This may result in mild hearing loss, as well as decreased auditory acuity, thus interfering with interpreting language. Secondly, in addition to hypotonia, deficits in motor coordination associated with Down syndrome may interfere with motor movements necessary for speech, resulting in a decreased oral diadokokinetic rate as well as decreased intelligibility of speech sounds. Another major contributing factor to language disabilities is cognitive deficits associated with Down syndrome. Memory deficits and slower lexical processing may result in language learning problems. Additionally, as the child gets older, language and communication skills appear to become increasingly deficient when compared to other abilities. Finally, there appear to be decreased expectations for language use and performance from family
members, resulting in decreased opportunities for communication and "limited opportunity to acquire new vocabulary and to practice those language skills that they do have in social situations" (Miller, 1988, p. 122).

After examining the effects of these factors on language development, Rosin and Swift (1989) concluded that children with Down syndrome experience a slower rate of language acquisition following the onset of language learning and may also experience a leveling off of language acquisition after simple sentence forms are mastered.

These barriers to language learning need to be addressed early in life to promote language acquisition in young children with Down syndrome. Also, a program using sensorimotor techniques such as vestibular stimulation may be beneficial. Niman-Reed and Sleight (1988) advocated the use of vestibular stimulation including a variety of movements with Down syndrome children to modify both hyper- and hypo-responsiveness to vestibular stimuli. They recommended implementing a program in infancy, but added that older children "usually respond favorably" (p. 99).

Kantner et al. (1976) presented four children with Down syndrome between the ages of six and twenty-four months with repetitive specific vestibular stimulation during one hour sessions for ten days and found that their motor skills increased when compared to their pre-test skills. Edwards and Yuen (1990) implemented an occupational therapy home program with a young child with Down syndrome to facilitate reflex integration, motor abilities, pre-linguistic skills
and cognitive development. Using vestibular stimulation, along with tactile stimulation and neurodevelopmental treatment techniques, they found the program to decrease the delay in development of the Down syndrome child along the parameters addressed. Raver (1980) found that when intense vestibular stimulation was presented as an antecedent event to language tasks, the receptive language of preschoolers with Down syndrome improved. The author reported that "all subjects acquired the language skills more quickly when stimulated for 90 seconds prior to training" (p. 83).

Many studies document the positive effects of vestibular stimulation on language deficits in developmentally delayed children. Kantner, Kantner, and Clark (1982) found increases in the language abilities (general communication, verbal language, and auditory language as measured by the Porch Index of Communicative Ability in Children) of mentally retarded children following a six-week program of passive, controlled semicircular canal stimulation. However, their findings did not support the hypothesis that vestibular stimulation would produce a significant increase in overall language abilities as compared to language therapy alone. Magrun, Ottenbacher, McCue, and Keefe (1981) reported significant increases in spontaneous verbalizations following self-initiated, active, vestibular stimulation, as well as a decrease in verbalizations following the removal of the stimulation in five pre-school developmentally delayed children and five mentally impaired children. They also reported more pronounced effects in the youngest children with more severe language delays, a group less responsive to traditional
methods of language stimulation.

Tew (1984) studied the effects of sensory integration therapy, emphasizing goal-directed vestibular stimulation on the language development of fifteen developmentally delayed pre-schoolers. The results indicated that this type of treatment, when used in conjunction with language therapy, had a significant effect on language gains. Morrison and Pothier (1972) found that a group of nine mentally retarded children who participated in a prescribed sensorimotor training program incorporating vestibular stimulation had a significant increase in language skills, as measured by the Language subtest of the Denver Developmental Screening Test, when compared to a matched control group who participated in only gross motor activities.

In a later study, Morrison and Pothier (1978) found no significant differences among groups of perceptual-motor training, perceptual-motor training with vestibular stimulation, or a control group on language measures. They did, however, find a significant difference between pre- and post-test scores on expressive vocabulary.

Additional research has documented the use of vestibular stimulation to improve verbalizations in individuals with a variety of language-limiting conditions. Ray, King, and Grandin (1988) found the percentage of verbalizations in a nine-year old boy with autism significantly increased during the time the child was involved in active vestibular stimulation, as compared to pre- and post-stimulation periods. Additionally, a single case study of a child with autism found a large
difference between the number of vocalizations made during vestibular stimulation and those made during pre- and post-intervention phases (Maddox, 1990). This study also found the number of vocalizations made during self-initiated sessions of vestibular stimulation to be marginally higher than during therapist-initiated sessions.

In 1977, Wolkowicz et al. implemented a four-month program incorporating the use of vestibular stimulation with four children with autism and found an increase in spontaneous verbalizations. Ayres and Hesket (1972) also documented an increase in auditory-language (receptive language) abilities of a seven-year-old girl with autism following a course of sensory integrative therapy.

The positive effects of vestibular stimulation on language has also been documented in individuals with schizophrenia. King (1974), hypothesizing that vestibular system dysfunction may be an etiological factor in adult, chronic, non-paranoid schizophrenics, employed a program utilizing vestibular stimulation to increase verbalizations. In 1978, Bailey worked with non-paranoid schizophrenics and found the quality of their language (number of words used, speed of responses, and relevance of responses) improved, but found no significant difference in the quantity of words spoken or the rate. An increase in the spontaneous use of language also was documented.

While studying pre-school children with aphasia, DePauw (1978) implemented a seven-month, twenty-minute daily sensorimotor program designed to provide vestibular stimulation along with tactile and proprioceptive stimulation.
In the group that received the experimental treatment program, spontaneous language use increased during and after the program. In addition, significant gains in motor abilities were displayed. In 1981, Ayres and Mailloux studied the effects of controlled vestibular stimulation with four aphasic children and found in all four subjects the level of language comprehension (as measured by the Test for Auditory Comprehension of Language) increased when treatment started.

Kawar (1973) studied the effects of sensory integration therapy including vestibular stimulation on the listening abilities of a group of eighteen children with learning disabilities. Results demonstrated that, for those receiving intervention, right ear scores on tests of dichotic listening abilities improved. According to the author, this indicated improved lateral specialization for language function (but not necessarily improved expressive language).

Clark, Miller, Thomas, Kucherway and Azen (1978), in their study of twenty-seven profoundly retarded institutionalized adults, found increases in vocalizations following sensory integration therapy using vestibular stimulation.

In summary, the aforementioned studies reported vestibular stimulation to have a generally positive impact, either improving or increasing expressive and/or receptive language use, in these various populations and potentially language-limiting conditions.

Vestibular stimulation can be presented in a variety of ways and positions. Additionally, different methods of administration will stimulate different receptors within the vestibular system. For example, linear acceleration will stimulate the
gravitational receptors in the utricle and saccule, while rotary movement will stimulate the rotational receptors in the semi-circular canals. Ayres (1972b) states that passive vestibular stimulation is most effectively administered by swinging or spinning a child in a hammock net. This type of movement will activate the rotary receptors. To stimulate the gravitational receptors, Ayres (1979) recommends the use of a scooter board and ramp. Other activities such as swinging on a bolster or platform swing and bouncing on a trampoline are linear movements that would activate the gravitational receptors. For treatment purposes, a variety of equipment providing opportunities for different types of vestibular stimulation should be available to the child with sensory integrative dysfunction (Ayres, 1972b, 1979; Koomar & Bundy, 1991).

Research indicates that precautions must be taken when providing vestibular stimulation to a child. First and foremost, the therapist needs to gain the trust of the child by ensuring him that the equipment used is safe and he/she will be safe on it (Koomar & Bundy, 1991). Additionally, the therapist should monitor the child's behavior for signs of an aversive reaction such as sweating, pallor, dizziness, nausea, vomiting, and avoidance of movement (Ayres, 1979; Koomar & Bundy, 1991). Vestibular stimulation such as spinning may also reduce breathing and blood pressure (Ayres, 1979).

An additional consideration when using vestibular stimulation is the concern that vestibular stimulation may induce seizures in seizure-prone children (Ayres, 1972b, 1979; Kantner, Clark, Atkinson & Paulson, 1982; Kantner, Kantner and...
Clark, 1982). Initially, Ayres (1972b, 1979) expressed concern that use of vestibular stimulation may be contraindicated in the seizure-prone individual, but later acknowledged that, while this should be a concern for practicing therapists, she had never witnessed that type of reaction in any children with whom she had worked (cited in Maddox, 1990).

Other researchers have found the claim of contraindication in the seizure-prone individual to be unsubstantiated as well (Kantner, Clark et al., 1982; Kinnealy, 1973). In their 1982 study, Kantner, Clark et al., after studying abnormal brain-wave patterns, found that semicircular canal stimulation did not accentuate EEG recordings in seizure-prone children. In fact, the authors observed a significant decrease in abnormal activity in six of ten subjects. They claimed that, according to their findings and other literature, a vestibular stimulation-induced seizure is an "extremely rare event" (p. 20). The authors continued by proposing that it could be possible for an inexperienced observer to mistake spinal level reflexes (evoked by spinning) for a seizure. Also, they attribute causal factors for seizures resulting from vestibular stimulation to fatigue, excitement, hyperventilation, or the result of a stroboscopic visual effect manifested by spinning in a lighted room. Therefore, the authors feel the concern for vestibular stimulation-induced seizures "has been based on hearsay and unconfirmed clinical impressions of practicing therapists" (Kantner, Clark et al., 1982, p. 16).

In further support of vestibular stimulation, Kinnealy (1973), in her study of aversive and non-aversive responses to sensory stimulation in mentally retarded
children, found vestibular stimulation to be generally a positive stimulus, even in those children who showed aversive reactions to other sensory stimuli, such as olfactory and gustatory stimulation.
CHAPTER III

HYPOTHESIS

Based on the above investigations, the present study was designed to explore how one aspect of sensorimotor therapy, specifically vestibular stimulation, may be used to facilitate language use and/or development in pre-school children with Down syndrome. It was hypothesized that vestibular stimulation, when presented immediately prior to language therapy, would increase expressive language, both verbal and non-verbal, in the subjects.

Specifically, "expressive language" for this study was defined in terms of "communicative attempts." For evaluative purposes, a communicative attempt was considered to be any successful or unsuccessful attempt, spoken, gestured, or combination of both, used to convey a meaningful message to another person.

Five categories of communicative attempts were employed to analyze changes in the subjects' language. Due to the subjective nature and difficulty involved in evaluation, facial expressions, although generally considered a valid form of communication, were not analyzed in this study. Single word utterances were defined as any single spoken word that was intelligible and carried meaning. Multiple word utterances carried the same definition for two or more intelligible words used in combination. Unintelligible utterances were identified as any spoken utterance, single or multiple word, which was unintelligible to the evaluator.
Gestures accompanied by vocal utterances, were defined as any physical gesture which was paired with a vocal utterance (intelligible or unintelligible) to convey meaning such as a want, need, or feeling. The final category, gestures, was defined as a physical movement, not paired with a vocal utterance, used to convey meaning such as a want, need, or feeling (e.g., pointing, shaking head to indicate "yes"/"no," signifying "mine").
CHAPTER IV

DESIGN AND METHODOLOGY

Subjects

Two subjects were selected for this study: one male, thirty months, and one female, twenty-six months. Both had a primary medical diagnosis of Down syndrome, Trisomy 21. Prior to the study, both subjects were identified as having speech/language delays or disabilities, as evidenced by below age appropriate scores on the Peabody Picture Vocabulary Test-Revised (PPVT-R) and the Sequenced Inventory for Communication Development (SICD). The pre-study diagnostic language assessments were administered by faculty-supervised master's degree students in the Speech/Language Pathology program at the Charles VanRiper Language, Speech, and Hearing Clinic at Western Michigan University, Kalamazoo, Michigan. The subjects had no history of hearing impairments and were administered formal audiological evaluations prior to the initiation of the study by master’s degree students in the Audiology program at Western Michigan University. The evaluations indicated hearing was within normal limits for both subjects. Additionally, neither subject had a history of seizure disorders.

Subject A was a thirty-month-old generally healthy male with a history of slight ear infections, the most recent occurring three months prior to this study.
He did not experience any ear infections throughout the course of the study. As is common in the Down syndrome population, Subject A also had a history of cardiac problems. Specifically, he had a septal defect and valve cleft, with restorative heart surgery scheduled when he reached the age of three years.

Subject B was a twenty-six-month-old generally healthy female, with no history of ear infections. Subject B also had cardiac problems which were repaired at the age of six months. The mother had reported no significant health problems since that time. However, during the study, Subject B became ill, developing otitis media in both ears, and was unable to complete the study.

As a condition of the study, both subjects received "traditional" speech/language therapy twice weekly for fifty minutes at the Charles VanRiper Language, Speech, and Hearing Clinic at Western Michigan University, during the Winter semester of 1992. Therapy was given by faculty-supervised student clinicians in the master's degree program in Speech/Language Pathology at Western Michigan University.

Prior to the study, each subject was assessed for vestibular system integrity by the primary researcher. A checklist of vestibular-related characteristics including integration of the asymmetrical tonic neck reflex (ATNR) in supine, symmetrical tonic neck reflex (STNR) in prone on the tester's lap, neck righting, and equilibrium reactions in supine and while seated was used to informally assess the vestibular system. In both subjects, STNR was present, as was ATNR upon passive rotation of the head to both the right and left. When tested for presence of the
neck righting reflex, non-segmental rolling was observed in both subjects. Additionally, both subjects displayed positive, but extremely delayed reactions when equilibrium was tested in both supine and seated positions.

In addition to the observations noted above, postrotary nystagmus, an indicator of vestibular system integrity, was also assessed. Because normative data do not exist for this population, a modified test of postrotary nystagmus adapted from Edwards and Yuen (in press) was used in this study. The authors modified Ayres' (1975) Southern California Postrotary Nystagmus Test for appropriate use with the subjects in their study of children with Down syndrome ages twelve months to fifty-two months. The authors found the mean duration of postrotary nystagmus in their subjects to be significantly lower than older Down syndrome populations, such as those tested in a study done by Zee-Chen and Hardman (1983). Edwards and Yuen (in press) found the mean duration of postrotary nystagmus when subjects were rotated to the right to be 2.52 seconds; 2.60 when rotated to the left. Similarly, in the present study, both subjects displayed a comparable shortened duration of postrotary nystagmus. Subject A displayed a postrotary nystagmus of 3.05 seconds following rotation to the right and 2.78 seconds following rotation to the left. Subject B also displayed a shortened postrotary nystagmus: 2.38 seconds when rotated to the right; 2.56 seconds when rotated to the left. The shortened duration of postrotary nystagmus, along with the presence of the above vestibular-related characteristics beyond age-appropriate expectations indicated problems with vestibular system integrity in
these two subjects.

Apparatus

Equipment used in this study included an infant/toddler swing attached to a swivel hook suspended from the ceiling, a scooter board, a small trampoline, a mat, a Sit 'N Spin toy, a rocking tilt board, a rocking see-saw, a stopwatch, and a hand-held video recorder.

Procedure

The experimental design employed in this study was a single subject, alternating treatment (ABA) design. A total of eleven experimental sessions (two per week) were conducted over a six-week period.

Throughout the duration of the six-week study, Subject A received "traditional" speech/language therapy twice weekly at the Charles VanRiper Language, Speech, and Hearing Clinic at Western Michigan University. Language therapy was provided by a faculty-supervised master's degree student clinician in Speech/Language Pathology, who was unaware of the conditions and purpose of the study and was instructed not to alter treatment goals or therapy sessions in an attempt to conform to the study. A brief description of treatment goals and activities used during speech/language therapy can be found in Appendix A.

For each of the eleven experimental sessions, data of the subject’s expressive language use were gathered and analyzed using language sampling techniques.
(adapted from Porter, 1987) taken from videotaped samples during fifteen minutes of speech/language therapy. During the first two-week period (four sessions), baseline data of the number of five types of communicative attempts were gathered. During the next two-week period (four sessions), the vestibular stimulation phase of the study, ten minutes of vestibular stimulation was presented to the subject fifteen minutes prior to language therapy. During the final two-week period (three sessions), the post-intervention phase, the subject returned to receiving language therapy alone.

According to sensory integration theory as promoted by Ayres (1979), the child with sensory integrative dysfunction (including vestibular system dysfunction) will actively seek out the stimulation he/she desires and needs. Ayres (1979) states that "therapy is most effective when the child directs his own actions while the therapist unobtrusively directs the environment. Integration most often occurs when the child wants the stimulus and initiates an activity to get those sensations" (p. 140). She goes on to suggest that the therapist "let the child serve as his own stimulus source in choosing which piece of equipment he will use to activate his vestibular receptors" (p. 142).

Adhering to this philosophy of sensory integrative theory, vestibular stimulation for a portion of this study was child-directed and therapist guided by placing the subject in a "vestibular stimulation-rich" environment where he had the opportunity to engage in a variety of different movement activities and was encouraged to participate in those found to be the most stimulating. However, prior to this
condition, the primary researcher in this study administered controlled, rotary and linear stimulation to provide consistent vestibular stimulation for the subject across treatment sessions.

Vestibular stimulation for the first five minutes of the ten minute period was administered by the primary researcher in this study. The subject was placed in a suspended swing and rotated slowly in a clockwise direction for a period of one minute. The researcher rotated the child continuously at a rate of one revolution per three seconds throughout the one minute period. Following this one minute period, the subject was stopped and given a twenty second rest period during which no rotation occurred. The procedure was repeated with rotation occurring in a counter-clockwise direction. Again, the subject was given a twenty second rest period with no rotation. Finally, to provide linear stimulation, the researcher rocked the child in the swing in a back-and-forth direction for a period of one minute.

For the next five minutes, the subject was placed in a "vestibular stimulation-rich" environment to encourage subject-initiated vestibular stimulation. For this study, various activities were chosen to provide different types of vestibular stimulation. The subject was given the opportunity to swing again in the suspended swing, bounce on a trampoline, rock on a tilt board or see-saw, spin on a Sit 'N Spin toy, and/or ride on a scooter board, depending on the subject's preference. The primary researcher guided the subject to appropriate activities to stimulate the vestibular system and, for safety purposes, served as a spotter and monitored
the subject's reactions for signs of aversive reactions to the vestibular stimuli.

Data Analysis

Videotaped recordings of the subject during language therapy were used for analysis of expressive language. A fifteen minute sample of the subject was videotaped every session beginning five minutes following the initiation of language therapy. A paid master's degree student in Speech/Language Pathology at Western Michigan University who was unaware of the conditions, phases, or hypothesis of the study, evaluated, through language sampling techniques adapted from Porter (1987), the subject's expressive language for frequency of use of single words, multiple word combinations, unintelligible vocal utterances, gestures accompanied by vocal utterances, and gestures/non-verbals (not accompanied by vocal utterances). Marked variability in the subject's responses was observed throughout the study, which complicated computation of statistical correlational analysis to determine significance level. Therefore, statistical procedures were not employed in the data analysis for this study. Frequency of use of these various categories of communicative attempts analyzed during the intervention and post-intervention phases of the study was graphed (Ottenbacher, 1986) to compare to baseline data taken during the pre-intervention phase to determine if vestibular stimulation increases expressive language when presented prior to language therapy. In addition, mean percentage improvement was calculated for total communicative attempts as well as for each phase and category analyzed.
CHAPTER V

RESULTS

Plotted graphs of the subject’s performance indicated a large difference between expressive language during pre- and post-intervention (language therapy alone) phases and during the intervention (vestibular stimulation before language therapy) phase. The subject displayed improvement in total communicative attempts when intervention data ($M=89.25$) were compared to the pre-intervention period ($M=69.75$) of language therapy alone (see Figure 1). Figure 1 represents a compilation of all categories of communicative attempts analyzed: single word utterances, multiple word utterances, unintelligible vocal utterances, gestures accompanied by vocal utterances, and gestures not accompanied by vocal utterances. Of all communicative attempts analyzed, 93.8% were spontaneous (gesture and/or vocal utterance initiated solely by the subject in an attempt to communicate, without extraneous prompting or elicitation by the student clinician).

Of the five categories of communicative attempts analyzed, improvements in two categories, gestures accompanied by vocal utterances and unintelligible vocal utterances, were the most noteworthy. During the intervention phase of the study, the subject used gestures accompanied by vocal utterances more frequently ($M=33.0$) than during the pre-intervention phase ($M=14.25$) (see Figure 2).
Conversely, the subject's use of unintelligible utterances decreased during the intervention phase ($M=14.0$) as compared to the pre-intervention phase ($M=18.25$) (see Figure 3).

Additionally, the subject displayed differences between pre-intervention and intervention phases in the means of the remaining categories of communicative attempts analyzed. The mean number of single word utterances declined slightly during the intervention phase ($M=17.5$) as compared to the pre-intervention
Figure 2. Total Gestures Accompanied by Vocal Utterances (Intelligible or Unintelligible) During a Fifteen Minute Sample.

phase ($M=20.5$) (see Figure 4). In contrast, the opposite occurred for spoken multiple word utterances, with the mean number of occurrences during the intervention phase ($M=18.0$) dramatically increasing as compared to that during pre-intervention ($M=4.5$) (see Figure 5). Finally, the mean number of gestures (not paired with a vocal utterance) used by the subject decreased during the intervention phase ($M=6.75$) as compared to the pre-intervention phase ($M=12.25$) (see Figure 6).
Figure 3. Total Unintelligible Vocal Utterances (Single and Multiple Word) During a Fifteen Minute Sample.

Figure 7 presents mean percent improvement from pre-intervention to intervention phases for total communicative attempts as well as for all categories of communicative attempts analyzed. The following formula was used to obtain mean percentages: intervention mean score minus pre-intervention mean score divided by pre-intervention mean score (adapted from Kantner, Kantner, and Clark, 1982). Overall, the subject improved the total use of communicative attempts during the intervention phase by 28%. However, the greatest mean improvement occurred in multiple word utterances and gestures accompanied by
vocal utterances, where the subject displayed a 300% and 132% improvement, respectively.

Figure 7 also depicts the percent mean improvement for unintelligible utterances as -23%, indicating the subject decreased the use of unintelligible utterances by 23% during the intervention phase. Additionally, the subject also decreased use of single word utterances by 14.6% and gestures not accompanied by vocal utterances by 45%.
Figure 5. Total Intelligible Multiple Word Utterances During a Fifteen Minute Sample.
Figure 6. Total Gestures (Not Paired With a Vocal Utterance) During a Fifteen Minute Sample.
Figure 7. Mean Percent Improvement Between Pre-Intervention and Intervention Phases.

Percentages were obtained with the formula: intervention mean score minus pre-intervention mean score divided by pre-intervention mean score.
CHAPTER VI

DISCUSSION

Statistical procedures were not employed: therefore, support or rejection of the hypothesis examined is not possible. However, the results appear to support the hypothesis that vestibular stimulation, when presented prior to language therapy, may increase expressive language use in a pre-school child with Down syndrome.

Although the results of this single-subject study cannot be generalized to the pre-school Down syndrome population, the data from this study indicate that this subject displayed an increase in overall expressive language use following vestibular stimulation, as evidenced by the 28% increase in total communicative attempts (including all categories analyzed). Future clinical studies are needed with larger populations of Down syndrome children and more controlled therapeutic variables before the effects of vestibular stimulation on language may be clearly understood. Similar studies could employ the use of a group study to document generalizable results.

The subject's improvement in the five categories of communicative attempts during the intervention (vestibular stimulation) phase merits further discussion. The subject displayed a dramatic increase in use of gestures accompanied by vocal utterances with each session during the intervention phase (see Figure 2). The
mean use increased 132% from the pre-intervention (baseline) phase compared to the intervention phase. In contrast, the subject's use of gestures alone (not accompanied by vocal utterances) decreased during the same phase by 45%. This may indicate an inverse correlation between the use of gestures alone and gestures used with speech. Further study is necessary to determine if the use of gestures alone decreases while the use of gestures accompanied by speech increases.

Also noteworthy is the apparent decline in use of unintelligible utterances by the subject during the vestibular stimulation phase of the study. Because unintelligibility interferes with the communication process, a decrease in use would indicate improvement in terms of communicative ability. Although unintelligible single and multiple word utterances were not measured separately, further study may reveal that differences exist between these utterances following vestibular stimulation.

There were differences between intelligible single and multiple word utterances when mean scores of pre-intervention and intervention phases were compared. Multiple word utterances markedly increased by 300% during the vestibular stimulation phase of the study, but use of single word utterances decreased by 15% during the same phase. While this indicates an improvement in expressive language abilities (multiple word utterances are more advanced developmentally than single word utterances), further study is needed to document a possible correlation between the decline in single word utterances and the subsequent increase in multiple word utterances following vestibular stimulation.
Another trend in the data which merits discussion is the possible retention or learned carry-over effect observed during the post-intervention phase, not only in the total use of communicative attempts (see Figure 1), but also in the majority of the categories of communicative attempts analyzed: gestures accompanied by vocal utterances, unintelligible utterances, multiple word utterances, and gestures not accompanied by vocal utterances (see Figures 2, 3, 5, and 6, respectively). The retention effect was expected following an intervention period incorporating vestibular stimulation. As a sensory integration treatment modality, vestibular stimulation serves to facilitate organization of sensory information for future use with behavioral responses (Ayres, 1979). If retention did not occur, vestibular stimulation would produce only temporary effects.

In this study, the retention effect during the post-intervention phase was observed not only in increased mean scores, such as those observed for total communicative attempts, gestures accompanied by vocal utterances, and multiple word utterances, but also in decreased mean scores (following a trend of decreased intervention phase mean scores) for unintelligible utterances and gestures not accompanied by vocal utterances. Further study using longer phases (more sessions) and adding an additional treatment phase may provide further support for the retention effect observed in this study. Additionally, the full impact of a retention effect in this study may have been dampened by the unusually low responses across all areas of communication attempts observed during Session 10 of the post-intervention phase.
Several factors may have contributed to the variability in results in this study. One factor, therapeutic interaction style of the student clinician, may have contributed to the low response rate during Session 10. Throughout the study, the student clinician maintained a very positive and nurturing relationship with the subject during language therapy, was very supportive and provided much positive reinforcement and feedback to the client. This high level of comfort and familiarity with the student clinician may have accounted for the subject's generally high response rate. However, immediately prior to the beginning of language therapy on the day of Session 10, the student clinician's faculty supervisor instructed her to simplify her speech, and recommended use of two- and three-word directions and comments to provide age-appropriate modelling for the subject and increased opportunity for the subject to respond. The interaction between the subject and student clinician was decreased during that session. The number of total communicative attempts by the subject was much lower when compared to the two other sessions in the post-intervention phase (see Figure 1). This sharp decline was also noted in single word utterances and multiple word utterances (see Figures 4 and 5, respectively). The sharp decline did not exist for the other areas of communicative attempts, however, generally low responses were indicated.

This trend in low responses for that particular session indicates a possible relationship between the therapist's style of interaction and the subject's responses. It suggests that the variable of interaction style can affect the number
and type of communication attempts elicited. Although specific correlational conclusions cannot be made on the basis of this study, further research into this confounding variable is warranted. In future studies, factors such as sentence structure level (e.g., one word, two word), question level (e.g., yes/no questions, wh-questions), and direction level (e.g., one-step, two-step) used by the therapist should be measured and controlled based on the subject's developmental level. A study using a larger number of subjects could investigate how therapeutic interaction style may affect subjects differently.

Another confounding factor related to therapeutic interaction style is treatment goals. A therapist may modify interaction style according to treatment goals and desired behavioral responses from the subject. For example, treatment goals emphasizing facilitation of expressive language abilities may significantly differ from goals emphasizing facilitation of receptive language abilities and each may require different interaction styles. In this study, the student clinician was focusing on expressive language treatment goals, which may have accounted for the high rate of spontaneous communicative attempts made by the subject. The student clinician also allowed more of a "child-directed"/"play therapy" approach to language therapy sessions than may be traditionally utilized. This may have contributed to the high subject response rate. Considering this was the subject's first enrollment period for speech/language therapy, one would expect to see improvements in language, not only due to the intervention, but also to the increased stimulation and the one:one contact with a student clinician.
Although the pre-school years are the prime period for early intervention in many areas including speech/language, motor skills, and cognitive skills, among others, this age also poses a confounding variable to research studies: maturational factors. The pre-school years are the critical period for language development, with increases in receptive and expressive language abilities emerging rapidly. Results in this study may have been confounded by maturational factors. The subject's expressive language abilities may have developed without experiencing the vestibular stimulation or receiving speech/language therapy. However, the improvement over such a short time period may not have been observed.

The short duration of this study was a limitation. Future studies should employ extended intervention periods to document the effects of vestibular stimulation on expressive language over time. It is also recommended that an additional intervention period (ABAB design) be employed in future studies to examine the retention/learned carry-over effect observed in the present study.

The effects of vestibular stimulation over four non-consecutive sessions of intervention were documented in this study. Modification to this design to incorporate more frequent and consistent periods (e.g., daily) of vestibular stimulation is recommended. Modification of the administration of vestibular stimulation should also be considered. Although this study attempted to adhere to sensory integration theory principles as much as possible by encouraging child-directed vestibular stimulation (Ayres, 1979), often the activities designed to provide vestibular stimulation chosen by the subject required motoric ability not yet
developed by the subject. The subject would become disinterested and not engage in the activities. This resulted in an inconsistent pattern of vestibular stimulation across treatment sessions. Developmentally appropriate activities and more therapist-directed vestibular stimulation to allow for consistency across treatment sessions and improved research control should be used in future studies.

Another confounding factor in this study, the subjective nature of language sampling analysis, merits discussion. Although pertinent information regarding use of language components is obtained through language sampling, this method of analysis also has limitations. Barrie-Blackley, Musselwhite, and Rogister (cited in Porter, 1987) state in their handbook that reliability is the greatest concern in language sampling. The reliability of the language sampling procedures used in this study was not established. Although only one rater was employed for the present study, rater-reliability could have been evaluated by using a randomly selected videotaped playback of one of the subject's language samples. After analyzing the language sample, the primary researcher could have compared the results to those of the primary evaluator in the study to calculate reliability correlations. Reliability of the rater's judgement should be addressed and analyzed in future studies of this nature.
CHAPTER VII

SUMMARY

Results of this study indicate an increase in the expressive language abilities of a pre-school child with Down syndrome when vestibular stimulation was presented immediately prior to language therapy. Although this study had several limitations: small sample size, short duration, and lack of established reliability measurements, among others, pertinent information regarding the use of vestibular stimulation in conjunction with language therapy was obtained.

In conclusion, results of this study suggest that vestibular stimulation, when presented prior to speech/language therapy, may play a supportive role in facilitating language ability or acquisition in young children with Down syndrome. This finding supports future interdisciplinary approaches to remediation of language deficits.
Appendix A

Description of Speech/Language Therapy
Description of Speech/Language Therapy

Speech/language therapy for this study was provided by faculty-supervised master's degree students in Speech/Language Pathology at the Western Michigan University Charles VanRiper Language, Speech, and Hearing Clinic during the Winter semester of 1992. Therapy was provided twice weekly for a period of fifty minutes.

Treatment goals for the subject who completed the study focused on facilitating expressive language, particularly vocalizations. The student clinician used minimal verbal prompting with this subject and encouraged the subject to use vocalizations through utilizing a structured yet flexible "play therapy" format. The student clinician chose activities (books, games, toys, music) appropriate and appealing to the subject and allowed him to direct therapy, while continuously encouraging vocalizations and spontaneous use of expressive language (verbal and non-verbal).

The subject and student clinician enjoyed a very positive and friendly relationship. The student clinician was very supportive and provided positive reinforcement and feedback for the subject's communicative attempts.
Appendix B

Human Subjects Institutional Review Board
Letter of Approval
Date: December 17, 1991
To: Tiffany Bergo
From: Mary Anne Bunda, Chair
Re: HSIRB Project Number 91-11-13

This letter will serve as confirmation that your research protocol, "The effect of vestibular stimulation on expressive language of pre-schoolers with down syndrome" has been approved after full review by the HSIRB. 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 approval application.

You must seek reapproval for any change in this design. You must also seek reapproval if the project extends beyond the termination date.

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

xc: Edwards, OT

Approval Termination: December 17, 1992
BIBLIOGRAPHY


Mahoney, G., Glover, A., & Finger, I. (1981). Relationship between language...


Orthopsychiatry, 48, 310-319.


Occupational Therapy in Pediatrics, 1, 1-11.


