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Intervention Settings for Children with Cochlear Implants and Developmental Disabilities

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Intervention Settings for Children with Cochlear Implants and Developmental Disabilities

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ABSTRACT

This study examined the relationship between educational environment (communication approach and mainstream setting) and receptive and expressive language outcomes for twenty-two children, ages three to six, with developmental disabilities who had received a cochlear implant. Existing data for children with developmental disabilities and cochlear implants are extremely limited. Thus, statistical analyses, including Spearman’s rank correlations, General linear model unadjusted and adjusted means, and Wilcoxon rank sum tests were conducted on data gathered for the twenty-two children. The data included results of language assessments (PLS-4), results of developmental testing (RGDS), and responses from simple questionnaires completed by caregivers. Analysis attempted to determine the impact that type of communication and mainstreaming (independent variables) had on the receptive and expressive language acquisition and growth of these children (dependent variable).

Conclusions drawn from data analyzed include: 1. No clear indication that one educational setting or communication mode produces better language outcome scores for children with developmental disabilities, 2. No clear indication that the longer these children have had their implant, the better their language outcomes, and 3. Enlightenment regarding the importance of more detailed investigation into the parent’s goals for their child when considering implantation. Thus, the ability to catch-up that is seen with the language outcomes of typical children with cochlear implants may not be seen in children with developmental disabilities. Findings indicate that, in addition to investigating language outcomes, it is extremely important to explore other positive impacts that the cochlear implant may have on children with developmental disabilities, such as enhanced quality of life, improved behavior, and increased level of arousal to determine the true benefits of implanting children with developmental disabilities.
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TABLE OF CONTENTS

CHAPTER I: INTRODUCTION ............................................................................................................. 8

CHAPTER II: LITERATURE REVIEW .............................................................................................. 11
  Communication Mode/Intervention Setting for Children with Cochlear Implants ................. 11
    Oral Communication versus Total Communication ............................................................... 13
    Oral Communication versus Sign Communication ............................................................... 15
  Other Factors ............................................................................................................................... 16
  Language Outcomes in Typical Children with Cochlear Implants ........................................... 17
  Language Outcomes in Children with Developmental Disabilities and Cochlear Implants .... 20
  Communication Mode/Intervention Setting for Children with Cochlear Implants and
  Developmental Disabilities ........................................................................................................... 24

CHAPTER III: METHODS ............................................................................................................... 27
  Definitions ................................................................................................................................... 27
  Hypotheses .................................................................................................................................. 29
  Data ........................................................................................................................................... 29
  Analysis ..................................................................................................................................... 37

CHAPTER IV: RESULTS ................................................................................................................ 41

CHAPTER V: DISCUSSION ............................................................................................................ 53

CHAPTER VI: CONCLUSIONS ..................................................................................................... 59
  Limitations ................................................................................................................................. 59
  Clinical Relevance ...................................................................................................................... 61
  Directions for Future Research ................................................................................................. 61

REFERENCES .............................................................................................................................. 63
LIST OF FIGURES AND TABLES

Figure 1: Participant Developmental Quotient ................................................................. 32
Table 1: Participant Quantitative Data .............................................................................. 33
Table 2: Participant Demographic Information ............................................................... 34
Figure 2: Participant Communication Mode ................................................................. 36
Figure 3: Participant School Setting ............................................................................. 37
Figure 4: Language Outcomes Based on Receptive Language Quotients ................. 43
Figure 5: Language Outcomes Based on Expressive Language Quotients ............. 43
Table 3: Spearman Rank Correlation Coefficients ....................................................... 44
Figure 6: Receptive Language Outcomes Controlling for Developmental Quotient .... 45
Figure 7: Expressive Language Outcomes Controlling for Developmental Quotient ... 46
Table 4: Spearman Rank Partial Correlation Coefficients ............................................ 47
Table 5: General Linear Model Unadjusted and Adjusted Means for Standard Scores 49
Table 6: General Linear Model Unadjusted and Adjusted Means for Language Quotients 50
Table 7: Wilcoxon rank sums for Standard Scores ..................................................... 51
Table 8: Wilcoxon rank sums for Language Quotients ................................................ 52
CHAPTER I:

INTRODUCTION

Strict guidelines have been implemented by the Joint Commission on Infant Hearing, which provide for immediate and proper interventions for infants born with hearing loss. Such stringent procedures ensure that infants who are in need of medical intervention obtain treatment as early as possible to correct any hearing difficulties that could arise as a consequence of the hearing loss being overlooked or left untreated and to avoid any setbacks in sound perception, speech and language development or resulting academic and social issues (Joint Committee on Infant Hearing, 2007; Carney & Moeller, 1998). Deaf children, those with severe to profound hearing losses, will require more than a hearing amplification system to allow them to develop speech perception, production, and in turn, language comprehension and expression through their auditory system. These are the children who potentially benefit greatly from cochlear implants (Gravel & O’Gara, 2003).

Much research has been gathered on language outcomes of children receiving cochlear implants including studies on: their ability to perceive speech (O’Donoghue, Nikolopoulos & Archbold, 2000), their spoken language outcomes (Geers, Nicholas & Sedey, 2003; Nicholas & Geers, 2007), their pattern of listening skill development (Miyamoto, Houston & Bergeson, 2005), their comprehension of spoken English (Geers, Nicholas & Sedey, 2003), and their means of communicating (Preisler, Ahlstrom & Tvingstedt, 1997). However, there are still many unanswered questions. Much of this research has been conducted by examining “typical” children with cochlear implants, or those individuals who do not have any other concomitant disabilities. There is a significant lack of research examining the outcomes of cochlear implants for children with developmental disabilities.
The research that exists on typical children with hearing loss confirms the eternally present controversy on the topic of cochlear implantation. When should it be done? What are the language outcomes? Who will benefit? What type of communication mode should be pursued pre and post implantation? In what type of educational environment should the child be placed? With the positive modifications in technology, the age of implantation has decreased, raising questions as to the benefits of such a surgery. Research indicates that the earlier a child can receive a cochlear implant, the better the speech and language outcomes will be for that child. The research also reveals continuing controversy as to what type of communication mode/environment will most effectively benefit the speech and language abilities of the child – oral versus visual versus total, or any combination of the three. Various researchers support an oral mode (Francis, Koch, Wyatt & Niparko, 1999; Geers, Nicholas & Sedey, 2003; Tobey, Rekart, Buckley & Geers, 2004), while others support a total communication approach (Conner, Hieber, Arts & Zwolan, 2000; Holt & Kirk, 2005). In addition, the research seeks to reveal the importance of mainstreaming individuals following cochlear implantation, and develop relative research studies while eliminating as many of the confounding variables as possible (communication environment, additional interventions, etc.).

Many variables impact the language outcomes of children with cochlear implants including age at implantation, family involvement, time since implantation, mode of communication pre and post implant, cognitive ability, educational placement, additional intervention, etc. It is important to understand this while reviewing the literature currently circulating on children with cochlear implants. While the research exists for typically developing children with hearing loss, there is not extensive evidence present on language outcomes of children with developmental disabilities who have received cochlear implants.
More specifically, advanced evaluation of the intervention settings and communication modes used for children with developmental disabilities have not been examined. Thus, the research question for this paper evolves: *Do intervention settings (educational program) affect language outcomes for individuals with developmental disabilities who receive cochlear implants?*

Using data gathered from a larger study investigating language outcomes of deaf children with cochlear implants who have developmental disabilities, demographic data and evaluation results were quantitatively examined to disclose relationships among language outcomes, intervention setting and communication mode. Data revealing receptive and expressive language were available for evaluation. The sample was assessed using standardized test methods and the data were compared across intervention settings to assess language outcomes for the twenty-two participant sample.

For the purposes of this study, the current literature available on variations across intervention settings and communication modes for typical children with cochlear implants, as well as children with developmental disabilities and cochlear implants will be reviewed. The methodology behind the research study will then be discussed in detail. The results of the study will be revealed and the relevancy of the information will be discussed. Limitations of the current research will then be explored, and from that, suggestions for future research will emerge.
CHAPTER II:
LITERATURE REVIEW

Cochlear implantation in children is a widely controversial topic and results in a major decision for parents who are faced with a child with profound hearing impairment. The decision can be made with the support of research investigating language outcomes for children with cochlear implants, as well as consideration of how age at implantation, communication mode, type of implant, family involvement, etc. may impact the success of the surgery. Following the choice to implant the child, is the decision as to what communication mode should be embraced in teaching the child language. As though these resolutions are not challenging enough, they may be further complicated when the child with the hearing loss has a developmental disability. Less conclusive research exists to assist parents with this significant decision. As with children without developmental disabilities, following the choice to implant, the communication mode must be selected. In order to assist individuals with these major decisions, a brief review of the literature currently available will include evidence presented from results of studies including: various intervention settings and the performance of children with cochlear implants in each of these settings, language outcomes for children who have received cochlear implants, language outcomes for children with developmental disabilities who have received cochlear implants, and information on intervention settings for children with developmental disabilities and cochlear implants.

Communication Mode/Intervention Setting for Children with Cochlear Implants

All individuals, those with normal hearing, those who are hard of hearing, and those who are deaf, have a strong desire (and need) to communicate (Gravel & O’Gara, 2003). Existing literature delineates the major modes of communication along a continuum that can be used with
any individual with a hearing disability. The points of the continuum range from entirely auditorily presented and received information to entirely visually presented and received information. Controversy exists as to the “best” mode of communication for children with cochlear implants.

(Chute & Nevins, 2006, p. 140). From this continuum, three major potential communication modes are established for presentation to individuals learning language with cochlear implants: oral communication (communication presented verbally and received auditorily without visual input), sign communication (communication presented visually through sign language), and total (simultaneous) communication (an approach combining the two previously presented modes utilizing auditory information and visual information – facial expressions, signs, gestures) (Gravel & O’Gara, 2003). Oral communication is most often praised by suggesting that with proper amplification, language teaching, and the development of speech abilities will allow
greater communication abilities. Total communication supporters believe that this approach is superior because of the visuo-spatial aspect which will lead to greater academic proficiency (Conner, Hieber, Arts & Zwolan, 2000). Many studies describe an approach somewhere along this continuum with significant differences among approaches. For the purposes of this study, we will examine the three primary categories (oral/auditory, visual/sign, total) and the lack of an empirical consensus as to which mode best supports these individuals.

**Oral Communication versus Total Communication**

A study completed by Conner, Hieber, Arts, and Zwolan (2000), specifically examined receptive and expressive vocabulary development and speech accuracy (specifically consonants) in children with cochlear implants enrolled in either an oral or a total communication (as defined above) educational setting. In an attempt to answer several research questions, including: impact of cochlear implant use on scores over time for consonant-accuracy and vocabulary, differences in communication mode when controlling for specific variables, and impact of age at time of implant on communication mode and scores, the researchers very specifically controlled for variables that may have affected the functioning of the cochlear implant including: age at onset of hearing impairment, age of implantation, residual hearing pre-implantation, type of technology used, and insertion of electrode, oversights they cited from previous research. Using standardized tests (with some being appropriately adjusted for this testing group) to gather results on 147 children, their findings indicate that despite communication mode in their educational setting, the earlier the implantation takes place, the better. Children who receive cochlear implants prior to the age of 5 will have better language outcomes than those who receive their cochlear implants after the age of 5. In addition, for children with normal cognitive
abilities and cochlear implants, language abilities improve across all categories assessed. More specifically, for the purposes of comparison with the current study, the overall finding suggests that children who did receive their implant early and were enrolled in total communication intervention settings, experienced more benefits from their cochlear implants than children who were implanted later in life and were using an oral approach to communication.

Critical evaluation of this research study reveals that interpretation of this information is difficult due to the researchers intense attention to the confounding variables mentioned above. Controlling for each of these variables provides a wealth of information and a solid base for data collection, although this approach makes the results difficult to clearly delineate. The overall question to be interpreted – “which communication mode is better?” – was not clearly defined. Although they controlled for cognitive ability, the authors made no reference to the effect cognitive ability could have on the results. In addition, although the participants in the study were grouped by communication mode, they came from a wide variety of school settings and programs (self-contained, inclusion, fully/partially mainstreamed) potentially affecting their intervention and influencing the results of the study.

The results of another study examining speech intelligibility (as a predictor of language performance) scores for children with cochlear implants contradicted the results from the previously mentioned study. Tobey, Rekart, Buckley, and Geers (2004) conducted a study in which they examined children with cochlear implants in two different education settings (special education, mainstream) with two different communication modes (oral, total), determined through parental questionnaires. Speech intelligibility measures were obtained using ratings from judges who had “virgin ears” to “deaf speech” for 131 congenitally deaf children. The results revealed that students who were fully mainstreamed (placed among hearing peers thus
forcing oral communication) and educated in an oral communication environment were rated with the highest speech intelligibility score. It is suggested that this is due to the emphasis placed on “listening and talking” in their learning environment.

Based on their results, the researchers suggest that communication mode prior to implantation has a great impact on speech intelligibility following implantation. They state that an oral environment, where children with cochlear implants are forced to interact with hearing peers, further increases their speech intelligibility and language growth (for further research presented to support this finding see Geers, Nicholas & Sedey, 2003). Critical evaluation of this research study suggests potential reliability constraints given the methodology (judges listening to speech samples) for intelligibility score attainment. Potential improvements in the acquisition of the speech intelligibility ratings, for example, a more standardized assessment, could increase the reliability of the data obtained.

In support of the results mentioned above, Francis, Koch, Wyatt, and Niparko (1999) obtained similar results. Their study suggests that with increased exposure to learning with the cochlear implant (more time since implantation) and encouragement to communicate using an oral approach, an increased ability to be mainstreamed and a reduction in the need for special education services occurs. With this comes a greater independence in the classroom and continued language growth from increased oral communication settings.

Oral Communication versus Sign Communication

In order to add further interpretation to the controversy over which communication mode is better for children with cochlear implants, Archbold, Nikolopoulos, Tait, O’Donoghue, Lutman & Gregory (2000), completed a study examining speech intelligibility and perception
and the relationship of these factors with communication mode (oral, signed). The researchers examined these factors using standardized assessment both prior to implantation (all subjects were deaf by age 3) and following implantation, at regular intervals. The results of this study indicated that children who used an oral approach to communication performed significantly better when speech perception and intelligibility were measured than children who used a sign or visual approach to communication at each of the specified increments, 36 months, 48 months, and 60 months following implantation.

This study also investigated changes in communication mode, pre and post implantation. Results proved that those children who changed to an oral communication mode from a sign communication mode performed as well as those beginning with oral communication prior to implantation. Some of the participants (those with additional learning disabilities) transferred from oral communication to sign communication and performed much more poorly in outcome testing. Thus, a question this study leaves to be further investigated: “Is it the oral approach that results in better performance?” Or, do “children use oral approaches because of their better performance?” (p. 263). Perhaps a more detailed examination of children who have cognitive difficulties and thus, have poorer performances, which is the topic of this current research discussion, could assist in answering such a question.

Other Factors

When more specifically examining children with cochlear implants, the decision of which communication mode to choose depends on many different factors. According to Gravel and O’Gara (2003), family involvement in the intervention, age of implant, degree of hearing loss, presence of other disabilities, and educational options all may have an impact on the decision of
how to best input language to individuals with cochlear implants. Due to the controversy that exists surrounding communication mode, some educational programs (intervention settings) have been forced to rely more on one mode verses another, making another difficult decision for families of children with these special needs as they become of school-age. The results of this examination of different communication modes reveal that it is not so much the mode chosen that will result in the most positive language outcomes, but family motivation and continual participation in the learning process that will bring the most positive outcome. This article provides generalization across populations including all individuals: children and adults, those wearing different amplification systems, those with cochlear implants, and those with other concomitant difficulties. Further examination of children with cochlear implants and developmental disabilities is important to determine specifically if one communication mode/intervention setting begets better language outcomes.

Language Outcomes in Typical Children with Cochlear Implants

It is important to note the continuing lack of consensus as to which type of environment (oral, sign, total communication) is most beneficial for children with cochlear implants who are attempting to learn both expressive and receptive language. Despite the controversy, as Gravel & O’Gara (2003) state, there is always a desire to communicate. Based on that desire, in combination with the guidelines posted by the Joint Committee on Infant Hearing, there is a responsibility to offer individuals with hearing loss, any assistance and intervention that is available. Cochlear implants have become more widely used over the past 20 years and can be used to provide individuals with profound hearing losses, who may not have had access to spoken speech, a greater chance at hearing and learning language through auditory input (Watson, Archbold & Nikolopoulos, 2006). Investigation, up to this point, has revolved around
the communication mode used in various intervention settings for children with cochlear implants. Placing the debate aside, research had indicated that cochlear implantation leads to increased language outcomes in children. In reviewing literature, it is important to remember that while speech production and perception are important characteristics of an individual’s communication abilities, they are not synonymous with language outcomes. Language must be developed over time with the placement of a cochlear implant; verbal/oral abilities increase with this increase in auditory environmental input (Preisler, Ahlstron & Tvingstedt, 1997). An examination of the impact cochlear implantation has on children’s language can be considered with a brief look at the literature available on the topic.

Nicholas and Geers (2007) examined the spoken language development of children with cochlear implants. This study intended to determine how spoken language development of children with early implantation compared to language development of children without a hearing impairment. It has been determined that the earlier a child can receive a cochlear implant, the more appropriate their language development (Geers, Nicholas & Sedey, 2003; Miyamoto, Houston & Bergeson, 2005; Nicholas & Geers, 2007; O’Donoghue, Nikolopoulos & Archbold, 2000; Watson, Archbold & Nikolopoulos, 2006) due to intervention prior to the development of a significant language delay.

For the purposes of the Nicholas and Geers (2007) study, however, in addition to examining age at time of implantation in greater detail to determine if younger age results in higher spoken language scores even when time of implant is constant, the researchers examined spoken language scores of children with cochlear implants and education provided through an oral communication mode to determine if it was possible for them to reach language scores consistent with those of their hearing peers during their preschool years. To complete this, they
used only children with average cognitive abilities and included a group of 24 typically hearing children and a group of 76 children with cochlear implants. Data were collected both in a naturalistic setting, in the form of a conversational language sample during a semi-structured play session with a parent, as well as with a standardized assessment for the older children. The results suggest that the more experience a child has with an implant, the greater their linguistic scores. In addition, the age at implantation seemed to be of greater importance. The older children in the study (who had received implants at a young age) seemed to achieve language abilities near those of their peers prior to entering kindergarten suggesting that with early implantation, language outcomes can be extremely favorable.

The study completed by Nicholas and Geers (2007), supports evidence previously presented. Oral presentation of communication to a young cochlear implant recipient encourages appropriate language growth, potentially allowing the child to enter into a mainstreamed educational setting which could lead to even greater gains in language. The study was completed using real-life scenarios in play with a preferred adult (parent) communication partner allowing for a more accurate portrayal of the child’s language usage. Thus, this study presents positive spoken language outcomes for children receiving cochlear implants by the age of 24 months.

Prior research presented by Geers, Nicholas & Sedey (2003) concurred that an oral approach to communication in educational settings was the most beneficial to increasing language outcomes for both total and spoken language approaches. For the purposes of this study, the researchers used standardized language testing to compare scores of receptive language, verbal reasoning, narratives, a speech only language sample, and a speech and sign language sample of 8-9 year old children with cochlear implants to the scores of hearing children (all without cognitive impairments) to determine if the individuals with cochlear implants had
achieved “normal” language development, how that development could have been affected by the uniqueness of the child or family, and the effect of communication mode in the classroom on the language development. By examining data from 181 children, it was determined that the ability to obtain language skills similar to hearing peers is present in children with cochlear implants who receive implants prior to the age of 5 and that there are impact factors both of the child (non-verbal intelligence and gender), and their family (size, socio-economic status) that can affect their language outcomes.

Additional research information confirms that cochlear implantation can lead to positive language outcomes. A study by Miyamoto, Houston, and Bergeson (2005) examined newly implanted infants and determined that the infants’ listening abilities emulated those of typically hearing infants. In general, the literature agrees that with better technology, younger age of implantation, and new findings regarding communication mode, the expectations for language outcomes and speech perception and production abilities for children with cochlear implants are increasing. In essence, it is possible for children who initially have a delay and receive a cochlear implant, to “catch up” to their peers with respect to their language use, production, and comprehension.

**Language Outcomes in Children with Developmental Disabilities and Cochlear Implants**

According to Pellegrino (2007), developmental disabilities “are conditions that are first recognized during early childhood as departures from expected patterns of development” (p. 224). Although it is not always exactly clear as to what may cause a child to develop differently, understanding of the patterns of development continues to grow. Cochlear implantation in individuals with developmental disability has been more recently studied.
Conner, Hieber, Arts, and Zwolan (2000), in their study addressing communication setting, stated that an individual’s cognitive ability, which may or may not be affected by a developmental disability, can directly impact their performance with a cochlear implant. Based on the current literature available, no agreement has been reached as to whether a child with multiple disabilities should receive a cochlear implant (Holt & Kirk, 2005). A review of the current literature available reveals the continuing question of language and perception outcomes in children with developmental disabilities and cochlear implants.

It has been determined that children with profound hearing loss often have additional disabilities. Wiley, Meinzen-Derr, and Choo (2004), investigated a group of children with cochlear implants to obtain specific demographic information (communication mode, type of disabilities, outside intervention), and determine specifically how many of these children had a hearing loss co-occurring with another disability. The results revealed that 46% participants had at least one additional disability and that 16% of those had two or more co-occurring disabilities. These results suggest that the decision of cochlear implantation facing almost half of those individuals with profound hearing loss falls on families who are faced with individuals who have additional disabilities. While it has been determined that children with typical cognitive abilities can “catch up” to their hearing peers when implanted early and receiving appropriate intervention, the question exists, what are the language outcomes for the 46% of children with profound sensorineural hearing losses who have additional disabilities potentially affecting their cognitive abilities?

Waltzman, Scalchunes, and Cohen (2000), completed a study in which they attempted to determine what types of gains children with additional disabilities might make with the introduction of a cochlear implant. With all of the literature suggesting that implantation will
allow for greater outcomes if completed earlier in life, questions arise as to implantation of children with additional disabilities. Many additional disabilities are not yet diagnosed at the time children are eligible to receive cochlear implants. The researchers intended to determine what, if any, benefits exists when implanting this population. To complete their research, they examined a group of 31 children with disabilities in addition to their profound hearing loss, assessing their speech perception at various levels (phoneme, word, sentence) using standardized testing to discover possible patterns of development. Although the data obtained were not complete due to difficulty with test completion for some of the participants, the results generally revealed that children with additional disabilities do achieve benefits from a cochlear implant in the areas of “auditory skills, communication skills, social interactions, and a general ‘connectedness’ to the environment” (p. 334). While standardized tests could not measure each of these areas, researcher observations revealed greater awareness and ability to continue to improve attention to the increased auditory input provided by the cochlear implant. These results suggest that although auditory learning may take place more slowly in a child with additional disabilities than that of a child without co-occurring disabilities, benefits to speech perception exist across the population of children receiving cochlear implants. Thus, the authors recommended that guidelines for cochlear implantation include populations with multiple disabilities.

Wiley, Jahnke, Meinzen-Derr, and Choo (2005) conducted a study formulating results that supported those discussed by Waltzman, Scalchunes, and Cohen (2000). These researchers were interested in determining specifically what qualitative benefits parents believed could be attributed to their child receiving a cochlear implant. An interview process involving the families of 22 children with cochlear implants was conducted. The children included in the
study had a variety of developmental disabilities, with and without cognitive involvement. More specifically, the results revealed a greater awareness to sound, greater attention at home, and a greater ability to communicate (whatever the mode). Despite the fact that the participants likely came from families who were more motivated, the results are not meant for the entire population. It can be understood that positive benefits were felt by the families of those children with developmental disabilities and cochlear implants. A universal suggestion is understood within the current literature: more research on this population is needed.

Holt and Kirk (2005) examined a similar population as those previously mentioned, however these researchers were interested in determining more specifically how the benefits of the cochlear implant affected the speech and language skills of those individuals with mild cognitive delays. The researchers compared the scores from several standardized tests (receptive language, expressive language, speech perception) of a group of children with early deafness, cochlear implants and mild cognitive delay, to a group of children with deafness and cochlear implants but without cognitive impairment. These groups were further divided by communication mode; oral or total. In accordance with the other results reported, all children showed gains in language development. All groups showed similar increases in word-recognition abilities. Children with cognitive delays were slower to achieve sentence recognition similar to those children without the cognitive delays and had more difficulty with expressive language and receptive vocabulary, the higher level speech and language skills. As mentioned, this research controlled for cognitive disabilities, in a retrospective fashion causing limitations as to use of the data that had been collected. Future research suggested further examination of the impact of other disabilities, and a definition as to what “benefit” means in discussing the importance of a cochlear implant for populations with developmental disabilities.
Communication Mode/Intervention Setting for Children with Cochlear Implants and Developmental Disabilities

Because of younger age at implantation and the fact that many of the children with developmental disabilities may or may not be diagnosed early, or have indication as to what their speech and language prognosis may be based upon their diagnosis, implantation of this population is still under scrutiny. The literature reviewed above, allows for conclusions to be drawn that implantation of several populations with disabilities does provide for increased auditory input and perceived benefits for children with developmental disabilities. It is not yet understood, however what the best communication mode or intervention setting is appropriate for the population of deaf individuals with cochlear implants and developmental disabilities.

The population in discussion is considerable. According to the Gallaudet Research Institute in their *Regional and National Summary Report of Data from the 2006-2007 Annual Survey of Deaf and Hard of Hearing Children and Youth*, 37,352 students in the nation have a hearing impairment. Almost thirteen percent (12.6%) of the children reflected by this total have received a cochlear implant and 92.2% of those use their implant in the classroom to facilitate their language learning. Of the entire hearing impaired, or deaf, population, 90.9% report receiving some additional support in the classroom but less than half (42.4%) participate in a regular education/mainstreamed setting. These results suggest that while, according to the literature, mainstreaming is beneficial for positively developing language outcomes, the reality of education with the deaf child may be different. It is also important to keep in mind the possible biased data source producing a total count (of children participating in a mainstreamed setting) that may not include those children who are fully mainstreamed.

Specifically, greater investigation into the group of children with developmental disabilities is appropriate. Of the total deaf population included in the Gallaudet summary,
51.4% reported the presence of an additional impairment including at least one of the following: visual impairment, deaf-blindness, developmental delay, specific learning disability, orthopedic impairment, attention deficit disorder, speech or language impairment, traumatic brain injury, mental retardation, emotional disturbance, autism, or other health impaired (multiple responses were allowed). Thus, further investigation into children with cochlear implants and developmental disabilities, and the education setting and communication modes that will best improve their learning outcomes is necessary due to the fact that about half of deaf students are estimated to have at least one other disability besides deafness.

The study conducted by Holt and Kirk (2005) mentioned above, also investigated the differences for the groups with mild cognitive impairments and their communication mode. Differences were discovered. The children with the cognitive delays, more closely resembled the children without cognitive delays who were using an oral approach to communication rather than a total communication approach when considering receptive language skills, thus suggesting that a total communication approach assisted the children without cognitive delays in the area of receptive vocabulary. The researchers also discovered the opposite was true when examining expressive language. The children with cognitive delays compared more closely with the children who used a total communication approach in the venue of expressive language, both with lower scores than those using an oral approach.

Research completed by Wiley, Meinzen-Derr, and Choo (2004), also detailed above, revealed, on average, the more disabilities a child had, the greater the chance they used a total communication approach. The results of Nicholas and Geers’ (2007) study indicated that children who were receiving an oral communication approach to learning, in combination with an early implantation (prior to 24 months) had a greater chance of catching up with their hearing
peers when evaluating spoken language ability. As a result, these children were more likely to enter into a mainstreamed education environment, a finding also supported with the information provided by Tobey, Rekart, Buckley, and Geers, (2004) as a more positive environment for typical children with cochlear implants.

Do the same advantages exist when examining language outcomes for children with developmental disabilities and cochlear implants in specific intervention settings based on mode of communication? The research has yet to determine the answer to this question. This study will attempt to uncover information regarding the type of intervention setting most appropriate to increase language outcomes of children with developmental disabilities.
CHAPTER III:

METHODS

Research investigating typical children with cochlear implants and their language outcomes has been reviewed. Findings reveal that the earlier the implant takes place, the more likely these children are to have language abilities near their same aged hearing peers. In addition, controversy as to the most beneficial communication mode for children following cochlear implantation exists, with no clear empirically supported recommendation. Research examining children with developmental disabilities and cochlear implants exists, although in minimal quantities with unclear language outcome data. Even more meager is the information available evaluating the intervention settings most beneficial for this population. For this reason, the current research study was completed. The research question investigated in this study was: Do intervention settings affect language outcomes for individuals with cochlear implants and developmental disabilities? This chapter will explain the methodology behind the investigation by detailing sample participants, data collection and the procedures that were performed to produce the results.

Definitions

The developmental disabilities included in this study were as follows: motor, cognitive, visual, or a combination of the three. The etiology of the participant’s deafness was due to one of the following: CHARGE syndrome, symptomatic CMV, infection, auditory nerve damage, or unknown causes.

The intervention settings investigated in this study were examined on two levels: mode of communication, and level of educational mainstreaming. The first, mode of communication, was classified as total communication, oral communication, sign communication, or behavior.
As previously discussed, total communication included orally (auditory) presented information as well as sign (visually) presented information, whereas oral communication was limited to oral (auditory) information and sign was limited to visually presented information. The second classification, level of mainstreaming, was categorized as fully mainstreamed, partially mainstreamed, special school, self-contained classroom, or home education.

The language outcomes measured were expressed as scores from the presented standardized testing producing auditory comprehension (receptive language) and expressive communication (expressive language) scores.

Auditory comprehension scores are those scores measuring an individual’s ability to understand language.

Expressive communication scores are those scores measuring an individual’s ability to expressive themselves using verbalizations, gestures, signs, or behaviors.

Developmental quotient was obtained from a developmental pediatrician through administration of the Revised Gesell Developmental Schedules (RGDS, see detailed description below), (Knobloch, H., Stevens, F., & Malone A., 1980), and was expressed as a number to quantify the individual’s developmental level.

As a more accurate measure of language ability, language quotient was derived from and used in addition to the expressive and receptive scores determined from the Preschool Language Scale-4 (PLS-4, see detailed description below), (Zimmerman, I.L., Steiner, V.G. & Pond, R.E., 2002). The PLS-4 provides both norm-referenced test scores, and age-equivalents. The language quotient was derived from the language age obtained on the PLS-4 divided by the chronological age of the child at the time of testing multiplied by 100. The closer to 100 the child’s language quotient was, the more age-appropriate their language was determined to be.
The language quotient was used in an attempt to provide a more accurate marker of the participant’s actual language abilities due to scoring constrictions of the PLS-4.

**Hypotheses**

Based on the results of the literature presented in above, the data available, and the research question for the current study, it was hypothesized that:

1. The children with higher developmental quotients and children who have had their cochlear implants for the longest amount of time would have greatest benefits as reflected by their expressive and receptive language scores on the PLS-4.
2. The children with developmental disability who were using an oral communication approach to education would have increased language outcome scores on the PLS-4.
3. Those children who were placed in a mainstreamed setting would have increased language outcome scores on the PLS-4.

**Data**

This study was part of a larger study investigating language skills following cochlear implantation for deaf children with developmental disabilities. These data were gathered for the research project entitled “Outcomes for Deaf Children with Developmental Disabilities.” Dr. Jareen Meinzen-Derr, the principal investigator, and her team conducted this study to compare matched pairs of deaf children with developmental disabilities and hearing children with the same degree of disability to quantify language outcomes.

The participants were recruited from a clinic site at an inner-city medical center through advertisement in the center’s Division of Developmental and Behavioral Pediatrics and Pediatric Otolaryngology, and the Ear and Hearing Center in the Division of Pediatric Otolaryngology.
Any additional eligible individuals were notified by mail providing them the option of participation in the study. Informed consent forms were signed prior to their participation.

The participants were eligible if they were between the ages of 36 to 72 months and had a diagnosis of an additional disability. The control group consisted of 22 children meeting these eligibility requirements who also had hearing within normal limits. The experimental group consisted of 22 children meeting the requirements who had received a cochlear implant prior to the age of 36 months (mean age - 58 months, mean age of implantation - 27.8 months). The participants consisted of matched pairs based on their chronological age and developmental level and their age at the time of the study. Developmental quotients were determined using the Revised Gesell Developmental Schedule, a standardized test typically used in developmental evaluations, to obtain means for appropriate matching. For the purposes of the current study, only the experimental group, those 22 children with cochlear implants, was considered.

Appointments were scheduled for language assessment through the speech language pathology department in the Division of Developmental and Behavioral Pediatrics. A language assessment was obtained using the Preschool Language Scale – Fourth Edition to evaluate auditory comprehension and expressive language ability. Language evaluations using the PLS-4 were completed by a speech language pathologist. If the participants used sign language to communicate, a sign language interpreter was available to supplement the testing. The addition of signed input provided by the interpreter was only used following an auditory only, verbal presentation of the test items. Both American Sign Language and, when necessary, Conceptually Accurate Signed English were used. Standard scores and age equivalents were obtained from both conditions, verbal only presentation and presentation with supplemental sign.
The PLS-4 was chosen because it provided the researchers with a large age range as it was designed for use with children from birth through 6 years, 11 months of age. In addition, this standardized test allowed for a modified administration for special populations including children with hearing impairments. The accommodation of using an interpreter detailed above was accepted and allowed for use of the norm-referenced test scores (standard scores, percentile ranks, and age equivalents).

The PLS-4 allowed for determination of the child’s receptive and expressive language abilities during assessment through elicited responses occurring in response to a test item, spontaneous responses occurring at another point during the evaluation, and caregiver response if the researcher was not able to assess the test item. Auditory comprehension was determined by investigating skills evident to formulate a strong a foundation for language. Specific skills assessed include: attention to speakers, appropriate play, ability to follow directions, basic vocabulary comprehension, and understanding of increasingly complex grammatical conventions. Expressive communication was determined by investigating skills evident for vocal and social communication. Specific skills assessed include: vocalizations, imitation, use of words and concepts in naming and description, pragmatic language usage, and use of a variety of grammatical conventions with varying lengths of communication. Compilation of this information provided a standard score, a percentile rank, and an age equivalency.

In addition, the Revised Gesell Developmental Schedules, a developmental assessment administered to those undergoing a multi-factored evaluation or being evaluated for a cochlear implant, assessed developmental level for the participants. The Revised Gesell Developmental Schedules assessed: fine and gross motor, adaptive, language, and personal-social skills and abilities. Based on the results of this assessment, the subject’s performance was compared to
others of matching chronological ages to determine their developmental quotient. A determined score of 80 would indicate a “typical” developmental quotient. The participant’s developmental quotient distribution can be seen below in Figure 1.

**Figure 1: Participant Developmental Quotient**

Language quotients, derived from receptive and expressive scores obtained from the PLS-4 using the total communication approach described above, were calculated and examined, in addition to the receptive and expressive scores. From comparing the standard scores obtained by the participants on the receptive and expressive language subtests of the PLS-4 to other children with the same chronological age, age equivalencies for the participant’s language ability were established. These age equivalencies, when divided by the participant’s chronological age, reveal their language quotient. Language quotients were used in analysis as they may be a better
indicator of language ability as will be discussed below. The participant’s developmental
quotients and language quotients can be found below (Table 1).

<table>
<thead>
<tr>
<th>Child</th>
<th>Developmental Quotient</th>
<th>Receptive Language Quotient</th>
<th>Expressive Language Quotient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>75</td>
<td>0.609</td>
<td>0.478</td>
</tr>
<tr>
<td>2</td>
<td>33</td>
<td>0.063</td>
<td>0.1</td>
</tr>
<tr>
<td>3</td>
<td>75</td>
<td>0.636</td>
<td>0.636</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>0.085</td>
<td>0.169</td>
</tr>
<tr>
<td>5</td>
<td>70</td>
<td>0.163</td>
<td>0.184</td>
</tr>
<tr>
<td>6</td>
<td>70</td>
<td>0.457</td>
<td>0.348</td>
</tr>
<tr>
<td>7</td>
<td>--</td>
<td>0.423</td>
<td>0.442</td>
</tr>
<tr>
<td>8</td>
<td>--</td>
<td>0.403</td>
<td>0.423</td>
</tr>
<tr>
<td>9</td>
<td>50</td>
<td>0.388</td>
<td>0.185</td>
</tr>
<tr>
<td>10</td>
<td>30</td>
<td>0.171</td>
<td>0.229</td>
</tr>
<tr>
<td>11</td>
<td>92</td>
<td>1.177</td>
<td>1.089</td>
</tr>
<tr>
<td>12</td>
<td>50</td>
<td>0.357</td>
<td>0.286</td>
</tr>
<tr>
<td>13</td>
<td>46</td>
<td>0.179</td>
<td>0.214</td>
</tr>
<tr>
<td>14</td>
<td>78</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>42</td>
<td>0.091</td>
<td>0.2</td>
</tr>
<tr>
<td>16</td>
<td>50</td>
<td>0.192</td>
<td>0.173</td>
</tr>
<tr>
<td>17</td>
<td>83</td>
<td>0.342</td>
<td>0.605</td>
</tr>
<tr>
<td>18</td>
<td>64</td>
<td>0.163</td>
<td>0.2</td>
</tr>
<tr>
<td>19</td>
<td>115</td>
<td>1.130</td>
<td>1.203</td>
</tr>
<tr>
<td>20</td>
<td>27</td>
<td>0.095</td>
<td>0.176</td>
</tr>
<tr>
<td>21</td>
<td>50</td>
<td>0.070</td>
<td>0.085</td>
</tr>
<tr>
<td>22</td>
<td>33</td>
<td>0.062</td>
<td>0.111</td>
</tr>
</tbody>
</table>

In addition to the language outcome data gathered with the PLS-4, a simple questionnaire
(see Appendix) was administered to the parent or caregiver accompanying the child to the
appointment. Specific relevant demographic data obtained through this survey used for the
purposes of this study included: mode of communication used by the child, the type of
school/day care the child attended, percent of time the child spent in each setting, and additional intervention received by the child. This information, in combination with the data gathered through the standardized testing, provided the necessary information to complete the analysis for this study. The participant’s demographic information can be found below (Table 2).

**Table 2: Participant Demographic Information**

<table>
<thead>
<tr>
<th>Child</th>
<th>Gender</th>
<th>Developmental Disability</th>
<th>Etiology of Hearing Loss</th>
<th>Age at Hearing Loss Identification (in months)</th>
<th>Age of Cochlear Implantation (in months)</th>
<th>Duration Since Cochlear Implantation (in months)</th>
<th>Intervention Setting</th>
<th>Communication Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>CHARGE</td>
<td>CHARGE</td>
<td>0</td>
<td>51.4</td>
<td>17.7</td>
<td>Preschool</td>
<td>Speech, Sign</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>Severe Global Cerebral Palsy (CP)</td>
<td>Enlarged Vestibular Aqueduct (EVA)</td>
<td>15.7</td>
<td>48.9</td>
<td>31.8</td>
<td>Preschool</td>
<td>Sign, Behavior, Sounds</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>Mild Cognitive Delay</td>
<td>Auditory Neuropathy (AN), Premature</td>
<td>6.8</td>
<td>24.3</td>
<td>20.1</td>
<td>Not in school</td>
<td>Speech, Sign</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>Autism Spectrum Disorder</td>
<td>Connexin</td>
<td>25.4</td>
<td>36.4</td>
<td>34.9</td>
<td>Day special, Preschool, Self-Contained</td>
<td>Speech, Sign, Behavior</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>Cognitive Delay</td>
<td>Congenital Cytomegalovirus (CMV)</td>
<td>15.4</td>
<td>20.9</td>
<td>28.7</td>
<td>Preschool, Home Education</td>
<td>Speech, Sign, Behavior</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>Mild Spastic Diplegia, Mild Cognitive Delay</td>
<td>Premature</td>
<td>3.0</td>
<td>36.6</td>
<td>9.9</td>
<td>Day special</td>
<td>Speech, Sign</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>Motor Delay</td>
<td>--</td>
<td>--</td>
<td>23.4</td>
<td>28.8</td>
<td>Preschool, Oral</td>
<td>Speech, Sign, Behavior</td>
</tr>
<tr>
<td>Child</td>
<td>Gender</td>
<td>Developmental Disability</td>
<td>Etiology of Hearing Loss</td>
<td>Age at Hearing Loss Identification (in months)</td>
<td>Age of Cochlear Implantation (in months)</td>
<td>Duration Since Cochlear Implantation (in months)</td>
<td>Intervention Setting</td>
<td>Communication Mode</td>
</tr>
<tr>
<td>-------</td>
<td>--------</td>
<td>--------------------------</td>
<td>--------------------------</td>
<td>----------------------------------------------</td>
<td>------------------------------------------</td>
<td>------------------------------------------------</td>
<td>---------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>Motor Delay</td>
<td>--</td>
<td>--</td>
<td>23.4</td>
<td>28.8</td>
<td>Preschool, Oral</td>
<td>Speech, Sign, Behavior</td>
</tr>
<tr>
<td>9</td>
<td>M</td>
<td>Cognitive, Quadra CP</td>
<td>Group B Streptococcal Meningitis</td>
<td>6.8</td>
<td>40.7</td>
<td>17.1</td>
<td>Home Education</td>
<td>Behavior</td>
</tr>
<tr>
<td>10</td>
<td>F</td>
<td>CHARGE</td>
<td>CHARGE</td>
<td>0</td>
<td>16.6</td>
<td>18.6</td>
<td>Not in school</td>
<td>Sign, Behavior</td>
</tr>
<tr>
<td>11</td>
<td>F</td>
<td>Motor Apraxis</td>
<td>AN</td>
<td>1.0</td>
<td>16.6</td>
<td>29.0</td>
<td>Oral School</td>
<td>Speech</td>
</tr>
<tr>
<td>12</td>
<td>F</td>
<td>CHARGE</td>
<td>CHARGE</td>
<td>0</td>
<td>15.0</td>
<td>13.1</td>
<td>Not in School</td>
<td>Behavior</td>
</tr>
<tr>
<td>13</td>
<td>M</td>
<td>Mild Cognitive Delay</td>
<td>Autosomal Dominant Hereditary, EVA</td>
<td>3.9</td>
<td>30.3</td>
<td>26.6</td>
<td>Preschool</td>
<td>Sign, Behavior</td>
</tr>
<tr>
<td>14</td>
<td>M</td>
<td>Mild Cognitive Delay</td>
<td>Wildervanck Syndrome, Mondini</td>
<td>11.9</td>
<td>--</td>
<td>--</td>
<td>Partially Mainstreamed, Hearing Impaired class</td>
<td>Sign</td>
</tr>
<tr>
<td>15</td>
<td>M</td>
<td>Mild Cognitive Delay</td>
<td>Congenital CMV</td>
<td>3.3</td>
<td>38.1</td>
<td>17.7</td>
<td>Preschool</td>
<td>Behavior</td>
</tr>
<tr>
<td>16</td>
<td>F</td>
<td>CP</td>
<td>Congenital CMV</td>
<td>1.0</td>
<td>13.9</td>
<td>38.5</td>
<td>Preschool, Day special</td>
<td>Behavior, Vision</td>
</tr>
<tr>
<td>17</td>
<td>F</td>
<td>CP</td>
<td>Congenital CMV</td>
<td>1.0</td>
<td>13.8</td>
<td>24.7</td>
<td>Home Education</td>
<td>Speech, Sign, Behavior</td>
</tr>
<tr>
<td>18</td>
<td>M</td>
<td>Cognitive</td>
<td>Congenital CMV</td>
<td>15.1</td>
<td>29.3</td>
<td>51.6</td>
<td>Fully Mainstreamed</td>
<td>Sign, Behavior</td>
</tr>
<tr>
<td>19</td>
<td>F</td>
<td>Ataxic Cerebral Palsy</td>
<td>Viral Encephalitis</td>
<td>11.1</td>
<td>17.3</td>
<td>52.1</td>
<td>Fully Mainstreamed</td>
<td>Speech</td>
</tr>
<tr>
<td>20</td>
<td>F</td>
<td>Severe Cognitive Delay, Deaf/Blind</td>
<td>Infantile Refsums</td>
<td>0</td>
<td>54.1</td>
<td>20.3</td>
<td>Partially Mainstreamed, Self-contained</td>
<td>Behavior</td>
</tr>
<tr>
<td>21</td>
<td>F</td>
<td>CHARGE</td>
<td>CHARGE</td>
<td>4.6</td>
<td>18.3</td>
<td>53.2</td>
<td>Partially Mainstreamed</td>
<td>Sign, Behavior, Gesture</td>
</tr>
<tr>
<td>22</td>
<td>F</td>
<td>CP</td>
<td>Meningitis</td>
<td>2.7</td>
<td>13.5</td>
<td>68.1</td>
<td>Partially Mainstreamed, Self-contained</td>
<td>Behavior</td>
</tr>
</tbody>
</table>
The data gathered included each of the concepts addressed in the hypotheses: developmental disability, developmental quotient, language quotient, receptive and expressive language scores, duration since cochlear implant, communication mode, and intervention setting. Developmental disability was reported by the developmental pediatrician, and expressed by type. Developmental quotient was reflected as a number measured by the Revised Gesell Developmental Schedules with a range of 30-115. Language quotient was reflected as a number determined by dividing equivalent language age (as determined by the results from the PLS) by chronological age. Expressive and receptive language scores were measured and reported as standard scores on the PLS-4 with a range of 50-119. Duration since cochlear implant, communication mode, and intervention setting were determined through parent/caregiver report on the background information questionnaire. The participant’s communication mode and school setting can be seen below in Figures 2 and 3.

**Figure 2: Participant Communication Mode**

![Communication Mode Graph]

- Speech
- Sign
- Behavior
- Other
The various communication modes used by the children involved in the study were provided by the responses in the caregiver questionnaire. Speech was defined as using a verbal means of communicating wants and needs. Sign was defined as using sign language as a means of communicating wants and needs. Behavior was defined as grunting, crying, laughing, or any other non-symbolic means of communicating wants and needs. Other was defined as gestures, vision, and sounds as was detailed and written in by the caregiver completing the questionnaire.

**Figure 3: Participant School Setting**

![Pie chart showing school settings](chart.png)

The specific intervention settings considered in the study were reported by the caregiver in the questionnaire. Specifically, an oral intervention setting, and several total communication settings were observed to gather background information for the purposes of this study. The oral communication intervention setting observed included intense intervention for *typical* children with hearing loss. Some of these children had hearing aids, (unilateral and bilateral), while some used cochlear implants. This educational environment focused on auditory only presentation for learning purposes. The children attending school in this oral environment did not use sign
language, but rather were always encouraged to verbalize, were bombarded with verbally presented information and were expected to make their speech and language as intelligible as possible. Teaching verbal communication is thought to give the students the ability to catch up to their normally hearing peers.

The total communication intervention settings varied between publically funded and privately funded institutions. The private setting observed emphasized that student learning take place in the child’s natural language. This school encouraged children to use the mode of communication most comfortable to them, including: sign language, finger spelling, behavior (gestures, writing, lip reading), speech, etc. Teachers in this environment were well versed in all modes of communication encouraged, and thus, no barriers existed between the student’s and teacher’s modes of communication. It is thought that the ability to communicate freely with others in their learning environment seems to give the students a greater ability to improve their speech and language skills, and thus, become more successful.

The total communication educational environment in a public school environment is more of a necessity. Many of the teachers in this environment do not know sign language, and thus, have a difficult time communicating with individuals with hearing loss. Thus, students who are in typical classes, but who have a hearing loss, often have an interpreter with them in each of their classes to help them comprehend the presented information in their natural language. In addition, they are expected, when appropriate, to participate in the classroom verbally, if possible, or through the interpreter when necessary. Immersing students with hearing loss in the public school environment allows them to be in classes with their typically hearing peers, and thus receive a similar educational experience despite their hearing loss.
Analysis

A quantitative analysis was used to investigate the research question (Field, 2005). In order to statistically analyze these data, the scores resulting from the PLS-4 assessment (auditory comprehension and expressive language) acted as the dependent variable across all three hypotheses. Developmental quotient, duration since implantation, approach to communication (oral communication), educational setting (mainstreamed) served as independent variables.

**Hypothesis 1:** the children with higher developmental quotients and children who have had their cochlear implants for the longest amount of time would have greatest benefits as reflected by their expressive and receptive language scores on the PLS-4. To investigate this hypothesis Spearman’s rank correlation coefficients were obtained for the relevant variables. Given that the data involved a small, non-probability sample it could not be assumed that values on the relevant variables were normally distributed thus this non-parametric procedure was used. The Spearman’s rank correlation first ranks the values on the relevant variables and then computes correlation between the ranks to determine the relationship between variables, including, in this case, developmental quotient, duration since implant, and language benefits inferred from analysis of scores obtained on the PLS-4. Due to the developmental disabilities expressed in the sample, many of the receptive and expressive standard scores obtained from the PLS-4 reached the lower limit of the test with scores of 50. While much of the sample obtained the lowest standard scores, it may not be accurate to state that the language ability of all the participants was equally delayed. Thus, language quotient was also examined in the correlation. Language quotients (calculated using language age and chronological age) served as a more appropriate measure of actual language ability because they were not artificially constrained by an arbitrary lower measurement boundary, as the PLS-4 scores were. Next, a Spearman’s rank
partial correlation was performed to control for the effects of development level, as measured by developmental quotient, in order to isolate the independent effect that the cochlear implant has on language outcomes. Holding developmental quotient constant eliminates effects that are beyond the participant’s already determined low developmental quotients thus allowing a more accurate assessment of the relationship between the two variables (language outcomes and duration since implant).

**Hypothesis 2**: the children with developmental disability who were using an oral communication approach to education would have increased language outcome scores on the PLS-4. To investigate this hypothesis, mean differences were examined for the variables, oral communication, standard scores, and language quotient. Any participant in the data set who used speech as a mode of communication was included in this analysis. Because any relationship determined could be related to developmental quotient, adjusted means, calculated using a generalized linear model, were examined to control for the developmental quotient.

**Hypothesis 3**: those children who were placed in a mainstreamed setting would have increased language outcome scores on the PLS-4. To investigate this hypothesis, a Wilcoxon rank sum test was conducted to examine the difference in medians of the relevant variables (expressive and receptive language outcomes expressed as language quotients of those individuals mainstreamed versus those not mainstreamed). Any participant in the data set who was fully or partially mainstreamed, as noted by the parent/caregiver in the questionnaire and interpreted as necessary by the researcher, was included in this analysis.
CHAPTER IV: 
RESULTS

A quantitative research design approach was used for this study in an attempt to determine the presence of a relationship between language outcome scores as determined by the PLS-4, and duration of cochlear implant, approach to communication, and educational setting for children with developmental disabilities. A review of the literature which is currently focused on children without developmental disabilities was conducted exposing arguments that the earlier the implantation takes place, the better the language outcomes for the child. Controversy continues to exist as to the best type of educational setting for the child, but overall research does reveal advantages in language outcome scores for typically developing children following cochlear implantation. Following the literature review, the methods of the study were discussed, and based on the data and previous literature detailed, hypotheses were proposed. The results of the study are as follows.

Results for hypothesis 1, children with higher developmental quotients and children who have had their cochlear implants for the longest amount of time would have the greatest benefits as reflected by their expressive and receptive language scores on the PLS-4 can be seen in Figures 4-7 and Tables 3 and 4. The Spearman’s rank correlation coefficient was 0.59 for receptive standard score and developmental quotient and was 0.67 for expressive standard score and developmental quotient. Both values were found to be statistically significant at $p < 0.01$. These positive correlations indicate that as developmental quotient increases, receptive and expressive standard scores increase, thus supporting the hypothesis.

Because many of the participants were functioning at a lower developmental quotient, and thus obtained scores at the lower limit on the PLS-4, language quotients were used as a more
accurate measure of language ability. The Spearman’s rank correlation coefficient was 0.64 for receptive language quotient and developmental quotient and was 0.60 for expressive language quotient and developmental quotient. Both values were found to be statistically significant at $p < 0.01$. Consistent with the standard scores, these positive correlations indicate that as developmental quotient increases, receptive and expressive language quotient increase, thus supporting the hypothesis.

The Spearman’s rank correlation coefficient for the correlation between duration since implantation and language scores were -0.09 for receptive and -0.14 for expressive standard scores. Because neither value was found to be statistically significant ($p > 0.01$) however, the data do not substantiate this relationship.

The Spearman’s rank correlation coefficient for duration since implantation and language quotients were -0.36 ($p = 0.11$) for receptive -0.31 ($p = 0.17$) for expressive language quotients. These weak negative correlations may suggest that as duration since implantation increases, receptive and expressive language quotients decrease, thus not supporting the hypothesis. While the probability of error is above the conventional $p < 0.05$ cutoff, and therefore these are not found to be statistically significant findings, results of a potentially significant relationship may be hindered by the small sample size.
Figure 4: Language Outcomes Based on Receptive Language Quotients

Receptive Language Quotients

\[ r = 0.64, \ p = 0.003 \]

Figure 5: Language Outcomes Based on Expressive Language Quotients

Expressive Language Quotients

\[ r = 0.60, \ p = 0.006 \]
Table 3: Spearman Rank Correlation Coefficients

<table>
<thead>
<tr>
<th></th>
<th>Auditory Language Quotient</th>
<th>Expressive Language Quotient</th>
<th>Receptive Standard Score</th>
<th>Expressive Standard Score</th>
<th>Development Quotient</th>
<th>Time Since Implantation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory Language Quotient</td>
<td>1.00</td>
<td>0.88***</td>
<td>0.69***</td>
<td>0.66**</td>
<td>0.64**</td>
<td>-0.36*</td>
</tr>
<tr>
<td>Expressive Language Quotient</td>
<td>-</td>
<td>1.00</td>
<td>0.67***</td>
<td>0.71***</td>
<td>0.60**</td>
<td>-0.31*</td>
</tr>
<tr>
<td>Receptive Standard Score</td>
<td>-</td>
<td>-</td>
<td>1.00</td>
<td>0.71***</td>
<td>0.59**</td>
<td>-0.09</td>
</tr>
<tr>
<td>Expressive Standard Score</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.00</td>
<td>0.67**</td>
<td>-0.14</td>
</tr>
<tr>
<td>Development Quotient</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.00</td>
<td>0.07</td>
</tr>
<tr>
<td>Time Since Implantation</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.00</td>
</tr>
</tbody>
</table>

*N = 21; *p ≤ 0.20, **p ≤ 0.01, ***p ≤ 0.001*

To determine if the impact of duration of implantation on standard scores and language quotients was influenced by the generally low developmental quotients of the participants, Spearman’s rank partial correlation coefficients were determined. Results can be seen in Table 2. The Spearman’s rank partial correlation coefficient (controlling for developmental quotient) for duration since implantation and standard scores were -0.16 for receptive and -0.24 for
expressive standard scores. These weak negative correlations reveal that, without developmental quotient as a variable, as duration since implantation increases, receptive and expressive standard scores decrease, thus not supporting the hypothesis. Because neither value was found to be statistically significant, however the data do not substantiate this relationship.

The Spearman’s rank partial correlation coefficient for duration since implantation and language quotients were -0.62 for receptive and -0.53 for expressive language quotients. Both values were found to be statistically significant at $p < 0.01$. These moderate to strong negative correlations reveal that, even after controlling for developmental quotient, as duration since implantation increases, receptive and expressive language quotients decrease, thus not supporting the hypothesis.

**Figure 6: Receptive Language Outcomes Controlling for Developmental Quotient**
Figure 7: Expressive Language Outcomes Controlling for Developmental Quotient

Expressive Language Quotients (Controlling for Developmental Quotient)

\[ r = -0.53, p = 0.022 \]
### Table 4: Spearman Rank Partial Correlation Coefficients

<table>
<thead>
<tr>
<th></th>
<th>Auditory Language Quotient</th>
<th>Expressive Language Quotient</th>
<th>Receptive Standard Scores</th>
<th>Expressive Standard Scores</th>
<th>Time Since Implantation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auditory Language Quotient</td>
<td>1.00</td>
<td>0.77***</td>
<td>0.58**</td>
<td>0.53*</td>
<td>-0.62**</td>
</tr>
<tr>
<td>Expressive Language Quotient</td>
<td>-</td>
<td>1.00</td>
<td>0.57**</td>
<td>0.66**</td>
<td>-0.53*</td>
</tr>
<tr>
<td>Receptive Standard Scores</td>
<td>-</td>
<td>-</td>
<td>1.00</td>
<td>0.53*</td>
<td>-0.16</td>
</tr>
<tr>
<td>Expressive Standard Scores</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.00</td>
<td>-0.24</td>
</tr>
<tr>
<td>Time Since Implantation</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1.00</td>
</tr>
</tbody>
</table>

$N = 19; *p < 0.05, **p < 0.01, ***p < 0.001$

Results of the hypothesis 2, *the children with developmental disability who were using an oral communication approach to education would have increased language outcome scores on the PLS-4*, can be seen in Table 5 and Table 6. The Generalized linear models were used to compare the mean receptive and expressive standard scores for the participants who use an oral (speech) approach to communication and those who do not use an oral approach to communication while controlling for developmental quotient. The unadjusted mean (standard error) receptive standard score was 66.30 (5.7) for those who used oral communication and 50.64
(5.5) for those who did not use oral communication. While this comparison was not statistically significant ($p = 0.06$) this may be due to the small sample size. Therefore, the difference in means potentially indicates that those who use an oral approach to communication will obtain higher average standard receptive scores, thus potentially supporting the hypothesis.

The mean (standard error) expressive standard score was $67.50 (5.6)$ for those who used oral communication and $50.27 (5.3)$ for those who did not use oral communication. This association was found to be statistically significant ($p = 0.038$). It appears that those individuals who use an oral approach to communication had higher average expressive standard scores, thus supporting the hypothesis.

To eliminate the possibility that any relationship seen between the variables was related to developmental quotient (a confounding relationship), adjusted means on the variables were determined. The adjusted (standard error) mean receptive standard score was $50.43 (8.0)$ for those who used oral communication and $65.14 (6.3)$ for those who did not use oral communication. Although the association was not statistically significant ($p = 0.26$) the relationship between receptive standard scores and oral communication approach appeared to be somewhat confounded by developmental quotient, thus not supporting the hypothesis.

The adjusted mean expressive standard score was $51.54 (7.4)$ for those who used oral communication and $65.0 (5.8)$ for those who did not use oral communication. The association was not found to be statistically significant ($p = 0.26$) and as with receptive standard scores, appeared to be partially confounded by developmental quotient, thus not supporting the hypothesis.
Table 5: General Linear Model Unadjusted and Adjusted Means for Standard Scores

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unadjusted Mean</th>
<th>Standard Error</th>
<th>H0: μ₁ = μ₂</th>
<th>Adjusted Mean</th>
<th>Standard Error</th>
<th>H0: μ₁ = μ₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receptive Standard Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Oral Communication</td>
<td>66.30</td>
<td>5.72</td>
<td>p = 0.0622</td>
<td>50.43</td>
<td>8.04</td>
<td>p = 0.26</td>
</tr>
<tr>
<td>• No Oral Communication</td>
<td>50.63</td>
<td>5.45</td>
<td>-</td>
<td>65.14</td>
<td>6.28</td>
<td>-</td>
</tr>
<tr>
<td>Expressive Standard Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Oral Communication</td>
<td>67.50</td>
<td>5.57</td>
<td>p = 0.0375</td>
<td>51.54</td>
<td>7.41</td>
<td>p = 0.27</td>
</tr>
<tr>
<td>• No Oral Communication</td>
<td>50.27</td>
<td>5.32</td>
<td>-</td>
<td>65.06</td>
<td>5.79</td>
<td>-</td>
</tr>
</tbody>
</table>

Unadjusted Mean, N = 2; Adjusted Mean, N = 19

Means for language quotients were also determined as a more accurate measure of language ability. The unadjusted mean receptive language quotient was 53.78 for those who used oral communication and 16.29 for those who did not use oral communication (p = 0.004). Based on the unadjusted means, it appears that those who use an oral approach to communication obtained higher receptive language quotients, thus supporting the hypothesis.

The unadjusted mean expressive language quotient was 55.28 for those who used oral communication and 17.54 for those who did not use oral communication (p = 0.002). Consistent with receptive language quotients, it appears that those who use an oral approach to communication obtained higher expressive language quotients, thus supporting the hypothesis.
The adjusted mean receptive language quotient was 28.22 for those who used oral communication and 37.16 for those who did not use oral communication. This association was not statistically significant. These results indicate that there is no evidence that the difference in receptive language quotients obtained is related to the use of oral communication when controlling for developmental quotient, thus not supporting the hypothesis.

The adjusted mean expressive language quotient was 30.03 for those who used oral communication and 38.11 for those who did not use oral communication. Again, this association was not statistically significant. There appears to be no evidence that the difference in expressive language quotients obtained is related to the use of oral communication when controlling for developmental quotient, thus not supporting the hypothesis.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unadjusted Mean</th>
<th>Standard Error</th>
<th>( H_0: \mu_1 = \mu_2 )</th>
<th>Adjusted Mean</th>
<th>Standard Error</th>
<th>( H_0: \mu_1 = \mu_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Receptive Language Quotient</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral Communication</td>
<td>53.78</td>
<td>8.24</td>
<td>( p = 0.0038 )</td>
<td>28.22</td>
<td>12.36</td>
<td>( p = 0.65 )</td>
</tr>
<tr>
<td>No Oral Communication</td>
<td>16.29</td>
<td>7.86</td>
<td>-</td>
<td>37.16</td>
<td>9.65</td>
<td>-</td>
</tr>
<tr>
<td><strong>Expressive Language Quotient</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oral Communication</td>
<td>55.28</td>
<td>7.58</td>
<td>( p = 0.0019 )</td>
<td>30.03</td>
<td>10.86</td>
<td>( p = 0.64 )</td>
</tr>
<tr>
<td>No Oral Communication</td>
<td>17.54</td>
<td>7.23</td>
<td>-</td>
<td>38.11</td>
<td>8.48</td>
<td>-</td>
</tr>
</tbody>
</table>

Unadjusted Mean, \( N = 2 \); Adjusted Mean, \( N = 19 \)
Results for hypothesis 3, those children who were placed in a mainstreamed setting would have increased language outcome scores on the PLS-4 can be seen in Table 7 and Table 8. A Wilcoxon rank sum was used to determine if there was a difference in receptive and expressive standard scores between two independent groups, those participants who were placed (fully or partially) in a mainstreamed setting and those who were not placed in a mainstream setting. Children who were in a mainstreamed setting (mean score = 11.0) did not seem to differ in receptive standard scores from children who were not in a mainstreamed setting (mean score = 11.0), $W_s = 55.0$, not significant.

Children who were in a mainstreamed setting (mean score = 10.6) did not seem to differ in expressive standard scores from children who were not in a mainstreamed setting (mean score = 11.13), $W_s = 53.0$, not significant.

### Table 7: Wilcoxon rank sums for Standard Scores

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Median</th>
<th>Range</th>
<th>W</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receptive Standard Scores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mainstreamed</td>
<td>5</td>
<td>50</td>
<td>50 - 115</td>
<td>55.0</td>
<td>1.0</td>
</tr>
<tr>
<td>- Not Mainstreamed</td>
<td>16</td>
<td>50</td>
<td>50 - 113</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Expressive Standard Scores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Mainstreamed</td>
<td>5</td>
<td>50</td>
<td>50 - 119</td>
<td>53.0</td>
<td>0.88</td>
</tr>
<tr>
<td>- Not Mainstreamed</td>
<td>16</td>
<td>50</td>
<td>50 - 107</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Wilcoxon rank sum test was also conducted using language quotients as a more accurate measure of language ability. Children who were in a mainstreamed setting (mean score = 7.4) did not seem to differ in receptive language quotient from children who were not in a mainstreamed setting (mean score = 12.13), $W_s = 37.0$, not significant.

Children who were in a mainstreamed setting (mean score = 8.4) did not seem to differ in expressive language quotient from children who were not in a mainstreamed setting (mean score = 11.81), $W_s = 42.0$, not significant.

Table 8: Wilcoxon rank sums for Language Quotients

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Median</th>
<th>Range</th>
<th>W</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Receptive Language Quotient</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mainstreamed</td>
<td>5</td>
<td>0.09</td>
<td>0.06 – 1.13</td>
<td>37.0</td>
<td>0.14</td>
</tr>
<tr>
<td>Not Mainstreamed</td>
<td>16</td>
<td>0.34</td>
<td>0.06 – 1.17</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Expressive Language Quotient</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mainstreamed</td>
<td>5</td>
<td>0.18</td>
<td>0.08 – 1.20</td>
<td>42.0</td>
<td>0.30</td>
</tr>
<tr>
<td>Not Mainstreamed</td>
<td>16</td>
<td>0.23</td>
<td>0.10 – 1.09</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
CHAPTER V:
DISCUSSION

The purpose of this study was to examine receptive and expressive language outcomes of children with developmental disabilities who have a cochlear implant and determine what type of relationship (if any) existed between the language outcomes and the participant’s duration since implantation, communication approach, and educational setting. The results of the study suggest that the higher the individual’s developmental quotient, the higher their language abilities as measured by the standard scores and language quotients determined by the PLS-4. When examining duration since implantation, however, the results suggest that a potentially significant relationship exists in that the greater the duration since implantation, the lower the participant’s language outcome as measured by the language quotient. Thus, the results support hypothesis 1 until the developmental quotient, as a variable, is controlled. In doing this, no support exists for the first hypothesis. The results suggest that as duration since implantation increases, language quotients actually decrease.

When specifically investigating intervention settings by examining communication approach and mainstreaming, little support for hypothesis 2 or 3 was found. Prior to adjusting for developmental quotient, language outcomes were higher for participants who used oral communication and thus, hypothesis 2 was supported. These results were commensurate with previous literature examining children without additional disabilities. Nicholas and Geers (2007) suggested that increased language growth is seen with oral communication and Geers, Nicholas & Sedey (2003) suggested that an oral environment would be most beneficial for language outcomes (both receptive and expressive using oral and sign communication.) The increased language growth resulting from an oral environment was thought, with typical children with
hearing loss, to in turn increase the child’s chances of being more successful in a fully mainstreamed educational setting (Nicholas & Geers, 2007).

When controlling for developmental quotient however, no evidence was found to support language outcomes and their relation to one communication approach (hypothesis 2). While the claim mentioned above from previous literature supported the oral environment for increased language development, those researchers also stated that intelligence, gender, and family involvement may also affect language outcomes (Geers, Nicholas & Sedey, 2003). Conner, Hieber, Arts, and Zwolan (2000) agree that an individual’s cognitive ability can directly impact the outcome performance of their cochlear implant. The results of the current study, then suggest that any exposure to language using any mode of communication will facilitate the language outcome; concluding that no one specific mode is more beneficial than another.

No evidence was found to support a mainstreamed environment as a factor positively impacting language outcomes (hypothesis 3). While Francis, et al. (2008) looked at the cost benefits of mainstreaming children, they state that, with typical children with hearing loss, increased use of and intervention with the cochlear implant leads to greater chances of being placed in a mainstreamed educational setting. Greater success in such an environment gives the students greater educational independence leading to better academic outcomes. “Children with longer experience in mainstream classrooms tended to have better language (p. 56S)” according to Geers, Nicholas & Sedey (2003) who also investigated typical children. Francis, et al. (2008) believe that with children who have severe hearing impairments, however, mainstreaming may do a disservice to the child’s language development due to their lack of access to auditory input. When children with severe hearing loss obtain cochlear implants, is mainstreaming the best route for increased language development? From the results of the current study it can be concluded
that the best environment for beneficial language outcomes depends not only on the presence of a cochlear implant, but also on the many other factors in the child’s environment including, but not limited to, his or her disability, the family, and the educational professionals involved.

As expected and reported above, children with higher developmental quotients performed better on language outcome measures. When educational setting and communication mode were examined, however, the general conclusions that may be drawn indicate no clear indication that a mainstreamed educational setting or oral approach to communication produces better language outcome scores for children with developmental disabilities. Thus, it is imperative that decisions as to what is best for each child’s language development be assessed on a case by case basis. A detailed examination of the types of goals the family has for the child’s language development will assist in determining the best educational setting and communication mode for that child. To investigate the family’s perspective it is important to know the answers to these questions: would the caregivers like their child to be verbal or use a multi-modal means of communication? How can we, as professionals, best assist them in reaching their communication goals?

The degree to which decisive conclusions may be drawn from these results could be influenced by the data available for the study. These data included many variables which were not isolated and controlled. Thus, the results require that these additional variables be considered to determine the best mode of communication and educational setting for the child and to isolate the variables affecting language. It is important to investigate: the communication mode used at home, the degree to which the school is involved in the child’s language development, additional interventions being received at school, additional supports available at home and the degree of family involvement. Although the authors did not conduct research on children with developmental disabilities, but rather typical children with hearing loss, the results of the current
study support those determined by Gavel and O’Gara (2003). These authors note that “family participation potentially has more impact on language development than age of identification, intervention, and degree of hearing loss. Thus, an ongoing process that empowers parents, considers family dynamics, and continually evaluates the changing needs of the child appears to be the best means of ensuring the development of optimal communication in children with hearing loss (p. 250).”

As we know for typical children with hearing loss, previous research has stated that prevention of the development of a significant language delay can occur with earlier cochlear implantation and thus, the earlier the implantation takes place, the more appropriate the language development of the child (Geers, Nicholas & Sedey, 2003; Miyamoto, Houston & Bergeson, 2005; Nicholas & Geers, 2007; O’Donoghue, Nikolopoulos & Archbold, 2000; Watson, Archbold & Nikolopoulos, 2006). In addition, Nicholas and Geers (2007), suggest that the longer the duration of the implant, the better the language outcomes. Children with developmental disabilities, however, depending on the type and degree of disability, likely will not make as much progress with intensive intervention as a typical child with a hearing loss. As suggested by Dettman, et al. (2004), children who have additional cognitive disabilities, “may not be able to process, analyze, and organize information as effectively” as children who do not have additional disabilities accompanying their hearing loss. While Miyamoto, Houston, and Bergeson (2005) suggest that it is possible for individuals who initially have a delay to catch-up with implantation, it is important to realize that while implanting children with developmental disabilities as early as possible may be beneficial, these children are at risk for an increased pre-implant delay due to their concomitant disabilities. Thus, as suggested by the results of the current study, because learning takes place more slowly, it appears that children with additional
disabilities continue to gradually fall further behind post-implant, and not catch-up, while their typically developing peers who receive an implant early in life have that ability to catch up to their normally hearing peers. It is important to remember that when investigating language outcomes, there is so little that can be measured at any one time. For example, the PLS-4 used in the current study, has a language progression. As a result, anything that is measurable may appear to be negative because it appears that these children are getting further and further behind. While they may be making gains in their language development, because of the natural progression of the test, their progress is not appropriately measured. Thus, the results of this study reveal that language quotient decreases as duration since implant increases, and as a result, no conclusions can be drawn to support hypothesis 1 that the longer children with developmental disabilities have their implant, the better their language outcomes.

While the language outcome benefits of cochlear implantation with a population of children with hearing loss and developmental disabilities are not as apparent as those seen with children without concomitant disabilities, it is extremely important to consider any additional outcome benefits that may occur for children with developmental disabilities following implantation. As suggested in the literature review, children with developmental disabilities do receive additional benefits including increased auditory and communication skills as well as social interaction benefits (Waltzman, Scalchunes & Cohen, 2000). More specifically, it has been found that with motivated family interactions, these children are more aware of environmental sounds, and have increased attention at home (Wiley, Jahnke, Meinzen-Derr & Choo, 2005). According to caregivers, additional benefits, not yet studied, may also be present following a cochlear implant including an increased quality of life, greater participation in daily activities, positive behavioral benefits, or an increased level of arousal/awareness.
A longitudinal study of children who are implanted and have additional disabilities is warranted to determine whether families who note initial gains in language ability continue to see benefits while the child ages and their communication and educational challenges become more obvious.
CHAPTER VI: CONCLUSIONS

While the results of this study neither delineate the use of oral communication as superior, nor find a mainstreamed environment as more beneficial for language outcomes for children with developmental disabilities who have received a cochlear implant, yet instead the results reveal that children with developmental disabilities who have received cochlear implants may not hold the same ability as typical children with hearing loss have to catch up with their peers in language skills following implantation. Thus, it is important to realize the necessity of individualizing each case. The question remains: should we implant children with developmental disabilities? With the already researched benefits, and suggestions for future research to further investigate beneficial outcomes, it remains a case by case decision. While differences in educational environment and communication mode may not positively or negatively impact the language outcomes as it was considered, additional benefits may be present based on these variables (type of communication and educational environment). Implantation in these children may in fact prove to be more beneficial when factors other than language outcomes are considered. Home environment, degree of family involvement, and the presence and type of additional interventions may help to determine the true benefits of the cochlear implant. Parental communication goals must also be considered and long term study of this population is needed to determine how attitudes and uses of the implant may change as the child ages.

Limitations

There were several potential limitations present in this study. The small sample size may have overshadowed significant differences between the different groups based on
communication mode and educational environment. This limitation may have been further impacted by the great amount of variability in the sample. Those participants included varied by: age, developmental quotient, age at diagnosis of hearing loss, etiology of hearing loss, mode of communication, age at implant, single or dual implantation, length of time since implant, developmental diagnosis and thus, developmental issues, educational environment, presence of additional interventions, and family motivation and involvement.

In addition to the small sample size, many of the variables represented in the data were not controlled in this study. Mode of communication at home, specific communication environment at school, additional interventions at home or at school and family involvement were all determined through the caregiver questionnaire. Controlling some of these variables may have allowed for more significant relationships to be determined.

The PLS-4 was used as the language outcome measure in this investigation. As mentioned above, due to the developmental disabilities expressed in the sample, many of the receptive and expressive standard scores obtained from the PLS-4 reached the lower limit of the test with scores of 50. While much of the sample obtained the lowest standard scores, it may not be accurate to state that the language ability of all the participants was equally delayed. Language quotient was examined in the correlation in an attempt to overcome this limitation; however questions are still present as to what differences a more sensitive test measure might uncover.

The data utilized were gathered using a cross sectional design. Thus, effects of the cochlear implant on the participant’s language outcomes over time could not be assessed. As mentioned previously, this limitation leaves questions as to changes in language outcomes as the
child matures, is exposed to more language, spends more time in various educational settings, and has more experience using the implant.

**Clinical Relevance**

The results of this study contribute to the small amount of already existing literature investigating language outcomes of children with developmental disabilities who have received a cochlear implant. Investigation of intervention settings and communication modes for this population had not yet been examined. Due to the limitations noted, however, results of this study lacking statistical significance may have overshadowed the potential of true relationships. Clinical differences may have been reached, thus further study is warranted to determine the nature of the relationships among the variables investigated.

**Directions for Future Research**

Several suggestions for future research emerge from this study. A larger sample size with less variability may allow for more specific conclusions to be drawn as to how language outcomes are affected for individuals with different types of developmental disabilities. Controlling for some of the variables mentioned may allow for patterns to emerge with language development for cochlear implants received at specific ages. In addition, future research should investigate the impact of additional interventions on this population to determine how their language outcomes compare.

In order to further decrease the impact of variability, future research should limit the research participants to specific developmental quotient criteria, or specific disabilities groups. In doing so, individuals with differing degrees of cognitive disabilities could be examined next to their peers, and thus, more specific language outcome data could be obtained.
As discussed earlier, there are many benefits to cochlear implantation for children with developmental disabilities, and it is necessary to more specifically further investigate these additional beneficial outcomes. Such benefits, not related to language outcomes, could be behavioral changes, increased level of arousal, quality of life benefits, greater productivity, or additional benefits as assessed by caregiver. Knowledge of these benefits may allow parents and caregivers to make more informed decisions about providing their child with a cochlear implant.

In future studies, elimination of the artificial lower boundary (created by the limits of the PLS-4), that may mask important language differences among participants with more significant language difficulties could more accurately assess language ability. With a more sensitive test measure qualified practitioners could subjectively assess subtle degrees of ability to give more accurate language assessments. Videotaping such an assessment might allow for a more detailed evaluation, and re-evaluation, of these subtle language growth areas. It is also important to consider that decontextualized standardized tests are known to be difficult for children with hearing loss (with or without additional disabilities), and thus this more dynamic assessment of communication might also be considered (Kretschmer, 2004).

Finally, future researchers should consider a panel study that might answer questions regarding the impact of implantation on language outcomes over time. Longitudinal research may provide insight into if language benefits eventually occur, yet take more time to become measurable because of the presence of the additional developmental/cognitive disability.
REFERENCES


APPENDIX

Background information about your child

1. What is your child’s gender?
   _____Male    _____Female

2. Child’s date of birth:  ___________________________
   month/day/year

3. What is your child’s race: (please check all that apply):
   ___African-American/Black
   ___American Indian or Alaskan Native
   ___Caucasian/White
   ___Hispanic/Latino
   ___Hawaiian/Pacific Islander
   ___Unknown
   ___Other (specify)__________________________

4. Please indicate how your child communicates (check all that apply):
   ___Speech   ___Signing   ___ Behavior   _____ Other (please specify)_____________

   Please circle the category that best describes the type of school or day care your child
   attends (circle all that apply).

Circle the percent of your child’s school day that is spent in each of the schools.

   _____ My child does not attend school
   Fully mainstream  1-25%  25-50%  51-74%  75-100%
   Partially mainstream  1-25%  25-50%  51-74%  75-100%
   Day special school  1-25%  25-50%  51-74%  75-100%
   Preschool disabilities  1-25%  25-50%  51-74%  75-100%
   Self-contained  1-25%  25-50%  51-74%  75-100%
   classroom
   Ohio Valley Voices  1-25%  25-50%  51-74%  75-100%
   St. Rita School for the  1-25%  25-50%  51-74%  75-100%
   Deaf
   Home education  1-25%  25-50%  51-74%  75-100%
   Other (please specify) _________  1-25%  25-50%  51-74%  75-100%
If your child has a cochlear implant, does he/she use interpreter services at school?

___Yes  ____No

Please indicate how often (i.e. 1 hour/week, 1 hour/month) does your child receive the following therapies at each of the locations below (check all that apply):

<table>
<thead>
<tr>
<th>Therapy</th>
<th>School</th>
<th>Private agency</th>
<th>Home based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speech therapy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupational therapy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical therapy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behavioral psychologist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vision Specialist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aural Rehabilitation</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Background information about yourself

1. What is your gender?

_____Male  _____Female

2. Please indicate which category describes your relationship to your child.

_____Mother/Stepmother  _____Father/Stepfather  ____Grandparent

_____Other (Please specify)  __________________________________

3. What is the highest grade or level of school you have completed?

__8th grade or less  
__Some high school  
__High school graduate/high school degree (GED)  
__Some college or technical school  
__Completed college  
__Post graduate training/degree
4. How many siblings does your child have? _____

5. Which category best describes your annual household income before taxes?

   ___ Under $10,000
   ___ Between $10,000 and $19,000
   ___ Between $20,000 and $29,000
   ___ Between $30,000 and $39,000
   ___ Between $40,000 and $49,000
   ___ Between $50,000 and $59,000
   ___ Between $60,000 and $69,000
   ___ Between $70,000 and $79,000
   ___ $80,000 or more

6. Which of the following best describes your child’s main source of health insurance?

   ___ Private health insurance provided by a commercial carrier (such as an HMO or PPO)
   ___ Public health insurance (such as Medicaid, Medicaid HMO, or BCMH)
   ___ A combination of Private and Public
   ___ No health insurance