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The goal of the present study was to compare the conversational language skills and interactions of four children who were d/hh and who received cochlear implants (CI) prior to the age of four years with four typically hearing peers matched for age, gender, teacher perceived language ability, and race. This exploratory, descriptive study was completed employing a quantitative design.

There were no statistically significant differences for the mean child vocalization counts (CVC), adult word counts (AWC), or conversational turn counts (CTC) between the kindergarten children using bilateral CIs and their typically hearing matched peers. The only measure for which the data indicated a statistically significant difference between the kindergarten students was for the estimated mean length of utterance (MLU) for the female dyad. Overall, the results of this study indicate the two kindergarten children using CIs demonstrated language and vocabulary development commensurate with their typically hearing matched peers.

Within the preschool dyads, there were no statistically significant differences in either dyad for CVC or MLU. The results of this study indicated there was a statistically significant difference in AWC between the two preschool dyads. It is not possible to draw cause/effect relationships based on statistically significant differences obtained from descriptive statistics; however, a difference between the AWC of the two teachers was noted.

The exploration of the conversational language skills of young children using CIs provided an opportunity to examine the effect of early cochlear implantation on the use of conversational language strategies with adults in the children's environments. Using quantitative methods to describe the relationship between the conversational language skills of young children using CIs and their typically hearing matched peers provided for the creation of a richer profile of the possibilities for intervention as well as language skills development and use of children implanted early in life. The small sample size in this study, four dyads, does not allow for generalization of the results from dyad to dyad or the larger population; however, it does suggest that cochlear implantation early in life with appropriate early intervention and conversational exchanges with others may significantly increase a child's potential to develop age appropriate conversational language.

COMMUNICATION SKILLS OF YOUNG CHILDREN IMPLANTED PRIOR TO FOUR YEARS OF AGE COMPARED TO TYPICALLY HEARING MATCHED PEERS

by

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Approved by

Dr. Judith A. Niemeyer
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This dissertation is dedicated to my parents, Joseph Francis and the late Muriel Faasse Lakawicz, who taught me the importance of education, and to my children, Matthew Jude and Danielle Nicole Losh who showed me why it should be special.

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Overview and Rationale

This research study begins with a review of the research that currently exists and documents the fact that since the National Institutes of Health Consensus Development Conference of March 1993 recommended Universal Newborn Hearing Screening (UNHS) for all newborns prior to hospital discharge, there have been over 24,000 babies identified annually in need of follow-up audiological assessment and intervention in the United States. Presently, 43 of the 50 United States have statutes or regulatory language related to UNHS. As the numbers of infants identified with hearing losses increases, so does the need for appropriate assessment, early invention, and family support services. (National Center for Hearing Assessment and Management, NCHAM, 2009). Immediacy in identification of hearing loss is imperative due to the nature of language development as well as the possibility of lifelong deficits in speech and language acquisition and use, academic performance, personal-social competence, and emotional difficulties without appropriate intervention (Cunningham, Cox, & Committee, 2003).

Recognizing that approximately 90% of the children who are consequently identified as being deaf or hard of hearing (d/hh) are born to hearing parents (Marshark, 2003; Mitchell & Karchmer, 2004), there is a significant need for accurate information regarding hearing loss, emotional support, and strategies for developing and using language. Cochlear implantation is a twenty-first century technology and strategy for providing young children who are d/hh with access to audition; thereby facilitating their acquisition of listening and spoken language. Cochlear implantation is an invasive strategy which requires major surgery to implant the electrode array into the child's cochlea as well as implanting the sound receiver/stimulator and magnet unit (also referred to as the internal coil) in the mastoid bone allowing for a connection with the external microphone/receiver and transmission coil. Thus, cochlear implantation is an invasive procedure for which the need must be thoroughly investigated and documented by families and medical professionals prior to surgical implementation. Pre-implantation investigation does not ensure success; however, it does ensure that children do not undergo unnecessary surgeries and that families understand the follow-up commitment necessary to facilitate successful use of the cochlear implant.

Research indicates that young children who receive cochlear implants (CI) prior to two years of age have the potential to develop receptive and expressive language and vocabulary skills at levels commensurate with their hearing peers (Brinton, 2001; Geers, Brenner, & Davidson, 2003; Moeller, 2000; Stredler-Brown, 1998; Yoshinago-Itano, 2004; Yoshinago-Itano, Sedey, Coulter, & Mehl, 1998). Additionally, the body of research documents that speech perception and production skills alone may not be sufficient to ensure communicative competence (DesJardin, Eisenberg, & Hodapp, 2006). Yoshinaga-Itano (2004) investigated the effectiveness of UNHS in Colorado by using a variety of statistical designs and discovered that regardless of the study sample size, all participants demonstrated positive developmental outcomes when provided early intervention opportunities during the first six months of life. The findings of Connor, Craig, Raudenbush, Heavner, and Zwolan (2006) provide further support of early intervention. They investigated the value of early implantation opposed to length of time using a CI and found that children who receive CIs prior to two years, six months of age seem to demonstrate substantially better speech and vocabulary outcomes than children implanted later in life.

The pioneer efforts of Yoshinago-Itano, Svirsky, Miyamoto and their research teams have documented the benefits of early detection, intervention, and cochlear implantation in the development of language of young children. Fryauf-Bertschy, Tyler, Kelsay, Gantz, and Woodworth (1997) found that consistent CI use early in life significantly improved the speech perception abilities of their study participants. In a study of 78 children who received CIs prior to the age of five years, Kirk et al. (2002) discovered that regardless of communication mode, children implanted prior to the age of three years appeared to acquire early receptive language skills at a rate commensurate with their typically hearing peers.

While a significant body of research exists to support the benefits of early cochlear implantation in young children in terms of the potential to develop age-appropriate receptive and expressive speech and language skills, there is a paucity of information available regarding the children's functional use of those skills for conversational purposes. Specifically, there is minimal research to support the interaction between development of such age-expected receptive and expressive language and vocabulary skills and the functional use of those skills during spontaneous conversational interactions of young children with CIs with their hearing peers. The current study was designed to begin addressing how the receptive and expressive language skills of young children implanted early in life meet the social conversational demands of meaningful communication with their hearing peers.

Purpose of Study and Research Questions

The overall purpose of this study was to compare the conversational language skills and interactions of children who were congenitally deaf or severely and profoundly hard of hearing and who received CIs prior to the age of four years with the conversational language skills of typically hearing peers matched for age, gender, race, and teacher perceived language ability. Specifically, the questions regarding functional communication skills addressed in this study are (a) does the child vocalization count differ between the two children in each dyad, (b) does the adult word count directed to the children differ between the two children in each dyad, (c) does the number of conversational turns differ between the two children in each dyad, and (d) does the mean length of utterance differ between the two children in each dyad.

The use of categorical data, also known as frequency data or qualitative data, allowed for a comprehensible system for describing these communicative behaviors in numerical terms (Howell, 2002). In other words, the conversational skills of child vocalization, adult word, and conversational turn counts as well as the mean length of utterance for each child involved in the study can be described by numbers for comparison. For example, "Child one produced 621.5 vocalizations/verbalizations and child two produced 790.0 vocalizations/verbalizations."

The Language Environment Analysis (LENA) system composed of digital recorders to collect data and software to analyze the data obtained was used to collect and analyze the data discussed in this study. Each dyad was observed in a classroom setting, for a minimum of four and maximum of nine hours. Recording sessions occurred during the center based learning opportunities in two general education kindergarten classrooms, one self-contained preschool classroom for children who were d/hh, and one inclusive preschool classroom. Focal children and foils were asked to wear the digital recorders in cloth pocket necklaces or vests; foils were used so the classroom teachers would not know which children were being actively recorded. Recorded data were downloaded and analyzed using the LENA software, which provided frequency count information of child vocalizations/verbalizations, adult word, and conversational turn counts. The computer analysis also provided a mean length of utterance for each child recorded during each session.

The sample size of this study was small and did not lend itself to an inferential statistical analysis; however, it did allow for a detailed description of the data obtained in relation to the participants involved in the study. For this reason, independent samples *t*-test comparisons were made within each dyad for the number of verbalizations/ vocalizations produced by each child, the number of conversational turns engaged in by each child, the mean length of utterances produced by each child, and the number of adult words spoken to each child. There was no statistically significant difference for the mean child vocalization/verbalization, adult word, or conversational turn counts between the kindergarten students using CIs and their typically hearing matched peers. The only measure for which the kindergarten dyads indicated a statistically significant difference was in the comparison of mean length of utterance for one of the two dyads studied. The preschool dyads did not exhibit any statistically significant differences for child vocalization/verbalization count or mean length of utterance. There was a statistically significant difference in the conversational turn counts between the child using CIs and his typically hearing matched peer for one preschool dyad. Logistically, it was necessary to observe the preschool children using CIs in a self-contained classroom and the typically hearing matched peers in an inclusive classroom. There was a statistically significant difference in the adult words spoken to the children using CIs and their typically hearing matched peers.

The results of the current study suggest that the kindergarten children who received cochlear implants prior to the age of two years developed and used receptive and expressive language skills at the same levels as their typically hearing matched peers in conversational exchanges with others in a classroom setting. The statistically significant differences in the adult words spoken to the preschool children who received CIs between the age of two years, six months and three years and their typically hearing matched peers is noteworthy; however, the fact that the data were collected in two different classroom settings is important to consider. The statistically significant difference in adult word counts in the two different settings suggests that further study is necessary to investigate the communicative behaviors of adults in self-contained and inclusive classrooms to determine the effect of classroom setting on the language skills development of young children using CIs.

Theoretical Framework

Bloom and Lahey (1978) identify three components of specific skills necessary for developing language: semantics (content and meaning), syntax and morphology (form), and pragmatics (use). Semantics describes the content and meaning of language, which includes the specific words and concepts used when communicating ideas to others. To develop semantic skills, a user must be able to experience the relationship between recognizing an object, action, or idea and the recognizing the word for the same (e.g. realizing that the fruit from the apple tree is called an apple, not an orange.) Syntax, commonly known as grammar, is the sequential ordering of words for communicating meaning (e.g. “That car is blue” as opposed to “Car is that blue”) and also involves morphology, the different forms words take in relation to verb tense and plurality (e.g. the difference between walk and walked or house and houses). Pragmatics is the functional use of language that conveys thoughts and ideas to others. This integration of the three dimensions allows for the use of spoken language as a tool for facilitating effective communication in natural situations with others.

Effective communication, is a tool used by individuals to convey thoughts, desires, and needs to and with others, and addresses engagement with familiar and unfamiliar others. Wood and Wood (1991) refer to such interactions as conversation and define it operationally as two or more individuals discussing events, experiences, people, or happenings that have, are, or will occur at other times or places. By this definition, conversation is an active process that involves a relationship between the participants, and is not simply a description of objects. Beaty (2009) referred to conversation as social discourse and defined it as an individual's ability to initiate and maintain dialogue with communicative partners over several conversation turns.

When interacting with all others, an effective communicator must rely on the use of overtly trained skills as well as covertly learned skills. Overtly trained skills of vocabulary, sentence structure, and grammar are clearly related to the specific language skills of semantics and syntax. As is evident in all of human tradition, the content or meaning of what a society considers necessary for survival is taught and rehearsed with new members so clear understanding and use is apparent. Covertly learned skills related to pragmatics or the use of language, specifically navigating communication interactions in terms of taking turns, remaining engaged with others on a mutual agreed upon topic, understanding tone of voice, and use of body language are equally important for effective communicators; however, society leaves the learning of such useful language aspects to observation and happenstance.

It is at the connection point between overtly trained and covertly learned skills that this researcher believes any individual, and particularly those with compromised sensory systems may encounter difficulty in becoming effective communicators. As explained in this section, effective language is built around three elements: syntax, semantics and pragmatics. Research supports the potential for young children implanted early to develop age appropriate syntax and semantic skills; there is little empirical evidence to support or refute the potential of young children using CIs to use those skills pragmatically at the same levels as their typically hearing peers. The current study was designed to explore if differences exist in the conversational (pragmatic) language skills of young children born d/hh and using CIs when compared with the conversational language skills of their peers with typical hearing.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Over 24,000 babies annually have been identified in need of follow-up audiological assessment and intervention as a direct result of Universal Newborn Hearing Screening procedures since the National Institutes of Health Consensus Development Conference recommended screening all babies for hearing loss prior to being discharged from the hospital in March 1993 (NCHAM, 2009). House bill H.R. 1198: Early Hearing Detection and Intervention (EHDI) Act of 2008 sponsored by Representative Lois Capps (D-CA23) was approved by U. S. House of Representatives on April 8, 2008 and would have extended the efforts of EHDI; however, the U. S. Senate failed to pass the bill (GovTrack.us, 2010). While such national legislation would have identified more children with congenital hearing losses as well as emphasize linking screening programs with diagnosis, family support, and early intervention services (Darcy & Potter, 2008), EHDI efforts are still evident at the individual state level.

Presently, 43 of the 50 United States have statutes or regulatory language related to UNHS. Currently, Alabama, Idaho, Michigan, North Dakota, South Dakota, Vermont, and Washington are the states without official legislation or regulations addressing UNHS. Of the 43 states with such legislation, 80% of them approved such legislation after 1998, most likely due to publication of major articles providing empirical results regarding the feasibility and benefits of implementing large scale UNHS programs. Additionally, 67% of the states implementing UNHS programs require hospitals to report data obtained to the state's departments of health, consistent with the view of UNHS as a public health program. Such efforts, while not following a national standard, are in fact increasing the numbers of young children identified with congenital hearing losses or deafness (NCHAM, 2009).

As the numbers of infants identified with hearing losses increases, so does the need for appropriate assessment, early intervention, and family support services. Immediacy in identification of hearing loss is imperative due to the nature of language development as well as the possibility of lifelong deficits in speech and language acquisition and use, academic performance, personal-social competence, and emotional difficulties without appropriate intervention (Cunningham et al., 2003). Evidence supporting early-in-life use of listening and the development of auditory perception as a means through which a child with a hearing loss can acquire spoken language reveals the following key findings: (a) the majority of children with hearing loss have useful residual hearing (Boothroyd, 1992); (b) when properly aided or implanted, children with hearing loss can detect most, if not all of the acoustic spectrum (Gabbard & Schryer, 2003; Houston, Ying, Pisoni, & Kirk, 2003; Pediatric Work Group, 1996); and (c) in the absence of stimulation, the neurological features of auditory pathways deteriorate (Luterman, 2006).

Early identification of hearing losses allows pediatric audiologists to fit young children with appropriate amplification and make referrals to necessary specialists so the use of audible signals and information can be maximized. Such early identification can facilitate the development and maintenance of aural/oral communication for learning and social-emotional development. Early fitting of hearing aids ensures the acoustic features of speech are received within a safe and comfortable intensity range as well as allows audiologists and otolaryngologists the opportunity to determine whether young children would benefit from cochlear implantation (Joint Committee on Infant Hearing, 2007; Pediatric Work Group, 1996).

Recognizing that approximately 90% of the children who are consequently identified as being deaf or hard of hearing (d/hh) are born to hearing parents (Marshark, 2003; Mitchell & Karchmer, 2004), there is a significant need for accurate information regarding hearing loss, emotional support, and strategies for developing and using language. Cochlear implantation is a twenty-first century technology and strategy for providing young children who are d/hh with access to audition; thereby facilitating their acquisition of listening and spoken language. Cochlear implantation is an invasive strategy which requires major surgery to implant the electrode array into the child's cochlea as well as implanting the sound receiver/stimulator and magnet unit (also referred to as the internal coil) in the mastoid bone allowing for a connection with the external microphone/receiver and transmission coil. Thus, cochlear implantation is an invasive procedure for which the need must be thoroughly investigated and documented by families and medical professionals prior to surgical implementation. Pre-implantation investigation does not ensure success; however, it does ensure that children do not undergo unnecessary surgeries and that families understand the follow-up commitment necessary to facilitate successful use of the cochlear implant.

This review of the literature is designed to provide an understanding of the CI process and how it facilitates the development of receptive and expressive spoken language skills in young children who are d/hh. It begins with a history of Universal Newborn Screening (UNHS), its implementation, outcomes, and how it impacts early intervention. It is followed by a discussion of CIs, including the history of implant development, how they work, candidacy for receiving an implant, and expected outcomes. This literature review will also include a discussion of the complex, family-driven decision-making process surrounding the implantation of young children. Empirical evidence regarding post-implant vocabulary and language development will be discussed, with a comparison of findings for children with implants and those with normal hearing. The comparison of language development between the two groups of children will lead into a discussion of social competence. The final section discusses a conceptual framework of language use which clearly illustrates the importance of actively using learned language skills for the purpose of communicating effectively with others on a routine basis.

Universal New Born Hearing Screening (UNHS)

Screening for congenital conditions such as cleft palate, Down's Syndrome, spina bifida, sickle cell anemia, and phenylketonuria (PKU) have become standard care procedures in birthing hospitals; yet the incidence of hearing loss in infants significantly outnumbers those conditions and UNHS occurs in only 43 states (NCHAM, 2009). This situation began receiving legislative attention in 1988 with the Commission on the Education of the Deaf Issues toward Equality report that recommended federal government implementation of initiatives in individual states to reduce the age of identification of children with hearing loss. This recommendation was included as a goal in the Healthy People 2000 report published in 1990 and was reaffirmed in March 1993 as part of the National Institutes of Health (NIH) Consensus Development Panel recommendation supporting a UNHS program in the United States. Although when the U.S. Preventive Services Task Force concluded with minimal evidence to support UNHS programs, EHDI programs legislation was passed in 1999, in part, because of efforts by New York Congressman, James Walsh. As a result of this legislative support of UNHS programs, fifty-three states and territories have received federal funding to develop EHDI programs. To date, 43 states have legislation related to newborn hearing screening programs and twenty-eight require universal screening of all babies (NCHAM, 2009).

Legislation alone has not ensured implementation of UNHS programs. Myriad barriers to implementation include: cost of screening equipment, hospital administration opposition to the program, ability of hospital staff to conduct the screenings, occurrence of home births, inadequate third party reimbursement, shortage of pediatric audiologists, and insufficient physician knowledge of the program and its effectiveness (Kerschner et al., 2004; White, 2003). In addition to such measurable barriers, there is a question of functional outcomes of UNHS.

The current UNHS begins as part of the medical and health system, but the final outcome of the program is dependent on the educational system (Yoshinaga-Itano, 2004).

While UNHS alone does not result in improved outcomes, it does allow for earlier initiation of evaluation and intervention which can capitalize on early brain development, facilitate early identification of hearing loss or deafness, and support families in the decision-making process surrounding amplification or implantation and communication mode to support positive child and family outcomes (DiPietro, 2000).

Although identification of effective strategies for positive outcomes must be determined on an individual basis, there are six general goals that need to be ascribed to by any EHDI program regardless of existing barriers: (a) screening must occur for all newborns prior to one month of age; (b) diagnosis must occur no later than three months of age; (c) once identified with a hearing loss, children should be enrolled in an early intervention program prior to six months of age; (d) EHDI services need to be coordinated by the child's medical home provider; (e) EHDI programs need to implement systematic data management and tracking systems to ensure that all identified children receive the services needed; and (f) information about hearing loss and early intervention needs to be provided to parents in easy to understand terms and in the families' primary language (Cook, Klein, Tessier, & Daly, 2004; NCHAM, 2009; White, 2003, 2005; Yoshinaga-Itano, 2004).

According to the 2006 data collected by the NCHAM (2009) from the state EHDI coordinators, 95.7% of all children born in the 50 states and the District of Columbia were screened within one month of birth for possible hearing loss; this is a dramatic increase from 70% reported in 2003 by White. This figure should be expected to increase in the future as a result of action taken by the U. S. Preventive Services Task Force

(USPSTF) in which it revised its recommendation for routine screening of newborns for bilateral congenital hearing loss by upgrading it from a rating of “I,” indicating insufficient evidence to recommend for or against a procedure, to a rating of “B,” which means there is at least fair evidence that the screening improves health outcomes and its benefits outweigh potential risks. (U. S. Preventive Services Task Force, 2008).

The goal of establishing a diagnosis no later than three months of age for children identified with a hearing loss through UNHS procedures is difficult to achieve because of the variance in newborn hearing screening protocols. Hospitals utilizing a one-stage protocol are more effective than those employing a two-stage protocol, but neither situation ensures diagnostic follow-up by the family once the child leaves the hospital (White, 2003). Additionally, it is difficult to ensure that every eligible child is enrolled in an early intervention program prior to six months of age, because successful completion of this goal is dependent upon availability of services, qualified intervention staff, and interpretation of individual state definitions of children who are eligible to receive Part C services. (Cook et al., 2004; White, 2003; Yoshinaga-Itano, 2004). Coordination of EHDI services by the child’s medical home provider is believed to support the completion of both goals, but requires that physicians and other medical providers become more knowledgeable about hearing loss and available services (White, 2003, 2005) as well as implementation of a systematic data management and tracking systems to ensure that all identified children receive the services needed (White, 2003).

In addition to defining program goals, it is necessary to define the purpose of universal newborn screenings as this will determine the success of intended outcomes.

Currently, purposes of various UNHS programs include: insuring optimal developmental outcomes for the child, earlier identification of hearing loss, earlier initiation of intervention, early access to communication and language development services, and early access to hearing (Yoshinaga-Itano, 2004).

Cochlear Implants

Historical Context

Hearing instrument technology had its humble beginnings when humans learned that they could modify the way sound was perceived by simply cupping their hands behind their ears and over time has moved through distinct phases of development, beginning with this mechanical phase and ending with the current integration of digital processing for improving the receipt of auditory information (Vonlanthen, 2000). Although strategies for improving the receipt of auditory information were implemented for hundreds of years, it was the plight of World War II veterans with noise induced hearing losses that provided the impetus for developing truly functional amplification devices. The success of adults using such devices prompted the use of hearing aids with children presenting with mild-to-moderate hearing losses. The search for better hearing instrument technology, ultimately resulted in the development of the cochlear implant (Chute & Nevins, 2006).

Similar to a hearing aid, a cochlear implant (CI) is a tool for increasing an individual’s access to auditory input; however, cochlear implants differ from hearing aids in the way that input is delivered. Hearing aids amplify the existing acoustical signal but cochlear implants change the acoustic signal into an electronic one that stimulates the auditory nerve to provide the recipient with an awareness of sounds (DesJardin et al., 2006). This electronic stimulation is achieved by the transmission of sound from the external speech processor and transmission coil to the electrode array surgically implanted in the cochlea. As the electrode array is activated, it stimulates the nerve endings in the auditory nerve, which is ultimately interpreted as sound. Thus, a CI provides opportunities for improved speech and hearing communication abilities for individuals with severe to profound sensorineural hearing losses (Luterman, 2006; Vonlanthen, 2000).

The first CI devices introduced in the early 1980s allowed recipients to detect environmental sounds and a wide range of tonal signals that afforded them access to conversational speech. This access allowed CI users to detect speech as well as process timing and intensity cues to assist them in speech reading; however, understanding of speech via the implant alone was not possible due to the single electrode technology used at that time (Chute & Nevins, 2006). Continued experimentation with the number and positioning of the electrodes resulted in the discovery that an increase in the number of electrode sites within the cochlea improved an individual's speech performance. In the 1980s, Cochlear Corporation, known today as Cochlear Americas, used this finding to create a multiple channel/electrode device called the Nucleus Cochlear Implant system, which allowed 40% of its adult recipients to understand spoken speech augmented with speech reading. The approval of this system by the Food and Drug Administration (FDA) in the United States ushered in the era of functional cochlear implants.

Pediatric implantation, began in the 1980s, and increased significantly due to technological advances in the decade between 1980 and 1990. Cochlear Americas' introduction of the Nucleus-22 implant in 1990 was the first system to receive FDA approval for use with children. In 1993, Advanced Bionics Corporation, formerly Minimed Technologies, began clinical investigations leading to the production of the Clarion system that received FDA approval for use with children in 1993. Med El introduced the Combi 40+ system in 1997. Another surge in CI technology was realized in 1998 when Cochlear Americas introduced the first behind-the-ear unit making the bulky, externally worn body processors obsolete (Chute & Nevins, 2006; Thoutenhoofd et al., 2005).

At the present time, only the three manufacturers previously mentioned, Advanced Bionics Corporation, Cochlear Americas, and MedEl produce the CIs used in the United States with the decision of the model to be used made by the surgeon and the audiologist based on the equipment and expertise available at the implantation center as well as consideration of third party reimbursement. Each system has unique qualities that are considered based on recipient need; however, in general, regardless of manufacturer, the systems operate quite similarly, and all consist of an external speech processor and transmission coil, as well as an internal receiver/stimulator and an electrode array.

Candidacy for Cochlear Implantation

As discussed in the historical context, adults have been receiving CIs for several decades; however, implantation of children, particularly teenagers, only began in the 1980s. The successful implantation and consequent speech and language outcomes of adolescents and older children (Clark et al., 1987; Fryauf-Bertschy, Tyler, Kelsay, & Gantz, 1992), the 1990s ushered in the use of CIs with children younger than two years of age. The team-based candidacy assessment is usually conducted at the medical center where the implant will be completed and involves the physician, audiologist, speech-language pathologist, psychologist, educator, and family. This assessment includes medical and radiological evaluations to determine overall health and anatomy of the ear and cochlea, audiological assessment to confirm the degree of hearing loss, speech-language assessments to document speech, language and communication proficiency prior to implantation, and psychological evaluation (Fryauf-Bertschy et al., 1992).

Currently, in the United States, children of one year of age are considered candidates for CIs if they demonstrate: (a) presence of severe to profound hearing loss, (b) limited benefit from hearing aids after a four to six month trial, and (c) adequate cochlear structure to receive the electrode array. Additional factors to be considered include: (a) the duration of deafness, (b) the age at time of implantation, (c) the presence of a formal language system, (d) the educational environment, (e) familial support and expectations, and (f) availability of professional support to the recipient and family (Advanced Bionics, n. d., Cochlear Americas, n. d., Chute & Nevins, 2006; Luterman, 2006; MedEl, n. d.).

Current CI candidates can demonstrate varying levels of cognitive delays and deficits (Edwards, Frost, & Witham, 2006; Kirk, Firszt, Hood, & Holt, 2006) providing the CI team is prepared to familiarize itself with the additional disabilities of the recipient, family needs and concerns, and intensity of the subsequent rehabilitation efforts

(Quaranta, Bartoli, & Quaranta, 2004). It is widely agreed that the level of the cognitive delay is a significant factor in determining the recipients' success with using the CI (Pratt, 2005); however, there is disagreement regarding whether the potential outcomes sufficiently outweigh the surgical and emotional risks of cochlear implantation (Edwards et al., 2006). While available studies conducted on small sample sizes (Hamzavi et al., 2000; Holt & Kirk, 2005; Kirk et al., 2006; Pyman, Blamey, Lacy, Clark, & Dowell, 2000; Waltzman, Scalchunes, & Cohen, 2000) suggest children with cognitive disabilities benefit from sound awareness, detection, and use of aural/oral communication by using a CI, it is evident that further research into the magnitude of the benefits is needed (Edwards et al., 2006; Quaranta et al., 2004).

Cochlear Implant Operations

CIs are hearing devices that are composed of two external and two internal components. The external components include the speech processor and the transmission coil; the internal components include the receiver/stimulator, also referred to as the internal coil that includes a magnet, and the electrode array. Generally speaking, the battery powered speech processor allows sound to enter the system through the microphone. The acoustical sound is then converted to a series of electrical pulses and signals that are delivered to the external transmission coil. The external transmission coil is secured in place by the magnetic connection between internal and external magnets and is responsible for transmitting the electrical pulses and signals to the internal receiver/stimulator coil and eventually the electrode array. Once the signals are received at the level of the electrode array, they stimulate the nerve endings in the recipient's auditory nerve and are interpreted as sound by the recipient. Initially, the received sound has minimal meaning to the recipient, but continued exposure and intensive auditory training allows the recipient to develop meaningful sound associations (Chute & Nevins, 2006; Luterman, 2006; Vonlanthen, 2000).

When a child is determined to be an appropriate candidate for a CI, family counseling is provided and informed consent obtained. Surgery is scheduled and the internal components of the device are implanted in the mastoid bone (the area of bone just behind the ear) by the surgeon who makes a two-inch incision and removes a small circular area of bone, large enough to tolerate the internal coil. The electrode array is inserted in the cochlea with the low frequency electrodes placed at the apex of the cochlea and the high frequency electrodes placed at the base of the cochlea to simulate natural cochlear function.

CI surgery is typically conducted as same day surgery with families educated in monitoring the site for signs of possible infection, facial nerve injury, anesthesia complications, and leakage of spinal fluid prior to taking the child home (Chute & Nevins, 2006). Following a healing period of two to four weeks, the audiologist attaches the external components to the internal components via the magnetic connection. Once the connection between the external components (speech processor and transmission coil) and the internal components (receiver/stimulator which includes the magnet and electrode array) is made, the implant can be turned on, or activated. Once this connection is made, and the CI is turned on, it is fully operational and a comfortable volume level can be established.

At the time of the activation, the audiologist is actually turning on the device for the first time and is setting an initial volume level that will comfortably allow the recipient to begin receiving auditory input by electrical stimulation of the cochlea. Oftentimes, when working with young children, this is conducted by a team of audiologists working together. One audiologist operates the test equipment outside the audiological booth while the second audiologist sits in the booth with the child and his/her caregiver and charts all of the child's behavioral responses. Together, the audiologists decide what stimuli to present at specific volume levels, so they are able to obtain the most accurate picture of the child's responses. In an ideal situation, both audiologists are sensitive to input from the caregiver and use that input to adjust the volume levels. This initial activation, which can be described as analogous to being in a very dark room into which bright light is suddenly introduced, can be somewhat scary for the children because they may never have had prior access to auditory information and are unsure of what they are experiencing. For this reason, it is recommended that overall stimulation be kept to a minimum and that the child's caregiver(s) be present. As the child becomes comfortable with receiving auditory input, an initial volume level can be set. This volume level will be used by the child for the first month or so after the implantation and is the first step in the mapping, or fitting process.

The goal of the mapping process is to properly adjust the device to ensure that the optimal signal is delivered to the recipient's auditory nerve and it must be completed using the hardware and software specific to the implant model and manufacturer. The mapping process is usually completed using computer software programs that require no visible or physical response by the recipient. The initial activation can be an intimidating experience for a young child; therefore, the mapping process is completed over a period of one year.

The mapping process allows the recipient time to adjust to what sound is, how it is used, and how the volume of sounds changes. Traditionally, the audiologist accomplishes this by meeting with the child and family for the activation appointment, and then a one-month, three-month, six-month, and one-year post implant. After the one-year post CI evaluation appointment, the recipient should be seen annually by the audiologist to determine the efficacy of the system. Such an incremental time frame for mapping the device allows the recipient to perceive sound, make sense of it, and increase volume settings as tolerated. In addition, mapping over time accounts for the recipient's increased awareness, understanding, and increased use of auditory input developed through exposure and auditory habilitation (Chute & Nevins, 2006; Luterman, 2006; Thoutenhoofd et al., 2005).

Once the CI is surgically implanted, properly mapped and being used consistently, it is necessary to maintain the device and conduct routine, daily checks to ensure the device is functioning properly. Daily maintenance checks can be conducted by family members and/or educational professionals. While there are specific differences in conducting maintenance checks based on particular devices, general areas to be addressed include: visually assessing the transmitting cable for proper placement, connection, and repair; confirming the processing unit is turned on, the batteries are functional, the sensitivity setting is at the recommended level and the microphone is responding to sound input. The final step in the routine maintenance check is to ensure the child is able to process the input received. In very young children, this is accomplished by observing their reactions to sound input once the unit is turned on; usually, older children are asked to repeat the Ling Six Sounds of /m, oo, ah, ee, sh, s/ while the speaker obstructs direct access to his/her mouth (Carolina Children's Communicative Disorders Program [CCCDP], 2008). Any inaccuracies are recorded and the child is given another opportunity to repeat the sound. Consistent difficulties require a follow-up with the audiologist and other CI team members as necessary (Advanced Bionics, n. d.; Cochlear Americas, n. d; MedEl, n. d.).

Complications of Cochlear Implantation

Daily maintenance checks are the first line of defense to ensure that the CI device is functioning properly. When necessary, troubleshooting efforts of replacing transmission cables, replacing batteries, adjusting sensitivity settings, or repairing other minor malfunctions are conducted by the family or CI team professional without significant effort, time, or expense (Advanced Bionics, n. d.; CCCDP, 2008; Cochlear Americas, n. d.; MedEl, n. d.). Most devices function reliably for the duration of the warranty (usually ten years); however, there are situations that require more intensive evaluation and in less than 10% of cases, possible re-implantation of the CI. The most common reasons for re-implantation in young children include: internal device failure, infection of tissue surrounding the internal device, and device upgrades (Goycoolea & The Latin American Cochlear Implant Group, 2005; Kumar, Mugge, & Lipner, 1999; Ohno et al., 2007; Raine et al., 2004).

The CI device is an electrical-mechanical device and is always subject to internal failure that cannot be accounted for by any other factors. In a study by Goycoolea and the Latin American Cochlear Implant Group (2005) it was determined that device failure occurred less than 3% of the time in the cases they studied, supporting the fact that CI devices are reliable. It must be understood that young children are more susceptible to internal device failure as a result of physical growth and their activity level (Ohno et al., 2007). While it is next to impossible to avoid mechanical failure as a result of physical maturation, it is possible to avoid failures caused by activity by having the child use a helmet when engaged in physical activity (Goycoolea & The Latin American Cochlear Implant Group, 2005).

Individuals receiving CIs are at increased risk for bacterial meningitis and it is highly recommended that they be vaccinated against streptococcus pneumoniae and hamemophilus influenzae type b, the two most common causes of the disease (Bjerklie, 2003; University of North Carolina at Chapel Hill Department of Otolaryngology, Head, and Neck Surgery, 2006). Since vaccinations do not completely eliminate the possibility of contracting the disease, families of young children who receive CI should be diligent in monitoring the child for any type of middle ear or general infection and obtaining the necessary medical intervention (UNC-CH Department of Otolaryngology, Head, and Neck Surgery, 2006). In addition to bacterial infections, CI recipients are susceptible to irritation and infection of the tissue around the internal device and the surgery incision site, as well as the external components. Surgical flap infections have been reported in fewer than 3% of all cases (Kumar et al., 1999). Other surgical complications include:

post implant acute otitis media, persistent middle ear effusion, facial nerve damage, temporary vertigo, tinnitus, and cerebrospinal fluid leak (Niparko & Blankenhorn, 2003; UNC-CH Department of Otolaryngology, Head, and Neck Surgery, 2006).

Device upgrades account for less than 1% of CI reimplantation, and are usually conducted at the discretion of the recipient (Raine et al., 2004). During the past decade, the incidence of bilateral implantation has increased to 3% of the implanted population world-wide (Shafer, 2007). Johnston, Durieux-Smith, Angus, O'Connor, and Fitzpatrick (2009) completed a critical review of available research on bilateral cochlear implantation in an effort to determine the efficacy and benefit of this trend with young children and determined that while bilateral cochlear implant recipients demonstrate improvements in sound localization and speech recognition in noise, the magnitude of such improvements appears to be greater for children implanted early in life and with abbreviated gaps between surgeries. Presently, there is no definitive empirical evidence addressing the longer-term outcomes of speech, language, and quality of life improvements. Regardless of the cause of re-implantation or multiple surgeries to accommodate bilateral implantation, in most cases, such procedures are safe and technically sound, facilitating improved audiological function for the recipients (Goycoolea, & The Latin American Cochlear Implant Group, 2005).

Auditory Habilitation Considerations

Mapping and activation of the CI are followed by auditory and language-communication training, as the recipient needs to learn how to attach meaning to the electrical signals now perceived by the auditory pathway and transmitted to the brain

(CCCDP, 2008; Easterbrooks & Estes, 2007; Wilkins & Ertmer, 2002). Intervention with very young children is most productive if it includes strategies that address needs in all communication situations the children will encounter on a daily basis such as home, school, and community settings and should encompass activities to facilitate development of auditory attention, recognizing sounds and objects that make sounds, sound localization, proper inflection, and vocabulary development and use (Bader, 1999; Guiberson, 2005). Although specific intervention practices will vary by clinician and client/family need, the general areas included in any auditory/language-communication facilitation intervention program include: (a) developing perceptual-oral skills, (b) maximizing listening to spoken language, and (c) utilizing appropriate wait time (Bader, 1999; Watkins, 2004).

Perceptual-oral skills facilitate attention to spoken language, its use, and include two main categories: joint attention and suprasegmental speech features, such as, parameters of pitch, intonation, volume, duration, and rhythm (Ling, 1988). Joint attention is the process in which the caregiver (professional or parent) and child are focused on the same activity (Watt, Wetherby, & Shumway, 2006). In the case of young children who are d/hh and who use CIs to facilitate development of spoken language, joint attention is focused on awareness and use of sound. One method for accomplishing this is by frequently pointing out naturally occurring environmental and conversational speech sounds to the child. While doing so, it is essential that the caregiver talk to the child at an optimal distance no less than six inches and no more than three feet from the microphone of the child's CI. This distance can be represented by the space between the caregiver or communication partner and child while they are sitting shoulder to shoulder (six inches apart) or holding hands and walking together (three feet apart). It is also imperative that the caregiver speaks to the child on a plane level with the microphone (Bader, 1999). This means that the caregiver should communicate with the child at his/her eye level, since the microphone is generally located behind the ear. As the caregiver establishes and maintains eye contact with the child, the auditory and spoken language input are delivered at the same level as the microphone, reducing the possibility of unwanted signal distortion (Bader, 1999; Moore & Teagle, 2002).

Maximization of listening is accomplished through parallel talking, labeling and answering, repeating, and expanding the child's verbal utterances (Bader, 1999; Peterson, 2004; Warren & Yoder, 1997). Parallel talking is used by the caregiver to surround the child in a spoken language environment. At this stage, the adult describes everything that occurs in the child's environment in much the same way a radio announcer describes a sporting event. Although the caregiver may feel somewhat uncomfortable with providing the ongoing verbal description of activity, it is essential as the child makes a mental connection between words, verbalization, and activity (Bader, 1999; Girolametto, Weitzman, & Greenburg, 2006). Frequent verbal descriptions of activities provided by the caregiver allow opportunities for the child to develop labeling and answering skills. The child's ability to label objects, actions, and events is instrumental for developing semantic knowledge as well as learning turn-taking skills (Bloom & Lahey, 1978; Girolametto et al., 2006). The mand-modeling process described by Peterson (2004) directly relates to the process of repeating and expanding upon the child's spontaneous spoken language attempts. Once a child begins making attempts to use spoken language to communicate with others, the caregiver repeats the child's utterance and adds slightly more linguistic content to it. This utterance reiteration reinforces the child's early speech approximations, offers opportunities for the caregiver to model the desired verbal output, and allows children with hearing loss to make a connection between the speech of others and their own speech efforts.

Language and Communication Training Options

Prediction variables of age at the time of identification of the hearing loss, the degree of hearing loss, age at the onset of intervention and implantation, and exposure to spoken language all significantly influence the language outcomes of young children who receive CIs (Compton, Niemeyer, & Shroyer, 2004). Of the myriad prediction variables, it appears that parental use of language, responsiveness to the child's use of language, and the quality of such responsiveness are more important predictors that the quantity of family involvement (DesJardin, 2006; DesJardin et al., 2006). While family involvement is identified as a key predictor in successful outcomes for young children with CIs, most studies focus on maternal behaviors, particularly communication skills. A study by Calderon (2000) specifically investigated the affect of maternal communication skills on the language development of young children with hearing loss and through regression analysis found that for the twenty-eight subjects in the study, 15.7% of the variance in Preschool Language Scale-3 (PLS-3) scores could be explained by maternal communication skill.

Even with parental/family support and strong maternal communication skills, children with CIs require intense auditory training, speech training and therapy to develop strong receptive and expressive language skills (Ertmer, 2002a; Wilkins & Ertmer, 2002). Auditory-oral (AO) and Auditory-verbal (AV) are two similar intervention approaches that facilitate a child's acquisition of language via auditory access to linguistic input. The major premise of these two approaches is to emphasize the future independence of children who are d/hh so they are prepared to live and work in a hearing society (Alexander Graham Bell Association for the Deaf and Hard of Hearing, n. d.; Gravel & O'Gara, 2003). The AO approach excludes the use of sign language or any formalized manual communication system; however, the use of vision as a supplement in comprehending language via speech-reading is encouraged. Historically, AO programs focus on helping children develop language and academic skills to facilitate their interaction in inclusive educational settings. The AV approach has featured parents and teacher/therapists working together and in one-on-one therapy sessions that focus the child's attention on listening to language without relying on visual input. In AV teaching, teacher/therapists and /or parents sit behind or beside the child, or cover their mouths to assist the child in using amplified or implanted hearing. Both AO and AV strategies are approaches to facilitating spoken language and listening, and support concrete goals for children who are d/hh by encouraging the following: early identification of type and degree of hearing loss, appropriate fitting and use of amplification as soon as possible, immediate enrollment in early intervention, and collaboration between parents and professionals to guide appropriate educational decision-making (Alexander Graham Bell Association for the Deaf and Hard of Hearing, 2005).

Although there is little empirical evidence to support the use of either AO or AV approaches (Dornan, Hickson, Murdoch, & Houston, 2007; Eriks-Brophy, 2004; Rosner, 2004), both approaches can provide documentation that they are beneficial. Wilkins and Ertmer (2002) provided an overview of Child's Voice, an oral school for children ages three to eight years, established in the southern United States in the late 1990s and documented that approximately 76% of its graduates (16 of 21 graduates) were mainstreamed and performing at grade level in reading and math upon graduation. Rhoades and Chisholm (2000) investigated the receptive and expressive language proficiency of children with CIs receiving language training in an auditory-verbal program and concluded that the auditory-verbal approach is a highly viable communication option for children who are d/hh, particularly for children beyond the first three years of life. Additionally, Dornan et al. (2007) studied the outcomes of an auditory-verbal program for children with hearing loss. Twenty-nine subjects with hearing loss (fifteen using CIs and fourteen using hearing aids) demonstrated significant progress in language and receptive vocabulary development following participation in an auditory-verbal program; however, their results did not find any statistical difference between the language and receptive vocabulary progress of the children with hearing loss when compared with those of their typically hearing matched peers. The fact that gains were made from pre-test to post-test sessions for the children who were d/hh is promising, but the gaps in language and receptive vocabulary proficiency between the children with hearing losses and normal hearing persisted. Time and increased research will show if there is an empirical difference between the two approaches and until then, parents will most likely continue to trust the professionals with whom they interact to guide them in making their therapy option decision.

Family Decision-making Surrounding Cochlear Implantation

As is evidenced by the issues discussed thus far, deciding to have a child implanted is not a quick or easy one (National Institute on Deafness and Other Communication Disorders, n. d.) and generally takes at least a year from initial screening to implantation. Parents and families grieve over the fact that their healthy appearing children are identified so shortly after birth with a life altering disability, and are frustrated by the slow diagnostic process, particularly the hearing aid trial phase, yet they feel the early screening should continue. Ultimately, parents feel that early screening allows for better long-term prognosis and enhanced opportunities for children to develop speech and language skills (Fitzpatrick, Graham, Durieux-Smith, Angus, & Coyle, 2007). While parents and families dislike the extensive CI evaluation period, it allows the CI team to consider a number of variables which affect a child’s successful use of the device: the child’s age at the time of identification, intervention attempted and its outcome, response to traditional amplification, the degree and duration of the child’s hearing loss, exposure to spoken language, and the child and family characteristics (CCCDP & CASTLE, n. d.; Compton et al., 2004). Many of the predictive variables are beyond experimental control; however, research clearly supports the fact that family involvement strongly influences the outcomes of cochlear implantation (Calderon, 2000;

Moeller, 2000; DesJardin, 2006; Yoshinaga-Itano, 2003). Calderon (2000) documents that maternal communication skill appears to be one of the most predictive variables for success with CIs in young children.

The results of UNHS are often difficult for families to deal with and accept (Rosner, 2004); however, once it is confirmed that a child is d/hh, families face the task of having to make decisions that will forever influence the child's future. As reported earlier, approximately 90% of all children who are d/hh are born to parents with normal hearing (Marshark, 2003; Mitchell & Karchmer, 2004). When interviewed, samples of parents who hear have reported the following reasons for choosing CI for their children: they wanted the children to have the best opportunities to succeed in life and be oral speakers like them (Bat-Chava & Deignan, 2001; Neuss, 2006); they hoped having a CI would make it more likely for their children to interact with hearing peers (Preisler, Tvingstedt, & Ahlstrom, 2005); and they wanted their children to be educated in inclusive education settings with acceptance by their peers who hear (Neuss, 2006). Additionally, families appear to question whether or not they want deafness to be their child's defining personal characteristic (Rosner, 2004). DesJardin et al. (2006) state that in order for a child to derive meaning from sound gained as a result of cochlear implantation, it is essential that the family be knowledgeable of the CI and be actively involved in the early intervention process. In an optimal early intervention scenario, CI implantation would begin early in life and subsequently become part of the child and not be viewed by others as a sign of being deaf or hard of hearing (Fitzpatrick et al., 2007).

Families also need to base their decision-making on the understanding that CIs have direct influence only on hearing function, and positive outcomes in speech, language, and communication cannot be guaranteed. This is difficult to remember, as clinicians and other professionals working with the child often emphasize the use of CIs for increasing sound awareness and feedback for listening, linguistic, and communication skills. When considering cochlear implantation, families and professionals must recall that the main objective is to realistically improve the quality of the recipients life, allowing them to make meaningful use of the sounds around them (Filipo, Bosco, Mancini, & Ballantyne, 2004). The aims and objectives of implantation, the obtainable level of change in sound perception, communication, language, educational and employment opportunities, and the desired quality of life of the recipient all must be considered (Edwards, 2007).

Language and Vocabulary Gains as a Result of Early Intervention

Any degree of hearing loss, and severe to profound deafness in particular, reduces children's adequate exposure to the complex phonemic patterns of spoken language. This limited exposure means the child's internal language system is based on incomplete, distorted, and muffled signals (Robbins, Green, & Waltzman, 2004). The historical ramifications of this situation have been that children who are d/hh have demonstrated delayed language development and reduced academic achievement (Mayne, 1988a; Mayne, 1988b). Hart and Risley (1995) documented that children who hear more utterances develop better language skills, and Yoshinago-Itano (1998a, 1998b) reported that the first six months of life, and possibly time in utero, are vital for auditory perceptual learning and acquisition of oral language and speech. This fact is confirmed by initial findings in the Childhood Development after Cochlear Implantation (CDaCI) five-year study. The findings indicate there are negative, pervasive effects of deafness prior to cochlear implantation. One of the significant differences highlighted in the study relates to quality of parent-child interactions between CI candidates and hearing peers. The study findings clearly indicate that parents of CI candidates evidence less sensitivity to child autonomy, and an indirectly provide less communicative stimulation (Eisenberg, Fink, & Niparko, 2006). While evidence exists that language acquisition for children with CI follows a developmental progression similar to that of their hearing peers (DesJardin et al., 2006), children with hearing loss do not have benefit of all the spoken language development strategies available to their hearing peers and are therefore at a communicative disadvantage from birth (Drinkwater, 2008; Svirsky, Robbins, Kirk, Pisoni, & Miyamoto, 2000).

Early identification of hearing loss and subsequent early intervention as a result of UNHS have increased the number of young children with hearing loss with functional speech and language skills. Yoshinaga-Itano (2004) investigated the effectiveness of UNHS in Colorado by using a variety of statistical designs and discovered that regardless of the study sample size, all participants demonstrated positive developmental outcomes when provided early intervention opportunities during the first six months of life. The findings of Connor et al. (2006) provide further support of early intervention. They investigated the value of early implantation opposed to length of time using a CI and found that children who receive CIs prior to two years, six months of age seem to demonstrate substantially better speech and vocabulary outcomes than children implanted later in life. Empirical studies such as these are limited; however, they do buttress the primary goal of cochlear implantation which is to facilitate an individual's comprehension and expression of thought through the use of spoken language (Niparko & Blankenhorn, 2003).

Children who are d/hh generally develop language skills at half the rate of their hearing peers (Miyamoto, Houston, Kirk, Perdew, & Svirsky, 2003; Svirsky, 2000) and do not have the same language base as their hearing peers; therefore, it is imperative that their delays in language and functional communication be addressed as early in life as possible (Ertmer, 2002a; Ertmer, 2002b). This is underscored by the fact that the outcomes for children receiving early intervention and CI are more positive and usually proven to be statistically significant when children receive implants at younger ages (Connor et al., 2006). Fryauf-Bertschy et al. (1997) were not able to provide definitive proof that early cochlear implantation is responsible for the speech and language outcomes of users; however, their study of thirty-four young CI users indicates that consistent CI use early in life can significantly improve the speech perception abilities of the recipients. Kirk et al. (2002) studied 78 children who received CIs prior to the age of five years and discovered that regardless of communication mode, the children implanted prior to three years of age appeared to acquire early receptive language skills at a rate commensurate with their typically hearing peers. Several studies (Ertmer, 2002a, 2002b; Guiberson, 2005; Kirk et al., 2002), have clearly documented that children who are prelingually deafened and receive CIs require intensive auditory and speech training.

Even with intensive training, the language development progress of CI recipients is slower and more variable than that of their typically hearing peers (Stallings, Kirk, Chin, & Gao, 2000), but it is more rapid than that of children who use hearing aids (DesJardin et al., 2006; Wilkins & Ertmer, 2002).

Empirical Evidence Supporting Use of Cochlear Implants to Facilitate Language and Vocabulary Skill Development

Evidence supporting the benefits of UNHS is plentiful and clearly supports the need for early, intensive intervention to facilitate improved language and communication skills for young children who are d/hh. While families, speech-language, and hearing professionals notice advances in language and communication skills of implanted young children (Easterbrooks, O'Rourke, & Todd, 2000; Li, Bain, & Steinberg, 2004; Zaidman-Zait & Most, 2005), such subjective testimony is not enough to warrant the growing use of CI with young children. A review of empirical evidence investigating the receptive and expressive language skills of young children with CI provides clear, concrete documentation that cochlear implantation is a viable early intervention that provides positive outcomes for young children.

A common language assessment used in many empirical studies investigating the receptive and expressive language skills of young children using CIs is the Reynell Developmental Language Scales (RDLS). The RDLS is a standardized assessment that evaluates verbal comprehension or receptive language skills as well as expressive language skills of children one to six years of age. The verbal comprehension section has two versions; one that allows the subject to respond verbally and the other allows subjects to respond by pointing. The expressive language scale has items designed to evaluate the subject's language structure, vocabulary, and content (Reynell & Gruber, 1990). Research using the RDLS (Miyamoto, Hay-McCutcheon, Kirk, Houston, & Bergeson-Dana, 2008; Miyamoto et al., 2003; Miyamoto, Kirk, Svirsky, & Sehgal, 1999; Miyamoto, Svirsky, & Robbins, 1997; Svirsky, 2000) clearly documented that the age at which a child receives a CI has a significant effect on subsequent receptive and expressive language skill development. The number of children with CI that served as participants in the studies ranged from one to 153, and although the RDLS scores revealed wide variability, when comparing the age at which children received their CI, there was conclusive evidence that the youngest participants in each study outperformed their older counterparts. In all the studies cited, the group of participants who received implants at the age of two years or younger, significantly outperformed their older peers on receptive and expressive language and vocabulary tasks. These data supported the seminal findings of Yoshinaga-Itano et al. (1998) in which they evaluated the language development skills of young children who were identified with hearing losses through UNHS using the Minnesota Child Development Inventory (MCDI). Their findings documented that children identified prior to six months of age earned significantly higher language quotients on the MCDI than those children identified with hearing losses after six months of age.

Svirsky et al. (2000) assessed 70 children prior to and following cochlear implantation using the RDLS and compared their scores to the predicted language ages for subjects who where d/hh and did not use CI. The language ages of this second group were predicted as a function of the participants' chronological ages, residual hearing, and communication mode (AO or Total Communication). Using a two-way repeated analysis of variance (ANOVA) measure, in which the factor was the testing interval post implant and the measure was the observed or predicted language age, the investigators determined that although the children with CIs lagged behind their hearing peers, they did develop language skills faster than predicted for the children who did not use CIs. In a second analysis in which the investigators examined data over a two and a half year follow-up period, the participants using CIs demonstrated greater gains in expressive language than those predicted for the children not using CI. Additionally, the cumulative expressive language gains of the CI users approximated the expressive language skills expected for hearing children of the same age. The results of the study conceal the wide variability of language scores of the children using CIs; however, the findings support the possibility that children using CIs can develop receptive and expressive language and vocabulary skills commensurate with those of their hearing peers.

Brinton (2001) used the Preschool Language Scale-3 (PLS-3), another standardized assessment that evaluates the receptive and expressive language and vocabulary skills of young children from the age of two weeks to six years, eleven months (Zimmerman, Steiner, & Pond, 1992) with 113 participants who received implants between the ages of three and four years. All participants were evaluated prior to receiving the implant and again at post-implant intervals of six months, and annually thereafter for five years. The decision to not involve a control group in the study limits the ability to correlate CI use with language gains made by the participants; however, with an increase in time post implant, an overall increase in language scores on all areas of the PLS-3 was observed and documented. The rate of receptive and expressive language skill change indicates a similar pattern to that of the receptive and expressive language skill development of hearing children.

In addition to research investigating the receptive and expressive language development of young children with CIs, studies have been conducted which investigated the speech perception abilities of the same population (Fryauf-Bertschy et al., 1997; Profant, Kabatova, & Simkova, 2008). Fryauf-Bertschy et al. (1997) studied the speech perception skills of 34 children, trained in Total Communication with three years or more of CI experience and discovered that although there was a wide variability of demonstrated speech perception skills, CI use affords improved perception opportunities. As documented in the receptive and expressive language skills using the RDLS or PLS-3, the children who received implants earlier in life outperformed those receiving CI later in childhood. This phenomenon was substantiated by the speech perception study by Profant et al. (2008) in which they discovered that functional speech perception outcomes for children implanted prior to the age of three years exceeded those of children implanted later in life.

Speech perception work by Stallings et al. (2000) underscored the importance of language experience and interaction with others on positive outcomes for children with CIs. In their study, they investigated how a parent’s working vocabulary influenced the language scores of children with CIs. The parents working vocabulary knowledge or word familiarity, was significantly associated with the children’s receptive language skills as assessed with the RDLS; however, there was no correlation between the parents' word familiarity and the children's overall language quotients. The findings of this study identified language environment, linguistic experience, and the relationship between language achievement and linguistic experience as the three mitigating factors in predicting the language ability of a young child who receives a CI.

Finally, the review of the literature produced one study (Duncan, 1999) that examined the conversational skills of children with hearing loss and using CIs as compared to those of hearing children in an inclusive kindergarten classroom in Australia. The author reported that the overall findings revealed both groups of children performed similarly; however, a detailed review of the study findings revealed that the children with hearing loss performed significantly below their hearing peers in the following areas: percentage of conversational initiation, percentage of conversational maintenance behaviors, use of minimally contingent maintenance behaviors, and demonstration of successful topic shifts in the classroom setting. Additionally, the children with hearing loss relied on physical initiation more often than their hearing peers.

Summatively, the studies discussed in this section support the efforts of UNHS implementation nationwide and provide empirical evidence that children with CIs have the potential to develop receptive and expressive language skills commensurate with their hearing peers. There is wide variability in the language scores of the children studied, and the effect of language experience and opportunity for communicative interaction are significant factors in predicting positive outcomes for children with CIs. Studying participants' knowledge of receptive and expressive language and vocabulary skills is important, however, it does not provide enough data to address whether young children who are CI recipients are demonstrating functional communication skills in everyday interactions with others. Additionally, as the study by Duncan suggests, simply because a child who is deaf has specific language skills, it does not mean that the use of those skills is commensurate with the social language skills of a child who hears.

Social Competence

As the review of the literature indicates, children who are born d/hh and receive CIs early in life are provided an advantage over children who are born d/hh and do not receive CIs; children implanted early in life have increased potential of developing receptive and expressive language and vocabulary skills commensurate with their hearing peers. While age appropriate language and vocabulary skills are important tools for developing social competence, or the ability to interact appropriately with others in social settings, studies have indicated they are not enough for any child, particularly one who is d/hh. In addition to the language and vocabulary demands of verbal and social interactions, children need to demonstrate effective peer interaction and relationship initiation, use of social skills across a variety of social settings, and linguistic interaction. While the abilities listed vary greatly amongst children who are d/hh, research has indicated that performance below that of peers with normal hearing increase the likelihood of social interaction difficulties for children who are d/hh (Antia & Kreimeyer, 1997; Antia, Kreimeyer, & Eldredge, 1994; Gresham & Reschly, 1986; Guralnick, Connor, Hammond, Gottman, & Kinnish, 1996; Vandell & George, 1981).

Social competence in children is an interactive, multi-dimensional construct dependent on sensitivity to others, the ability to engage in complex play and form friendships (Howes, Matheson, & Hamilton, 1994), reciprocity of behavior (Sutherland & Morgan, 2003), self-control (Olson, 1989), self-efficacy (Bandura, 1989), and adaptive behavior, social skills, and peer relationship variables (Gresham & Reschly, 1986). Social competence is an evolving skill that begins at birth with initial bonding with parents (Puckett & Black, 2004) and continues throughout a person's lifetime. Individuals considered to be socially competent encounter experiences in all the behaviors just outlined and for that reason, social competence must be explained by discussing these individual components and their relationship to each other.

Sensitivity to Peers

Fifty years ago, children were born and raised within family settings in which the majority of mothers remained at home to care for children, creating microcosmic social communities of parents and children. Younger children were able to learn social rules of behavior by interacting with older siblings. Parents, usually mothers, were present to mediate disputes and intercede as necessary to ensure the safety of all children in the home. Such vertical guidance allowed children to develop proper social behavior in a safe environment with a variety of models. Over the last half century, however, many economic and social changes have required both parents in a family unit to work outside the home, significantly changing the social contacts of infants and young children (Morrison, 2009). Vertical guidance has been replaced by horizontal interactions in childcare settings where children are grouped by chronological age to meet licensing regulations. Children currently are learning social rules with and through their peers as opposed to through assistance of mixed age siblings and friends (Saracho & Spodek, 2003).

The current social community of young children with and without normal hearing necessitates that they be responsive to the behaviors and needs of their chronologically aged peers. Peer acceptance is dependent on a child's ability to empathize with peers, share materials, and understand the tacit rules of the group (Birch & Ladd, 1998; Chang, 2004; DeRosier & Thomas, 2003). Failure to demonstrate these skills decreases social support and increases the possibility of victimization and ostracism (DeRosier & Thomas, 2003).

Play Interactions

Parten identifies five levels of play in young children. *Onlooker play*, the lowest level in the hierarchy is characterized by observation of others. Such play is common among infants and very young children and is followed by *solitary play*. Children engaging in solitary play are content to play by themselves and may engage in activities entirely different from those in the surrounding environment. Older toddlers between the ages of two and three begin participating in *parallel play*, or play in which they position themselves near each other and engage in similar activities without interacting. Parallel play leads to *associative play* in which young preschoolers talk with others while playing together, but all participants follow their own play plans. Finally, older preschoolers engage in *cooperative play*, characterized by organized and cooperative play with all participants following the same play sequence or script (Tomlin, 2008).

Although Parten attaches ages to each level of play, children may participate in all types of play regardless of chronological age or communicative ability. The importance of the levels is in understanding the progression of social skills needed to be included in a play sequence with peers. In order for children to be accepted in a group, they must master prerequisite play skills of lower levels and move from an egocentric to a community focus. By meeting social expectations (e.g. classroom interactions) in this fashion, children increase their opportunities for peer acceptance; failure to conform to the play expectations increases the possibility of peer rejection (Chang, 2004).

Friendships

Research (Gonzalez-Mena & Widmeyer, 2009) has shown that toddlers are capable of establishing genuine friendships. Initially, friendships are based on shared items of interest (e.g., toy, article of clothing) that lead to collaborative interactions (e.g., passing toy to each other through an adult intermediary). Sustained interactions of this type allow children to imitate each other, join in shared activities, and enjoy each other's company. With maturation, their friendships are founded on proximity, shared activities, and physical similarities. Early friendships require that children have multiple and frequent interaction opportunities. Paradoxically, early friendships often are contentious as a result of the egocentric nature of young children. Young children concentrate on their needs and desires and often are unable to understand differing perspectives. As their cognitive and communicative development matures and encounters with peers increase, children learn to accept and compromise regarding differences. Such development occurs within peer group settings and through experiencing and internalizing the tacit rules of social behavior

Reciprocity of Behavior

Sensitivity to others, the ability to engage in complex play, and the ability to develop as well as maintain friendships all are dependent on transactions between the participants. Such transactions are influenced by participant behavior, events surrounding the interaction, and reactions of participants to each other. The relationship among these three factors facilitates opportunities for participants to respond to each other. As opportunities to respond to others increases, children are able to monitor their behavior and develop the social skills necessary to remain in a group situation (Sutherland & Morgan, 2003).

Self-control

As children learn to respond appropriately to their peers, they concomitantly develop the ability to control their own impulsive behavior. Self-control is a skill learned through interactions with others (Gonzalez-Mena & Widmeyer, 2009). Infants and young children exposed to warm and mutually satisfying relationships with caregivers learn to comply with requests and modify their behavior to meet expected social standards. Alternatively, infants and young children exposed to coercive caregiving are less likely to comply with requests of others and do not know how to conform their behavior to social standards (Olson, 1989; Puckett & Black, 2004). Failure to control impulses increases the likelihood of behavioral problems that interfere with the ability to form relationships with others (Sutherland & Morgan, 2003).

Self-efficacy

Finally, successful social interaction, or social competence, is dependent on self-efficacy skills. Self-efficacy has been defined as personal belief in the ability to perform a given behavior, and applies to the behavior itself, rather than the outcome of the behavior (Bandura, 1986). Children must feel they are capable of meeting various task demands in order to succeed at them. Success promotes success, making children more willing to persist in mastering the tacit rules of social behavior. Failure to develop positive feelings of self-efficacy often causes children to abandon social contact and inhibits social competence (Bandura, 1989).

Language and Communication

With their first cries, babies begin using non-verbal language and communication skills to interact with others. Over time and in response to positive interactions from communicatively competent others, children learn the influence of vocal sounds and body language. As these behaviors are mastered communicative repertoires are increased to include word approximations, actual words and universally recognized gestures. By the age of three, most children with normal hearing are able to speak in three to four word utterances to gain attention and request information from others, comment upon their surroundings, and act upon the environment. This pragmatic approach to language and communication illustrates the significant use of these tools to develop social competence (McCormick & Schiefelbusch, 1994).

The terms language and communication often are used interchangeably; however, they are different. Language involves a community’s systematic use of rules to create an infinite number of sentences to share thoughts and ideas. Grammar and sentence structure vary with different languages (e.g., English, Spanish, American Sign Language), and it can be verbally or gesturally based. Regardless of the language system used, communication becomes a purposeful means of sharing one's intent with others. Communication involves knowing the message to be conveyed, delivering it in the most effective means possible (Muma, 1978), and listening to input from others to gain knowledge and share ideas (Seefeldt, 2004).

Massey (2004) presents four levels of conversational communication used by young children. First, labeling involves using specific words to identify objects and concepts. Communicators begin with this level of communication to learn the content of a language, share basic knowledge, convey wants and needs, and respond to factual questions. Next, recall is characterized by the ability to use details to describe objects and concepts, complete cloze sentences and recall facts and sequences. Third, inference skills enable communicators to summarize ideas, define words and concepts, and make judgments between and among items. The final level, explanation, involves using language to predict outcomes, problem solve and explain how and why events occur. Competent communicators master skills at all levels and use them as appropriate to convey their message to listeners.

Children need to be immersed in a language rich environment to become competent communicators. Opportunities to respond to others in verbal and non-verbal ways increase incidences of appropriate social behavior and reduce behavior problems (Sutherland & Wehby, 2001). For example, use of behavior specific praise increases on task behavior in young children (Sutherland, Wehby, & Copeland, 2000) and enables them to participate in group learning activities. Pragmatic skill development such as culturally appropriate eye contact, interactional distance, turn-taking and flexibility (Santos & Ostrosky, n. d.; Seefeldt, 2004) cannot occur in a vacuum; they must be introduced, practiced, and mastered within social settings. As communication involves learning to listen, discuss ideas, and gain knowledge and involves a minimum of two people, it is integrally related to social competence.

After reviewing the literature on social competence in general, and language development specifically, the common denominator or catalyst for optimum development is the adults in the child's environment. Caregivers (which include parents, teachers, and childcare providers) are the adults responsible for creating the language rich environment in which children are to be immersed to develop communication competence. The influence of each adult group on a child's development varies with contact time, but summatively, they interact with each other and the child and significantly affect the child's behavioral and communicative functioning during the developmental stages and later in life (Pianta, Nimetz, & Bennett, 1997).

Usually children are born into and raised by their biological family, although it must be acknowledged that this is not the case for all children. For purposes of this paper, parents and family will refer to the adults primarily responsible for the daily care of children within a home setting. This encompasses biological, adoptive, foster, and temporary care parenting situations. Mothers are the most significant adults in terms of children's social and communication development (Baydar, Reid, & Webster-Stratton, 2003; Carpenter, 1997; Pianta et al., 1997; Swick, DaRos, & Kovach, 2001; Webster-Stratton, 1998). Generally, the mother is the adult with whom children have the most contact during the infant, toddler, and early preschool years, and the nature of this relationship significantly affects a child's social competence development. Children exposed to caring, emotionally positive maternal relationships with consistency in disciplining practices are more likely than children not exposed to such practices to become non-aggressive, self-regulated children capable of interacting appropriately with peers and other adults (Baydar et al., 2003; Pianta et al., 1997). Although conclusive research is unavailable, it appears the mother-child relationship is the strongest and most consistent predictor of social competence and adjustment in young children (Howes et al., 1994; Pianta et al., 1997). Pianta et al. (1997) suggest this significance is related to the increased amount of time mothers spend with their children and the fact that the mother-child relationship is more consistent over time (i.e., educational caregivers may change each year; a child's relationship with his mother generally lasts a lifetime).

Caregivers other than parents and families have a secondary influence on development of social competence in young children. Like parents and families, educational caregivers spend a substantial amount of time with the children in their care and the relationship established between them significantly influences the development of social competence. Further, just as parent-child interactions shape teacher-child interactions, teacher-child interactions affect children's peer relationships (Pianta et al., 1997). Teaching is an interactional and interpersonal process that forms a lasting impression on the academic achievement, social development, and behavioral competencies of young children. With children entering learning environments (e.g., child care and preschool settings) at earlier ages, the classroom climate created by the teacher or caregiver is crucial to a child's social competence abilities. Variables such as classroom organization, curriculum content, and socio-cognitive demands stipulated by the teacher contribute considerably to the daily setting in which children learn to interact with others (LaParo, Pianta, & Stuhlman, 2004). The emotional nature of the teacher's verbal and non-verbal language behaviors affects the classroom climate as well (Kugelmass & Ross-Bernstein, 2000).

In creating positive classroom climates, many teachers and caregivers structure their daily schedules to allow for multiple free play sessions. Such planning allows for divergent and elaborate interactions that facilitate Massey's (2004) fourth level of conversational communication. Not only does this structure allow for increased opportunities to interact and respond to peers (Sutherland & Morgan, 2003; Sutherland & Wehby, 2001), it builds a solid foundation for meeting social and cognitive demands children encounter throughout life (LaParo et al., 2004).

The research discussed clearly indicates that social competence is integrally intertwined with language and communication competence. Social competence involves the ability to treat others with empathy and sensitivity while interacting at varying levels of complexity. As such interactions continue over time, friendships are developed and each partner in the relationship learns to understand and respond to the behaviors of others. While responding to others, children learn to monitor and control their own emotions and behaviors within established social standards. Finally, as each of these behaviors is mastered, children develop a positive sense of self in which they realize they are capable and competent individuals.

When human beings interact in social settings, the medium through which they share information is language and communication skills. Children convey needs, wants, thoughts, and intended messages to others verbally and non-verbally. Expressive language interactions occur at four distinct levels of labeling, recall, inference, and explanation. Competent communicators develop these skills in a linear and vertical hierarchy and use the levels interchangeably as circumstances dictate.

Social, language, and communication skills are modeled by significant adults in the lives of children, with mothers playing the primary role. It is believed this primacy effect is related to the constancy of the maternal relationship as well as the quantity of time mothers and children share. Educational caregivers enter into caring relationships with children as well; however, the frequency of educational caregiver change during the early childhood and preschool years appears to lessen their influence on development of social competence. Regardless of the adult relationship to the child, children exposed to warm, caring, and positive emotional experiences generally develop into socially competent individuals able to effectively use language and communication skills to problem solve solutions to novel situations. Social competence is not taught as a set response; instead, it is a repertoire of behaviors and skills available for use on an as-needed basis.

Rationale for the Current Study

A significant body of professional research currently exists that documents the fact that young children who receive CIs prior to two years of age have the potential to develop receptive and expressive language and vocabulary skills at levels commensurate with their hearing peers (Brinton, 2001; Geers et al., 2003; Moeller, 2000; Stredler-Brown, 1998; Yoshinago-Itano, 2004; Yoshinago-Itano et al., 1998). It has also been documented that speech perception and production skills alone may not be sufficient to ensure communicative competence (DesJardin et al., 2006). Pioneer work by Yoshinaga-Itano has proven the benefit of early detection and intervention of hearing loss in young children and the work by research teams led by Svirsky and Miyamoto have documented the benefit of cochlear implantation in the development of language of young children, however, there is a paucity of information available regarding the interaction between development of age-expected receptive and expressive language and vocabulary skills and the functional use of those skills during spontaneous conversational interactions of young children with CIs with their hearing peers. The current study begins addressing how the receptive and expressive language skills of young children implanted early in life meet the social conversational demands of meaningful communication with their hearing peers.

CHAPTER III

METHODS

Design

The goal of the present study was to compare the conversational language skills and interactions of four children who are d/hh and who have received CIs prior to the age of four years with four typically hearing peers matched for age, gender, teacher perceived language ability, and race. This study was conducted by observing the interactions of four dyads of children, each composed of one child using a CI and a matched peer with typical hearing, interacting with others in their preschool or kindergarten classrooms. The goal of this present study was to describe the unique communication behaviors of the children under study in terms of child vocalization/verbalization, adult word, and conversational turn counts as well as mean length of utterance.

This exploratory, descriptive research study employed a quantitative design. Quantitative measures of frequency of conversational turns, verbalizations/vocalizations, mean length of utterance, and number of adult words spoken were used to describe the functional communication behaviors of the participants under direct study. This use of categorical data allowed for a comprehensible system for describing communicative behaviors in numerical terms (Howell, 2002). The small sample size of this study provided a detailed description of the data obtained in relation to the participants involved in the study.

Digital sound recordings and detailed data analysis using the Language Environment Analysis (LENA) software formed the foundation of the data-gathering component of this study. This study gathered and analyzed data on matched dyads of young children alike in age, gender, teacher perceived language ability, and race but differing in hearing status to gain an in-depth understanding of the conversational language skills of young children using CIs when compared typically hearing peers. The specific questions of concern in this study include: (a) does the child vocalization count differ between the two children in each dyad, (b) does the adult word count directed to the children differ between the two children in each dyad, (c) does the number of conversational turns differ between the two children in each dyad, and (d) does the mean length of utterance differ between the two children in each dyad.

Participants

The participants in this study were members of one of the two following categories: focal children or passive participants. The focal children were those students using CIs and their typical hearing matched peers. These children all wore the LENA recorders/processors. The passive participants included the classroom teachers, classroom teacher's assistants, and the remaining students in the class who did not wear a LENA recorder/processor. Participant selection was initially determined by criteria related to the children using CIs. Each child using a CI: (a) was congenitally d/hh, (b) had a minimum of one and a half years experience using the CI on a daily basis for a minimum of eight hours per day, and (c) participated in a preschool or kindergarten classroom that met for a minimum of two half-days a week. The matched peers with typical hearing were of the same age, gender, race, and teacher perceived language ability as the focal children using the CIs. The participants in this study included students and classroom adults from two kindergarten classrooms, one self-contained preschool classroom for children who were d/hh, and one inclusive preschool classroom. The demographic and setting information for each setting follows.

Site One (Kindergarten)

Site one was an inclusive kindergarten classroom in the central Piedmont region of North Carolina. At the time of the study, the class was composed of twenty students, including the two focal children, whose ages ranged from 5 years 0 months to 6 years 4 months at the time of the study. The class was composed of eleven males and nine females. One student had an individualized education plan (IEP). The school in which the classroom was contained followed a traditional school year calendar. The demographics of site one are illustrated in Appendix A.

The teacher has earned a North Carolina Department of Public Instruction Kindergarten-Sixth Grade teaching license. She has been teaching kindergarten in the same school district and classroom for four years. She began this school year with this class of students and had been working with them for six months at the time this study was conducted. The assistant teacher has twenty years experience and has been working with this teacher in a kindergarten setting for four years.

Of the twenty children enrolled in the classroom, parent consent to participate in the study was received from eleven of the children; seven boys and four girls. During the recording session, the focal children and two other children with signed consent to participate were asked by the researcher to wear a cloth pocket. All children in the classroom were able to wear the cloth pocket necklaces if they chose, as extra cloth pockets were made available by the teacher in the dramatic play center of the classroom; the researcher did not directly request any of these children to wear a cloth pocket. Children of both genders and all races represented in the classroom, Asian, African American, Caucasian, and Hispanic, chose to wear cloth pockets during the study.

The two focal children were each recorded for ten hours using the LENA DLPs. Following each recording session, the DLP recordings were downloaded to the computer and analyzed for child vocalization count (CVC), adult word count (AWC), conversational turn count (CTC), and estimated mean length of utterance (MLU) using the LENA software. The child who was d/hh used bilateral CIs was 6 years 4 months of age. The typically hearing matched peer was 6 years 2 months of age. Both students were Caucasian females, perceived by the teacher to demonstrate language and vocabulary skills that were well above average for their age. The child who was d/hh used bilateral CIs. Per parent report, she received her first CI at the age of one year and the second CI within three months of her second birthday. She has used the bilateral CIs for all waking hours for four years.

Site one was one of five general education classrooms at the elementary school serving students in grades preschool through fifth grade. The school housed thirty-four classrooms: one self-contained preschool class for students identified with autism, five kindergarten classrooms, six first, second, third grade classrooms, five fourth and fifth grade classrooms, and two self- contained classrooms, one for students identified with autism and one for students identified with emotional disorders. Students enrolled at the school are of the following racial backgrounds: Asian, African American, Caucasian, and Hispanic.

The kindergarten classroom in which the observations occurred was designed as a center-based learning classroom. The centers were arranged around the perimeter of the classroom and included: Writer's World, Math, Language and Literacy, Science/Social Studies, Dramatic Play, Reading Corner, and Manipulatives. Appropriate visual images and written word labels to indicate the different centers were hung on the wall above or near each center. A word wall was posted along the wall in proximity of the Writer's World and Language Literacy centers. In addition to the learning centers, there was a large group time carpeted area that edged the middle of one wall and extended into the center of the room. The wall space of the large group area sported a white board, a monthly calendar, and a center time assignment chart.

The classroom had six developmentally appropriate sized tables and chairs. Four students were assigned to each of five rectangular tables; the sixth table was a kidney shaped table used for teacher directed activities during both morning and afternoon center time periods. The tables were in the center of the room and arranged so they surrounded but did not touch the group time carpeted area. Students sat at assigned seats at the tables for the morning check-in routine; however, throughout the remainder of the day, the students sat at the large group carpeted area, worked in the individual classroom centers, or sat at the various tables to complete center activities. In addition to the developmentally appropriate student sized furniture, the classroom contained one teacher desk. The students were able to access all work materials independently and were responsible for cleaning up the work areas at the conclusion of morning and afternoon center activity times.

The classroom had its own bathroom with a toilet; the sink was located in the classroom proper, to the left of the bathroom door. The compact disc (CD) player was located near the large group area, behind the teacher's rocking chair. The students stored their personal items in cubbies that lined one wall, to the left of the teacher's desk.

Student work was displayed at each center in the classroom as well as in the hallway immediately outside the classroom. Students displayed work completed each day in the appropriate centers. Additionally, all students had personal work folders that were stored in the chair covers of their assigned seats. The students understood they were to find their daily work in their folders, complete it, have it checked by the teacher or teacher's assistant, and file completed work in the appropriate shelf unit each day. New daily work was put in the folders each afternoon by the teacher's assistant after the children were dismissed.

The teacher used the lights to indicate when the children needed to change their behavior. The teacher would turn off the lights and ask the children "to blueberry" which meant they were to put their hands on their heads and be quiet so they could hear the teacher's instructions. Once the directions were delivered (i.e. to be quieter when speaking, to clean up, to be reminded of their work task, etc), the teacher turned the lights on and told the children to "un-blueberry," at which time, they did what she had requested of them. In instances where one or two children were behaving inappropriately, the teacher or teacher's assistant would talk to them quietly, remind them what was expected of them, and have them return to their task. In the few instances where this was not a productive strategy, the students were asked to go their seats and put their heads down until they felt they could behave as expected; when the children felt ready to return to their work tasks, they went to the whichever adult asked them to sit at the table, conferenced about appropriate behavior and returned to their work tasks. Neither of the focal children displayed inappropriate classroom behaviors during the recording sessions.

Site Two (Kindergarten)

Site two was a private school inclusive kindergarten classroom in southeastern Virginia. At the time of the study, the class was composed of sixteen students, including the two focal children, whose ages ranged from 4 years 5 months to 5 years 5 months. The class was composed of 9 males and 7 females. Three students had IEPs. The school in which the classroom was contained followed a college academic semester year calendar. The demographics of site two are illustrated in Appendix A.

The teacher has earned a Virginia Department of Education elementary license, which certifies her to teach in kindergarten through sixth grades. She has been teaching kindergarten at the same school for 22 years. She began the school year with this class of students and had been working with them for eight months at the time this study was conducted. There were three different assistant teachers in the classroom during the recording sessions. All assistant teachers were students at a four year institution of higher learning and they had been assisting in this classroom for eight months.

Of the sixteen students enrolled in the classroom, parent consent to participate in the study was received from eight children; seven males and one female. During the recording session, the focal children and two others were asked by the researcher to wear a cloth pocket. All other children in the classroom were able to wear the cloth pocket necklaces if they chose, as extra cloth pockets were made available by the teacher in the dramatic play center of the classroom; the researcher did not directly request any of these children to wear a cloth pocket. Children of both genders and all races represented in the classroom, Asian, East Indian, American Indian, and Caucasian, chose to wear cloth pockets during the study.

The two focal children were each recorded for approximately nine hours using the LENA DLPs. As explained for site one, following each recording session, the DLP recordings were analyzed for CVC, AWC, CTC, and estimated MLU. The child who was d/hh used bilateral CIs and was 5 years 1 month of age. The typically matched peer was 5 years 7 months of age. Both students were Caucasian males, perceived by the teacher to demonstrate language and vocabulary skills that were above average for their age. Per parent report, the child using bilateral CIs received both implants at the age of 22 months and has used them during all waking hours since they were initially mapped.

Site two was one of two inclusive, half-day kindergarten classrooms at the private school serving students in preschool and kindergarten only. The school housed seven classrooms: the two kindergarten classrooms, one self-contained preschool class for students who were d/hh, and four preschool classrooms. Students enrolled at the school are of the following racial backgrounds: Asian, African, African American, American Indian, Caucasian, East Indian, and Hispanic.

The kindergarten classroom in which the observations occurred was designed as a center-based learning classroom; as with site one, the classroom materials and activities were teacher facilitated and child directed. As students entered the classroom, they went to their cubbies located to the right of the entrance to deposit their backpacks and personal items. As they entered the classroom proper, they deposited their home-school communication notebooks in the collection basket located on the table to the left of the cubbies. The first half of the classroom contained four rectangle tables with five chairs at each table in a line spanning the width of the classroom. The tables were used for writing and manipulative tasks; the remaining centers for dramatic play, literacy/reading, computer access, listening, science, discovery, and large group interaction were arranged around the perimeter of the room. Student created artwork, charts, and writing samples were displayed on all the walls.

As the students entered the classroom each day, they were allowed to engage in self-selected activities for the first twenty minutes; once all students attending that day were present, the teacher sat at one of the tables and as the children noted her position, they joined her. At the tables, the students found their table work for the day and were given the directions for completion by the teacher and the assistant present that day. As students finished their work and had it checked by the teacher or assistant, they were free to explore any area of the classroom as they chose for a maximum of one and a half hours. During the free exploration period, the teacher and assistant mingled with the students, engaging them verbally to describe what they were doing and thinking. At the end of the free exploration time, the teacher moved to the large group interaction area. The students took her change of position as the cue to clean up and join her. Large group interaction time lasted for approximately thirty minutes each day and was followed by a thirty minute outdoor recess. Upon returning to the classroom, the students washed their hands, ate their snacks and prepared to go home.

The classroom had its own bathroom with a sink and toilet, as well as a sink in the classroom proper area. Additionally, the classroom was equipped with a Frequency Modulated (FM) system that was in place to facilitate an enhanced audio environment for the child using CIs. The teacher wore a FM microphone during the large group interaction and outdoor recess times during all recording sessions.

Site Three (Self-contained Preschool Classroom)

Site three was a self-contained preschool class for students who were d/hh at the private school in southeastern Virginia. At the time of the study, there were six students enrolled, all of who had an IEP. The class was equally divided by gender and ranged in age from 3 years 2 months to 5 years 1 month. The school in which the classroom was contained followed a traditional college semester calendar. The demographics of this preschool class are illustrated in Appendix A.

The teacher at site three had earned a Virginia Department of Education Early Childhood Special Education license. She has been teaching preschoolers who are d/hh for ten years, and has been at the current school for two years. She began the school year with this class of students and had been working with them for eight months at the time of this study was conducted. There were two graduate assistants working with her, and they had both been working in the classroom for the past eight months. Both graduate assistants were working on earning a Master's degree in Speech-Language Pathology.

Of the six students enrolled in this half-day, private school self-contained classroom for children who are d/hh, parent consent to participate in the entire observation period was received from two of the children; two boys and no girls. Parental consent was received for a third male student on the last day of observations; therefore, data was not collected on this student. The teacher felt it would be best for the students if the researcher did not interact with the children. To accommodate this request, the researcher put the DLPs in each cloth pocket necklace, activating them for the two focal children and making them non-active for the other children. The children's names were put on each cloth pocket necklace so the teacher and her two graduate student assistants would know which one to put on each child. Any child had the opportunity to decline wearing the cloth pocket necklace, but none chose to do so.

The two focal children in this classroom were each recorded for six hours using the LENA DLPs. As with the recordings obtained in the kindergarten settings, the recorded information was downloaded and analyzed following each recording session. The focal male, who was 4 years 3 months of age and Caucasian, used a unilateral CI and a hearing aid in the opposing ear. This child was aided at the age of eight months, and received the unilateral CI at the age of two years six months of age. The focal male, who was 5 years 1 month of age and African American, used a unilateral CI that he received at three years of age.

Site three was the only self-contained preschool classroom at the school. The classroom was also the only classroom located on the second floor of the building; all other rooms on the second floor were dedicated as offices, resource material locations, or assessment rooms. There were two kindergarten classrooms and five preschool classrooms on the first floor of the building. The students in the self-contained preschool classroom arrived by bus, were greeted by the two graduate assistants on the ground floor, and escorted to the classroom. Students enrolled at the school are of the following racial backgrounds: Asian, African American, Caucasian, East Indian, Hispanic, and Native American.

This self-contained classroom in which the observations of the children using CIs occurred had a center based learning floor plan; however, instruction was provided in a teacher directed format. The majority of the children's daily routine included teacher or assistant directed activities in which the children were expected to provide appropriate verbal/vocal responses. The children engaged in center based activities for the first twenty minutes upon arrival at school and following lunch, for the last thirty minutes of the day.

This preschool classroom had two rectangle tables with six chairs at each, positioned in an "L" shape at the entrance area. To the left of the entrance area, there was a sink, refrigerator, and teacher workspace. To the right of the entrance area and arranged around the perimeter of the classroom, there were activity centers for literacy, dramatic play, computer access, and the large group meeting area. Each center had an adequate amount of materials for two to three children to work together at one time. Student work and appropriate teacher made and commercially available visual images were displayed on the walls of the classroom. The entrance area and kitchen/work area floor was covered with tile; the activity centers and large group meeting area was carpeted. The classroom did not have a bathroom, but there was a bathroom across the hall. Student cubbies were located in the hallway outside the classroom.

This preschool classroom was teacher facilitated and teacher/graduate assistant directed. The children followed the daily schedule as directed by the adults and were able to predict the sequence of activities based on routine and the use of a visual schedule chart. The students were engaged in large group activities for morning gathering and activity time; all other learning opportunities were provided in small groups of two or three. Small group learning opportunities were teacher/assistant directed and designed to be direct teaching opportunities. The adults told the children what they were expected to do; when the children responded correctly, they were verbally praised. When the children did not respond appropriately, the teaching adult and one or both of the other adults engaged in a modeling scenario for the child to imitate. All three adults in the classroom modeled appropriate speech and language skills for the children throughout the day, often requesting the students to imitate them so the children would learn proper conversational structures. Appropriate spontaneous vocalization and verbalization by the children was socially rewarded by peers and the adults in the classroom.

The teacher verbally directed the children they needed to change their behavior. The teacher would call the student by name and remind him/her of the classroom expectations. When individual children were not able to follow the classroom expectations for behavior, they were removed from the classroom by one of the adults and taken to the observation room/office separated from the classroom by a door. The adult would sit with the child until he/she had calmed down and was able to verbally interact with the adult. When the child indicated he/she was ready to return to the classroom, the adult and the child discussed the behavior that resulted in the time out and how the child could respond more appropriately in the future. One of the focal children had to be removed from the classroom twice on the last day of the recording session for inappropriate behavior towards his classmates. Each time out period was for less than three minutes.

Site Four (Inclusive Preschool Classroom)

Site four was an inclusive preschool class in southeastern North Carolina. At the time of the study, the class was composed of fifteen students, including the two focal children matched for age, gender, race and teacher perceived language ability for the two children using CIs from site three. Of the fifteen students, nine were male and six were female. Five children in the classroom had IEPs. The school in which site four was contained followed a traditional school year calendar. The demographics of site four are illustrated in Appendix A.

The teacher of site four had earned a North Carolina Department of Public School Instruction license in Special Education, with add-on licensure in Birth-Kindergarten Education. She had seven years of teaching experience, with three years experience in preschool settings. She has been at this center for two years, began the school year with this class of students and had been working with them for eight months at the time this study was conducted. The assistant teacher had two years of experience and had been working with this teacher for that entire time.

Of the fifteen children in this classroom, parent consent to participate in the study was received from five of the children; three boys and two girls. During the recording sessions, the focal children and two other children with signed consent to participate were asked by the researcher to wear a cloth pocket. All children in the classroom were able to wear the cloth pocket necklaces if they chose, as extra cloth pockets were made available by the teacher in the dramatic play center of the classroom; the researcher did not directly request any of these children to wear a cloth pocket. Children of both genders and all races represented in the classroom, African American, Caucasian, Native American, Hispanic, chose to wear cloth pockets during the study.

The two focal children serving as matched peers for the children in the self-contained classroom were each recorded for five hours using the LENA DLPS. The time difference of the recordings of the children with CIs and the typically hearing matched peers was due to the children's attendance in their respective classrooms. While the recording times differed, all children were actively engaged in all classroom activities during the recording sessions. The data collected on each typically hearing matched peer was consistent in all areas for each recording session.

Site four was one of nine inclusive preschool classrooms at a public school preschool center. There are classrooms for three, four, and five year old students within this center. In addition to the preschool classrooms, there is one transitional kindergarten classroom at this center. Children enrolled at this center represent African American, American Indian, Caucasian, and Hispanic racial groups.

The inclusive preschool classroom in which the typically hearing matched peer observations for the children from site three occurred was also designed as a center-based learning classroom. The activity centers were arranged around the perimeter of the classroom and included: Dramatic Play, Discovery, Sand/Water, Literacy, Art, Listening, and Manipulatives. Appropriate visual images and written word labels in both English and Spanish were hung on the wall above or near each center to indicate the different centers. Student work was displayed on all walls and windows at the children's eye level. The large group interaction area was located in the center of the room and was delineated with a large oval shape area rug.

There were three developmentally appropriate sized rectangular tables with four chairs each located along the back wall of the classroom. The tables were located in two rows in the back area of the classroom, near the manipulatives center. Students sat at the tables for meals, snacks, and when working at the Manipulatives center. The children were allowed free access to the learning center activities during the first half hour of the day, following large group time, and after their afternoon rest period. In addition to the developmentally appropriate student sized furniture, the classroom contained one teacher desk and one work table. The students were able to access all work materials independently. The children were responsible for cleaning up the work/play areas at the conclusion of the day; however, adult supervision and assistance was provided as necessary. The classroom had its own bathroom with a toilet; the sink was located outside the bathroom in the classroom proper area. Student cubbies for backpacks and personal items were located near the entrance.

The teacher used recorded music as the transition indicator to let the children know when it was time to switch tasks. When the children were louder than allowed, the teacher would turn off the lights; when the children lowered their voices, the teacher would turn the lights back on. During the center based activity learning opportunities, the teacher and assistant monitored the classroom by walking from center to center and engaging the children in verbal exchanges. If any children acted inappropriately, an adult would speak with them quietly to remind them of the classroom rules and expectations, and allow them to return to their work task.

Data Collection and Analysis System

Data was collected in each of the general education kindergarten classes and the self-contained preschool classroom over three consecutive days, approximately three hours each day, for a total of ten hours. Data was collected in the inclusive preschool classroom over three consecutive days for a total of four hours. There were fewer inclusive preschool classroom recording sessions due to the student schedule and because the data obtained was consistent from session to session. All recording sessions occurred during the center based learning opportunities facilitated in each classroom; therefore, the time of day of each recording session varied by classroom. The kindergarten students in one classroom were recorded in the late morning and late afternoon, while the students in the second kindergarten classroom were observed for the entire afternoon (1 pm-4 pm). The preschool students in the self-contained classroom were observed from their arrival in the morning until dismissal after lunch (9:30 am-1:30 pm). The preschool students in the inclusive preschool classroom were observed during the late morning. The difference in recording sessions was necessitated by the daily routine classroom schedules.

The Language Environment Analysis (LENA) system was used to collect and analyze the data discussed in this study. The LENA system has two components: digital recorders to collect data and software to analyze the data obtained using the digital recorders. The digital processor weighed approximately two ounces and was worn in a cloth pocket necklace or a fabric vest. The cloth pocket was the preferred method used in this study; however, in cases where the necklace was a distraction to the children under study, a vest designed by the LENA corporation, with a pocket in the front to hold the recorder and snaps that fastened in the back to keep the vest on were used. The LENA software allowed for tabulation of adult word count, child vocalization count, conversational turn count, and estimated mean length of utterance.

The adult word count provided the number of words spoken by all adults in the child's environment during the recorded time frame. The software did not differentiate between the adults in the environment; therefore, the adult word counts reported in this study incorporate verbalizations by the classroom teacher and paraprofessional. The child vocalization count provided the number of vocalizations produced by the child wearing the recorder. A child vocalization had to be surrounded by a break or pause greater than 300 milliseconds in duration, or an interruption by a change in speaker or interfering noise. The system was calibrated to recognize the child's voice as the primary child voice by the volume and strength of the vocal signal. This measure was dependent on the location of the digital recorder, which was six inches from the child's mouth and located on the middle of the child's chest. A conversational turn was counted by the system whenever a child vocalized and another individual responded within a five second span of time or vice-versa (LENA manual).

At the conclusion of each recording session, the data were downloaded to the DELL 32-bit operating system desktop computer. The computer requirements were outlined by LENA Foundation. The computer used was dedicated to analyzing the data for the duration of the study.

Procedure

This study of the conversational language skills of young children who received cochlear implants prior to the age of four years employed a two-tiered recruitment effort. As parents/guardians of children using CIs contacted the student researcher, she explained the purpose of and procedures for implementing the study. Parents were given up to one week to decide whether they wanted their child to participate in the study; the parents contacted the student researcher by phone or email to render their decision. All families (3) who contacted the researcher granted permission for their children to participate in the study. In addition to the three families that responded to the researcher, two professionals in early childhood education contacted families they worked with to alert them of the study. The early childhood educators explained the details of the study to the families and all families (2) decided to allow their children to participate in the study as well.

In the meetings with the administrators of each research setting, the researcher explained she was studying the conversational language skills of preschool and kindergarten students, in an effort to protect the confidentiality of the children using CIs; when meeting with the administrator of the self-contained preschool classroom, the researcher explained the actual purpose of the study to justify requesting permission to observe and record students at the facility. Each school administrator demonstrated approval of the project at their facility by completing a letter of support. At the conclusion of the study, the administrators, teachers, and paraprofessionals were informed of the study's focus on the conversational language skills of young children who received cochlear implants prior to two years of age (Appendix E).

To identify matched peer candidates as well as gather accurate classroom demographics the classroom teachers were asked to complete the Classroom Demographic sheet (Appendix B) for all students in the classroom. The completed sheets indicated age, gender, race, and teacher perceived overall language and vocabulary abilities for each child in the given classrooms. Once the teachers submitted their completed sheets to the researcher, she selected the typically hearing peer closest in age and perceived language and vocabulary abilities and of the same race and gender for each child using a CI and requested consent from the children's families for these children to participate as the matched peers for each dyad. While it was not necessary to do so, in the event that the first child in a particular classroom was not given family consent to participate in the study, the next most appropriate candidate's family would have been contacted; this process would have been followed until a typically hearing matched peer was identified for each child using a CI.

As the dyad pairs were identified, arrangements were made with the classroom teachers to schedule classroom recording sessions. Each session was arranged during normal classroom operating hours and parents of all children were aware that the student researcher was present in the classroom. All LENA recording sessions occurred in each classroom for a minimum of four and a maximum of ten hours of classroom activity time in which the children were given the opportunity to engage in open conversation with their peers. The minimum number of recording hours was used if the data showed consistency after four hours of recordings; additional hours, up to and including the maximum number of hours was recorded until consistency or the maximum number of ten hours was reached. Classroom recordings were scheduled for consecutive days until adequate data had been obtained. In the event that one of the focal children of a dyad was absent on a given day, recording of the child present occurred, and recording days continued until adequate data was obtained for each child. In the event that both focal children were absent on the same day, recording did not occur on that day and continued the next day either or both focal children were present. Ultimately, each focal child was recorded for 4-10 hours.

Prior to the first recording session in each classroom, the student researcher arranged with the classroom teacher to visit the classroom, be introduced to the students, and explain that even though she is an adult, she is a student in school just like they are and in need of their help to "complete her homework." The student researcher continued to explain that her homework involved watching the students as they went about their daily routines during various times of their school day, and while she was present, she would be watching, not working with the children and would ask some of them to wear a "cloth pocket necklace." Additionally, it was clearly explained that all students were helping the student researcher with her homework whether they wore a cloth pocket necklace or not. In the case of the inclusive classroom settings, vests with front pockets and fastening snaps on the back were used so the children would not be distracted by the cloth pocket necklaces.

Recorded and downloaded data were analyzed using the LENA software for the number of utterances spoken by each focal child, number of conversational turns encountered by each child, the number of adult initiated interactions with each child, and the each child's mean length of utterance during each recording session. During all LENA recording sessions, each focal child wore a LENA digital recorder/processor contained in a cloth pocket, worn around the neck like a necklace or the vest with a front pocket. The digital recorders/processors were turned on and placed in the pockets out of sight from all students and classroom adults. Additionally, a maximum of four other children in the classroom were asked to wear cloth pockets or vests identical in appearance, but containing a placebo device the same size and weight as the digital recorders/processors to those worn by the focal children. All other children in the classrooms were given an opportunity to wear a cloth pocket necklace containing a placebo device if they chose, as pocket necklaces were made available at a teacher determined classroom location.

At the conclusion of each recording session, the cloth pockets were removed from the children wearing them and the digital recorders/processors were turned off out of sight of all students and classroom adults. The recordings obtained using the LENA digital recorders/processors were downloaded to the DELL 32 bit operating system computer designated for that purpose following each recording session. Downloading of data occurred in an isolated location away from the classroom to prevent others not related with the study from having access to any identifiable information.

Quantitative Analysis

Data obtained from the LENA system analysis was further analyzed using the PASW statistical package. The means of each item considered in the data analysis (number of utterances produced by each child, number of conversational turns for each focal child, the number of adult initiated interactions with each focal child, and the mean length of utterance for each child) was compared using independent one tailed t-test comparisons. Independent samples *t*-test comparisons were selected as the analysis measurement in this study because the necessary analysis required testing the difference between the means of two independent subjects. As this study involved four independent dyads, specifically the members of each dyad pair compared to each other, it is likely that the sample means would differ by some amount; however, it is not certain that the difference will be large enough to be statistically significant. Independent samples *t*-test analysis allows for such determination. Further, since the population addressed in this study is so small, it was not possible to assume a normal distribution of scores, hence the independent t-test analysis was conducted using a one tailed test to determine level of significance (Howell, 2002).

Independent samples *t*-test comparisons were made within each dyad for each of the following measures:

- the number of vocalizations produced by each child. The number of vocalizations produced by each child was compared to determine whether there was a difference in the amount of active verbalizing and vocalizing engaged in by each child.
- the number of adult words spoken to each child. The comparison of the means for adult words spoken to each child provided an indication of a difference between the time teachers and paraprofessionals engaged each child verbally during the recording sessions.
- number of conversational turns engaged in by each child. Comparison of the conversational turn-taking means was conducted to provide an indication of whether a difference existed between children's ability to interact verbally with their conversational partners, regardless of whether they were adult or child partners.
- the mean length of utterance of each child. Comparison of the mean length of utterance for each child during the recording sessions was conducted to provide an indication of the age-appropriateness of utterance length.

CHAPTER IV

RESULTS

The overall purpose of this study was to compare the conversational language skills and interactions of children who were congenitally deaf or severely and profoundly hard of hearing and who received CIs prior to the age of four years with typically hearing peers. LENA DLPs and analysis software were used to determine child vocalization counts, adult word counts, conversational turn counts, and estimated mean length of utterance for the children using CIs and their typically hearing matched peers. The LENA software measured functional communication behaviors between classroom adults and the focal children as well as the child vocalization counts using frequency counts. The mean length of utterance for each child was determined by dividing the number of child vocalizations by the number of conversational turns initiated by each child.

In this chapter, data analysis of each dyad pair is reported. The data in this study was obtained by recording four dyads of children; two dyads in kindergarten settings and two dyads in preschool settings. The sample size of this study was small and did not lend itself to an inferential statistical analysis; however, it did allow for a detailed description of the data obtained in relation to the participants involved in the study. For this reason, independent samples *t*-test comparisons were made within each dyad for each of the following measures:

- the number of vocalizations produced by each child. The number of vocalizations produced by each child was compared to determine whether there was a difference in the amount of active verbalizing and vocalizing engaged in by each child.
- the number of adult words spoken to each child. The comparison of the means for adult words spoken to each child provided an indication of a difference between the time teachers and paraprofessionals engaged each child verbally during the recording sessions.
- number of conversational turns engaged in by each child. Comparison of the conversational turn-taking means was conducted to provide an indication of whether a difference existed between children's ability to interact verbally with their conversational partners, regardless of whether they were adult or child partners.
- the mean length of utterance of each child. Comparison of the mean length of utterance for each child during the recording sessions was conducted to provide an indication of the age-appropriateness of utterance length.

The hypothesis of this study assumed non-directional differences between two children in each dyad; therefore, a two-tailed analysis was conducted. For all statistical analyses, an a priori probability level of $p \leq .05$ was selected. The dependent variables in the analyses are the degree of hearing: use of CIs by children who are d/hh and typical hearing of the matched peers.

The dyad results for each kindergarten classroom will be provided by site as the children using CIs and their matched peers were in the same classroom. Due to logistical issues, it was not possible to observe children using CIs in an inclusive setting; therefore, the focal children using CIs were observed in a self-contained preschool classroom for children who are d/hh in southeastern VA; the matched peers were observed in an inclusive classroom in southeastern NC. Because data was collected in two different settings for each preschool dyad, the LENA outcomes for each preschool dyad will be recorded by dyad and not site. Results for each dyad, regardless of setting, will be discussed in the following phases: number of child vocalizations produced, number of adult words spoken, number of conversational turns, and the estimated mean length of utterance.

Site One (Kindergarten): Outcome of LENA Recordings

For all statistical analyses, an a priori probability level of $p \leq .05$ (2-tailed) was selected. The researcher conducted independent-samples *t*-tests to compare the CVC, AWC, CTC, and MLU between the child using the CIs and her matched peer. As illustrated in Table 1, the child using CIs had a higher child vocalization and conversational turn counts than her typically hearing matched peer; however, the differences were not large enough to be statistically significant (t=2.224, p=.052; t=2.138, p=.051, respectively). The adult word count was slightly lower for the child using CIs, yet the difference was not statistically significant (t=-.108, p=.915). When comparing the MLU, however, the mean score for the child using CIs (M=4.8) was statistically significantly higher than the mean for the child with typical hearing (M=4.46, *t*=3.172, *p*=.011). Thus, while there were no statistically significant differences for CVC, AWC, and CTC, there was a statistically significant difference in the mean length of utterances produced during the recorded sessions.

Table 1

Comparison of Focal Children at Site One (Kindergarten)

Variable	Child With CI (CA=6-4) *M* (*SD*)	Matched Peer (CA=6-2) *M* (*SD*)	*t*-value	*p*
Child Vocalization Count (CVC)	449.5 (303.2)	191.1 (126.8)	2.224	.052
Adult Word Count (AWC)	2159.8 (1317.3)	2244.5 (1784.0)	-.108	.915
Conversational Turn Count (CTC)	65.3 (38.6)	32.6 (19.4)	2.138	.051
Mean Length of Utterance (MLU)	4.8 (.15492)	4.460 (.20125)	3.172	.011

Outcome of LENA Recordings for Site Two (Kindergarten)

For all statistical analyses, an a priori probability level of $p \leq .05$ (2-tailed) was selected. The researcher conducted independent-samples *t*-tests to compare the CVC, AWC, CTC, and MLU between the child using CIs and his matched peer. The child using CIs had a higher CVC than his matched peer (*M*=851.7; 770 respectively); however, the difference was not statistically significant (*t*=.896; *p*=.420). Although the AWC was higher when the adults interacted with the child with typical hearing as opposed to the matched peer (*M*=6364.7; *M*=7408, respectively) this difference was not statistically significant (*t*=-.452; *p*=.675). There was no statistically significant difference between the estimated MLU for the child using CIs (*M*=4.14; *SD*=.159) and the typically hearing matched peer (*M*=3.85; *SD*=.203, *t*=1.915, *p*=.128).Therefore, as indicated in Table 2, there are no statistically significant differences in any of the conversational language measures for the two focal children enrolled at site two.

Table 2

Comparison of Focal Children at Site Two (Kindergarten)

Variable	Child With CI (CA=5-1) *M* (*SD*)	Matched Peer (CA=5-7) *M* (*SD*)	*t*-value	*p*
Child Vocalization Count (CVC)	851.7 (84.3)	770.0 (133.1)	.896	.420
Adult Word Count (AWC)	6364.7 (2332.2)	7408.0 (3252.6)	-.452	.675
Conversational Turn Count (CTC)	156.0 (80.0)	168.0 (81.0)	-.183	.864
Mean Length of Utterance (MLU)	4.14 (.159)	3.85 (.203)	1.915	.128

Outcomes for Preschool Dyad One

The child using CIs in preschool dyad one was 5 years 1 month of age, and an African American male. Per teacher report, he received his unilateral CI at three years of age, and demonstrates language and vocabulary skills that are well below age expectations. The child using CIs was recorded for six hours. The typically hearing matched peer was 5 years 2 months of age, and an African American male. The inclusive preschool teacher perceived his language skills to well below age expectations. The typically hearing matched peer was recorded for four hours. The time difference of the two recordings was due to children's attendance in their respective classrooms. While the recording times differed for the two focal children, both children were actively engaged in all classroom activities during the recording sessions and did not appear to be affected by wearing the cloth pocket necklaces.

For all statistical analyses, an a priori probability level of $p \leq .05$ (2-tailed) was selected. The researcher conducted independent *t*-tests to compare the CVC, AWC, CTC, and MLU between the child using CIs and his matched peers. As illustrated in Table 3, there were no statistically significant differences for CVC, CTC, or MLU. When comparing the AWC, however, the mean score for the child using CIs (M=8182.5) was statistically significantly higher than the mean for the child with typical hearing (M=2843.5, t=5.163, p=.048). Thus, while there were no statistically significant differences for CVC, CTC, or MLU, there was a statistically significant difference in the AWC.

Table 3

Comparison of Focal Children of Preschool Dyad One

Variable	Child With CI (CA=5-1) *M* (*SD*)	Matched Peer (CA=5-2) *M* (*SD*)	*t*-value	*p*
Child Vocalization Count (CVC)	621.5 (115.3)	790.0 (41.0)	-1.948	.261
Adult Word Count (AWC)	8182.5 (1222.6)	2843.5 (802.6)	5.163	.048
Conversational Turn Count (CTC)	282.0 (76.4)	181.5 (31.8)	1.718	.285
Mean Length of Utterance (MLU)	2.91 (.396)	3.8 (.000)	-3.179	.194

Outcomes for Preschool Dyad Number Two

The child using CIs in preschool dyad two was a 4 years 3 month old Caucasian male, who used a unilateral CI and a hearing aid in the opposing ear. Per teacher report, he was aided at eight months of age and received his unilateral CI at 2 years 6 months of age, and demonstrates language and vocabulary skills that are well below age expectations. The child using CIs was recorded for six hours. The typically hearing matched peer was a 4 years 3 month old Caucasian male. The inclusive preschool teacher perceived his language skills to be well below age expectations. The typically hearing matched peer was recorded for four hours. As with preschool dyad one, the time difference of the two recordings was due to the children's attendance in their respective classrooms. The child using the CI and hearing aid did not appear to be affected by wearing the cloth pocket necklace as he interacted with his classmates and teachers in a calm and natural manner. The matched peer appeared to be bothered by the cloth pocket necklace, but when asked by the teacher if he wanted to take it off, he said no. During the recording time in the inclusive classroom, the matched peer did not appear to engage with his classmates or the classroom adults, preferring to play alone.

For all statistical analyses, an a priori probability level of $p \leq .05$ (2-tailed) was selected. The researcher conducted independent *t*-tests to compare the CVC, AWC, CTC, and MLU between the child using CIs and his matched peers. As illustrated in Table 4, there were no statistically significant differences for CVC or MLU. When comparing the AWC, however, the mean score for adult words spoken to the child using the CI and hearing aid (M=7803.5) was statistically significantly higher than the mean for the matched peer with typical hearing (*M*=1244.0, *t*=12.935, *p*=.001). Additionally, when comparing the CTC, the mean score for the child using the CI and hearing aid (*M*=270.5) was statistically significantly higher than the mean for the matched peer (*M*=51.70, *t*=11.710, *p*=. 001). Thus, while there were no statistically significantly differences for CVC or MLU, there were statistically significant differences in AWC and MLU.

Table 4

Comparison of Focal Children of Preschool Dyad Two

Variable	Child With CI (CA=4-3) *M* (*SD*)	Matched Peer (CA=4-3) *M* (*SD*)	*t*-value	*p*
Child Vocalization Count (CVC)	767.5 (26.2)	397.7 (423.2)	1.171	.326
Adult Word Count (AWC)	7803.5 (438.1)	1244.0 (605.4)	12.935	.001
Conversational Turn Count (CTC)	270.5 (26.2)	51.7 (17.0)	11.710	.001
Mean Length of Utterance (MLU)	3.2 (.346)	2.87 (.000)	1.531	.368

Summary

It is not possible to make generalizations from dyad to dyad or the population at large due to the small sample size of kindergarten and preschool students in this study who received CIs prior to age five years. Nor is it possible to compare the kindergarten dyads with the preschool dyads due to the difference in implantation age. While the results of this study can not be used to make holistic comparisons to the population of young children who received CIs early in life, it is possible to discuss the data analytically for each dyad in the study.

It is interesting to note, that there was no statistically significant difference for the mean child vocalization, adult word, or conversational turn counts between the kindergarten children using bilateral CIs and their typically hearing matched peers. The only measure for which the data indicates a statistically significant difference between the kindergarten students is for the estimated mean length of utterance for the female dyad. Overall, the results of this study indicate the two kindergarten children using CIs demonstrated language and vocabulary development commensurate with their typically hearing matched peers.

It is clearly evident within the preschool dyads, that there was no statistically significant difference in either dyad for CVC or MLU. The data of this study indicates there was a statistically significant difference in AWC between the two preschool dyads. It is not possible to draw cause/effect relationships based on statistically significant differences obtained from descriptive statistics; however, a difference between the AWC of the two teachers was noted. Finally, it is interesting to note that while the kindergarten students appeared non-plussed by the presence of the cloth pocket necklaces, it may have been an item of consternation for the typically hearing matched peer in preschool dyad two. While it is not possible to definitively identify the child’s behavior in response to the cloth pocket necklace as the cause for the statistically significant difference in CTC, it is a possibility that must be considered. It must be noted that the age of implantation is another factor that limits the possibility of comparing the preschool dyads to the kindergarten dyads.

CHAPTER V

DISCUSSION

The overall purpose of this study was to compare the conversational language skills and interactions of children who were congenitally deaf or severely and profoundly hard of hearing and who received CIs prior to the age of four years with typically hearing peers. As this was a quantitative study, frequency count data of child vocalization/ verbalization, adult word, and conversational turn counts, as well as estimated mean length of utterance for the children using CIs and their typically hearing matched peers were the foundation of the study. Specifically, the frequency count data was used to address the following questions regarding functional communication skills: (a) does the child vocalization count differ between the two children in each dyad, (b) does the adult word count directed to the children differ between the two children in each dyad, (c) does the number of conversational turns differ between the two children in each dyad, and (d) does the mean length of utterance differ between the two children in each dyad.

The results of this study indicated that there were no statistically significant differences between the child vocalization, adult word, or conversational turn counts between the children using CIs and their typically hearing matched peers for the kindergarten dyads. There was a statistically significant difference in MLU for the female dyad. The analysis of the conversational language skills of the preschool dyads indicated that while there was no statistically significant difference in the child vocalization count or the mean length of child utterance, there was a statistically significant difference between the adult word and conversational turn counts between the children using CIs and their typically hearing matched peers. While the functional communication behaviors between the focal children and the classroom adults involved in this study were examined through the lens of objective quantitative data, it is not possible to suggest ways to effectively use this information without also discussing some of the subjective, qualitative features gathered informally in this study. Therefore, this section will discuss the results within the context of daily life and how they might influence teacher practice and/or teacher preparation.

Nature of Educational Research

Maxwell (2005) describes his qualitative research design model as having different components which form an integrating whole, in which each component is closely tied to the others rather than being linked in a linear or cyclic sequence. The nature of this exploratory, descriptive research study was to study the conversational language skills of young children using CIs as compared to their matched peers with typical hearing employing a quantitative design. As Maxwell indicates and this researcher believes, it is not possible to reduce any research study, particularly one involving the communication and conversational language skills of human beings to quantitative data alone.

This study was designed to study six dyads of children, each composed of one child using a CI received prior to the age of two years, and a matched peer with typical hearing. This seemed to be a straight forward study, with clearly defined participants. The pilot study designed to address the investigation of the conversational language skills of young children who received cochlear implants prior to the age of two years went very smoothly. A participant using CIs and a matched peer with typical hearing were easily identified using the recruiting method described in the methods section of this dissertation; each focal child and the passive participants in the classroom were eager to participate in the study by wearing the cloth pocket necklaces; the classroom routine allowed for twice daily opportunities to record the focal children during center based learning opportunities.

Yet, when the dissertation study process was begun, it seemed the pilot study population was not at all a sample of the larger population. Recruiting participants was a difficult process as very few people would respond to the recruitment requests; this required the researcher to recruit participants from two different states, in two different preschool classroom settings. Obtaining clearance to observe at one location was delayed by a major snowstorm which closed state offices for over one week and delayed data gathering in two classrooms by over two months. Two of the preschool children using CIs with parental permission to participate in the study refused to wear the cloth pocket necklace or a vest to hold the digital recorder. This refusal made it impossible to gather data on these children, which meant the study involved four dyads instead of six dyads of children. Additionally, because this was a study of the conversational language skills of young children, to be successful in gathering data, the participants needed to talk with others; however, there were times when the participants' communicated non-verbally with their peers and the classroom adults. There were several instances when the focal children would use manual gestures (e.g., crooking a finger and bending it toward themselves in a "come here" gesture), physical overtures to gain attention (e.g., tugging on the teacher's sleeve; tapping a peer on the shoulder), or facial expressions (e.g., smiles, frowns, or confusion). When this occurred, it was not possible to gather recordable data, which may have affected the results.

Each component of this study was closely tied to several others, and the actions of any one component had an effect on the others. For example, the emotional demeanor of the focal children affected their interactions with the classroom adults and peers and opportunities for conversational exchanges. In situations where the focal children were not in the mood to talk with others, it was not possible to capture the conversational exchanges that occurred non-verbally. Additionally, the results suggest that the classroom settings and the behavior of the classroom adults may have affected the verbal/vocal behavior of the focal children. Finally, one of the limitations of this study, the inability to transcribe the recorded utterances to analyze them for complexity, affected the discussion of practical outcomes supporting early cochlear implantation. Specifically, in the one kindergarten dyad for which the quantitative data reported indicated there was a statistically significant difference in mean length of utterance, it was not possible to discuss if there was a difference in the complexity of the utterances or simply the number of words verbalized in each utterance.

Exploratory, descriptive research study employing a quantitative design appeared to be an uncomplicated method for completing this study; however, human beings, unlike electronic technology are complex beings. All participants in this study had their own individual personalities that affected the implementation of the study. The researcher had her agenda of needing to gather objective data within a practical time frame. The human involvement factor meant that on any given day, circumstances could affect the data gathered. It was discovered that research regarding the human behavior of conversational language skills involves consideration of the integrated and interacting whole and cannot be viewed through a linear or cyclic sequence lens.

Conversational Language Skills of Young Children Using CIs

Previous research has shown the importance of UNHS and the early identification of hearing losses in young children (Boothroyd, 1992; Cunningham & Cox, 2003; Gabbard & Shryer, 2003; Houston et al., 2003; Luterman, 2006; NCHAM, 2009; Yoshinago-Itano, 1998a, 1998b, 2003, 2004; Yoshinago-Itano et al., 1998). Reasons for supporting UNHS include: (a) providing appropriate amplification to children born d/hh as early in life as possible, (b) making appropriate referrals to necessary specialists, and (c) facilitating the development and maintenance of spoken language and listening skills for learning and social-emotional development (Joint Committee on Infant Hearing, 2007; Pediatric Work Group, 1996). Additionally, a significant body of professional research exists documenting the importance of early intervention. In particular there is evidence that early intervention allows the opportunity for young children who are born d/hh to develop age appropriate receptive and expressive language and vocabulary skills (Brinton, 2001; Geers et al., 2003; Moeller, 2000; Stredler-Brown, 1998; Yoshinago-Itano, 2004; Yoshinago-Itano et al., 1998). However, a paucity of information exists regarding the interaction between the development of age-expected receptive and expressive language, vocabulary skills, and the functional use of those skills during spontaneous conversational interactions with peers.

The child vocalization count results disclosed in this study indicate there was not a statistically significant difference in any of the four dyads. Regardless of the grade (preschool or kindergarten), age at time of implantation (ranging from twelve months to three years), or unilateral or bilateral implantation, all four children using CIs and their typically hearing matched peers used the same number of vocalizations/verbalizations when speaking with other children and adults in the classroom. Additionally, there was no statistically significant difference in the conversational turn counts between the adults and any of the children in the kindergarten dyads, nor was there a statistically significant difference in the mean length of utterance between the children in three of the four studied dyads. These consistent results across dyads appear to support the research indicating that UNHS, early intervention, and cochlear implantation early in life allow young children born d/hh to develop expressive language and communication skills commensurate with their typically hearing peers.

The analysis of the quantitative data made it possible to show that each of the children using CIs in this study was able to demonstrate conversational language skills commensurate with their typically peers, but it was not able to show the possible real-life influence of CI use. Each focal child in this study using CIs was able to speak using age appropriate articulation skills and vocal quality skills. Specifically, the vocal quality of the children who were d/hh and using CIs did not have any tonal qualities associated with "deaf speech" such as stridency, lack of intonation changes, or speech rhythm abnormalities. Without visual access to the classroom settings, it was not possible to identify the children using CIs from their classmates, as there was no aspect of their speech production that indicated they were d/hh. Because each of the male subjects in this study had short hair, it was visually apparent that they were using CIs; yet for the female in the study who had long hair which covered her CIs, it was not. By the nature of cochlear implantation, each of the focal children using CIs were d/hh when not using the CIs; however based on their verbal proficiency in classroom settings, it appears that the early identification of such hearing losses, the early intervention received, and the daily, routine use of CIs early in life has allowed them to develop expressive language and communication skills commensurate with their peers with typical hearing.

It was also notable to observe the communication and conversational language skills of the young children using CIs in the classroom setting with classroom adults and peers and with their parents. In the classroom settings, each of the four focal children using CIs communicated with the classroom adults and other children without apparent difficulty, regardless of the physical distance from the speaker. It did not appear that any of the focal children using CIs had preferential seating in the classrooms during large group interactions, nor did they position themselves within close physical proximity to the classroom adults when receiving verbal directions. However, during informal observations of the focal children using CIs interacting with their parents in the classroom during arrival/departure times or times when the parents were volunteering in the classrooms, the focal children using CIs behaved differently. When interacting with their parents, each of the four focal children using CIs moved to within three feet of their parents and two of the four children tugged on their parents' arm or shirt to gain attention prior to speaking. One focal child using CIs even cocked her head to the side, looked at her mother and asked for repetition of directions each time they were given, a behavior unobserved in ten hours of classroom interactions with the classroom adults.

This communicative difference of the children when interacting with classroom adults and parents was an interesting phenomenon to observe. In reflecting on the exchanges observed, this researcher has hypothesized it may have occurred for any of four possible reasons. First, the parents of each focal child were their first language trainers prior to and following cochlear implantation. The AO and AV approaches to language development of children who are d/hh are based on children learning to pay attention and respond to auditory input. Parents and family members are taught how to help the child focus on auditory input. It is quite possible that the attention getting behaviors observed could be the strategies developed as the children initially learned language. Secondly, human beings are creatures of habit. If the children were demonstrating behaviors they developed during initial language facilitation opportunities with their parents, neither the children nor the parents may have been aware of this behavior since it had become a habit. Thirdly, it is possible the child who cocked her head to the side and asked her mother to repeat all directions was testing her teacher and her mother. Human beings, particularly children, will test the limits placed upon by the settings in which they find themselves. It is possible that this child was simply "playing the system" to see how either or both adults would respond. It is also possible the child wanted her mother's attention to herself, and did not want to share her mother's attention with the other students in the classroom. While the child was speaking to her mother and requesting repetition of the directions, it was not possible for the mother to work with any other children. Finally, it is possible the observed behaviors were just that: behaviors observed on that particular day. Further study of the communication language behaviors of young children with CIs with classroom adults and parents/other family members may be productive research study to pursue to provide clarification of this behavior.

Conversational Language Skills of the Classroom Adults

There was no statistically significant difference in the adult word counts directed at any of the children in the kindergarten dyads; however, there were statistically significant differences in the adult word counts for both of the preschool dyads. In each preschool dyad, the adults in the self-contained preschool classroom for children who were d/hh used significantly more words with the children using CIs than the adults in the inclusive preschool classrooms used with the typically hearing matched peers. This finding is not generalizable from dyad to dyad within this study or to the population at large due to the small sample size of this study; however, it does allow an opportunity to consider why such differences were noted.

One reason for the statistically significant differences in the adult word counts in the preschool dyads is the fact that two different teachers were involved. By personal account, the preschool teacher in the self-contained classroom disclosed that she was a speech-language pathologist who became a preschool teacher; she was accustomed to providing language facilitation in a directive, one-on-one situation as opposed to large group situations. She admitted she was a directive teacher, but felt that was necessary so she could accomplish as much as she could to help her students master language skills in the short time she had with them each day. The teacher in the self-contained classroom was also aware that as her students entered kindergarten, the language demands expected of them in terms of listening, having to discriminate speech in noisy environments, having to ask others to repeat themselves, and responding appropriately to auditory input in the presence of competing distracters such as others talking and speakers who use a low volume would increase. It was her opinion that it was her responsibility to overtrain language skills for her students so using them would become automatic in all settings.

The teacher in the preschool inclusive classroom felt it was her responsibility to provide learning opportunities in all developmental domains without directing their activity. While she allowed the students ready access to the learning activity centers in the classroom and followed their lead in responding to them and their interaction with the materials, she did not use much verbal direction. As observed, this teacher frequently responded to the conversational exchanges initiated by the children, and only rarely initiated the conversational exchanges herself. It appears that due to the inclusive classroom teacher's philosophy that learning opportunities in the classroom should be teacher facilitated and child directed, there may have been less demand for her to verbally interact with the children. The two kindergarten teachers involved in the study demonstrated that a teacher facilitated, child directed approach to learning could possibly account for the absence of any statistically significant differences in adult word count. As the kindergarten teachers appeared to share similar teaching philosophies, the fact that no statistically significant differences in the adult word count was an expected result.

While early childhood educators support providing early intervention to all preschoolers in inclusive settings whenever possible (Grisham-Brown, Hemmeter, & Pretti-Frontczak, 2005), based on the results of this study, it is possible that adult directed instruction in a self-contained setting during the preschool years allows young children using CIs to develop the receptive and expressive language skills necessary to perform at levels commensurate with their typically hearing peers in kindergarten and subsequent academic years. Both preschool teachers were special education trained teachers, which suggests they plan instruction to meet the individual needs of their students. The preschool teacher in the inclusive setting appeared to be as aware of the language abilities and needs of her students as the preschool teacher in the self-contained classroom was of the language abilities and needs of her students. Each teacher used conversational interaction skills to facilitate student learning and often asked for students to indicate they understood what was expected them. In the preschool setting, students were asked to repeat directions or demonstrate the appropriate behavior, to indicate they understood the teacher. This awareness may explain the difference in the adult word counts for these two teachers. Moreover, the kindergarten teachers appeared to treat all children in their classrooms in a similar fashion. There was no variance in the verbal directions given to all children, nor did the teachers ask for any clarifications or verification that the students understood what was expected of them. While it is not possible to make any generalizable statements about these differences, it is possible that the awareness of and response to individual student differences in a self-contained preschool environment by a teacher trained to address individual student needs might help young children using CIs in kindergarten settings to demonstrate conversational language development at levels commensurate with their matched peers with typical hearing.

The findings in this study also imply it would be worth investigating the effectiveness of early childhood education presented in a self-contained or inclusive setting for young children implanted early in life. Such investigations could impact the service delivery options for young children born d/hh and who use CIs. The two fundamental components of the Individuals with Disabilities Education Act (IDEA) are that: (a) all children are entitled to a free, appropriate, public education (FAPE), and (b) the FAPE is provided in the least restrictive environment (LRE). Most often, LRE is referred to as mainstreaming or inclusion in general education/inclusive settings; however, mainstreaming or inclusion is to be secondary to the need for providing a free, appropriate public education (Wright's Law, n. d.). It is not possible to explain the differences in adult word count and its possible effect on the conversational language development of young children as they progress from preschool to kindergarten based on this study; however the results suggest further investigation for its relation to determining the LRE for young children using CIs. The statistically significant differences in the adult word count between the two preschool teachers when interacting with their students suggests that young children using CIs need both teacher directed instruction to develop age appropriate language skills as well as teacher facilitated learning opportunities to develop age appropriate social and emotional skills. If this is true, young children using CIs need to be supported by an educational service delivery model that allows for both learning opportunities: teacher directed as well as teacher facilitated experiences within the classroom. To accomplish this, teachers and families need to understand that LRE is a philosophy, not a placement and they need to advocate for young children who are using CIs to receive services in both settings as determined by individual student need.

Additional Preschool and Kindergarten Differences

This study was designed to investigate the conversational language development of child vocalization, adult words spoken, conversational turns, and mean length of utterance of children who were d/hh and used CIs. As the data were analyzed, two other areas of concern emerged: (a) did the age of implantation affect the results obtained, and (b) did the use of unilateral or bilateral CIs affect the results obtained. Because of the issue previously mentioned regarding participant recruitment, it was not possible in this study to separate the issues of age of implantation or use of unilateral versus bilateral cochlear implants; however, they are worthy of future investigation.

Both kindergarten students consistently used bilateral cochlear implant technology by two years of age, providing each of them with over three years experience with the CIs and exposure to digitally enhanced auditory input. Both preschool students in this study who were d/hh used unilateral CIs received at or after 2 years 6 months of age, providing them with a maximum of two and a half years experience with the CIs and exposure to digitally enhanced auditory input. It would be interesting to note if the differences noted in the two groups was due to age of implantation or the use of one or two CIs. Investigating the influence of these factors could also support the importance of determining the LRE for each student based on individual need.

Limitations of the Present Study

As with any research study, there are several limitations and challenges that need to be discussed. First, it was not possible to insure that that the focal children using CIs in this study were representative of the larger population of young children using CIs; as mentioned previously in this chapter, the small sample size makes it impossible to make any generalizations to the population of young children who are born d/hh and receive cochlear implants early in life. Three of the four focal children using CIs in this study were male, which does not allow for the consideration of gender differences in this population.

Secondly, the language abilities of the focal children using CIs were based on teacher perception of those skills and typically hearing matched peers were selected accordingly using the same teacher perception of ability. It appears that the teacher's knowledge of the students in all settings was appropriate; however, it was not possible to discern that empirically. It would have provided more rigor to the study and the outcomes if the vocabulary and language abilities of the focal children using CIs and subsequent matched peer candidates were determined using standardized assessments of vocabulary and language skills usage as well as transcribed conversational language samples.

The use of a standardized receptive and expressive language skills instrument (i.e., Preschool Language Scale-4 or Reynell Developmental Language Scales) and receptive vocabulary assessment instrument (i.e., Peabody Picture Vocabulary Test-4) would have allowed for a clear description of the focal children's language growth as opposed to relying on teacher perception. Transcribed language samples of all focal children involved in the study would have provided snapshots of each child's spontaneous conversation. Such transcribed conversational samples could have been used to document receptive and expressive vocabulary development; use and understanding of slang, idioms, and humor; maintenance of conversational topic; ability to transition from one topic to another; and conversational turn taking skills with peers. Additional contextual observations or analysis of video recordings could have supplied valuable information regarding strategies used by the focal children to gain the attention of conversational partners, understanding and use of personal space and body language, and understanding and use of vocal tone and inflection.

Thirdly, the inability to establish typically hearing matched peers for the focal children using CIs in the self-contained preschool setting was a limitation because although matched peer comparisons were possible, the adult word and conversational turn counts were based on different adults interacting with different children. A further complicating factor is that the self-contained classroom was in VA and the inclusive classroom was in NC, introducing the possibility of cultural and socio-economic differences in the two classrooms. Based on the available data in this study, it is not clear if the difference in adult word and conversational turn counts is due to the innate conversational communication tendencies of the adults, the classroom setting (inclusive or self-contained) or the innate personality differences of the children and adults. In the future, recording children in inclusive settings might provide more validity to the results obtained. As educational options increase for young children with special needs, the effect of this limitation may be reduced or eliminated.

Fourth, the electronic analysis of the downloaded digitally recorded data simplified the data analysis process; however, it reduced the contextual information available to the researcher. In the future, pairing electronic analysis with transcription of audio recordings and contextual or video-based observations would provide a much clearer description of the various factors contributing to conversational effectiveness. The current study allows for conclusions drawn on frequency counts alone; as previously discussed, future studies may need to consider use of physical space, method of conversational initiations and maintenance of conversational exchanges, and the complexity of child produced verbalizations to provide a more global view of conversational language skills of young children.

Finally, the current study analyzed and discussed the conversational exchanges of the focal children with the adults in their environment. To achieve a complete understanding of how well young children using CIs use conversational language features on a daily basis, it is necessary to analyze their verbal interactions with their peers. The data analysis in this study using the LENA software only was not able to provide such information. In the future, it would provide more information if the data was analyzed using the LENA Advanced Data Extractor (ADEX) standalone software utility to process audio recording files. The ADEX extends the scope of the LENA software beyond the measures of child vocalization, adult word, and conversational turn counts. Using the ADEX, the researcher can focus on conversational language features such as child-child verbal exchanges and child versus adult conversational initiations (Infoture, 2009).

Implications for Professionals

It appears that the most interesting finding in this study was the statistically significant difference in adult word counts with each preschool dyad. As previously discussed, this study is not able to determine the causal influence for this difference, but it is possibly related to the classroom setting (self-contained or inclusive), teaching style (teacher directed or teacher facilitated learning), cultural context of the classroom, or a combination of any or all suggested influences. Regardless of the influencing factors, the results of this study suggest considerations for pre-service and in-service professional development.

Early childhood education programs need to increase pre-service and in-service teachers understanding of the continuum of available classroom settings to provide classroom learning opportunities to all children. Additionally, pre-service and in-service teachers need to be knowledgeable of how to advocate for students so appropriate educational decisions can be determined. IDEA requires that children receive a free, appropriate, public education in the least restrictive environment. Unfortunately, not all school systems interpret the law in the same way or as the law is intended (www.wrightslaw.com); therefore, there are instances in which students receive educational services in settings that are beneficial to the school district, not the child. Furthermore, professionals and parents are uncomfortable in refuting decisions determined by school administrations. Pre-service and in-service teachers should understand that there is not a one size fits all approach to the education of young children who are d/hh and using CIs. It is crucial that all teachers be aware of individual student learning needs and that they provide instruction in the least restrictive environment.

In addition to learning about and using the continuum of educational setting options, pre-service and in-service teachers should learn and use a wide variety of educational strategies when working with young children who are using CIs. It is necessary to provide teacher preparation instruction and professional development in using teacher directed as well as teacher facilitated learning opportunities. No one strategy will work in all instances and teachers need to be prepared to meet individual student needs. Early childhood and special educators should broaden professional horizons and extend their comfort zones beyond their personal philosophies of education to enhance their effectiveness as educators.

Implications for Future Research

This research study examined and described the conversational language skills of young children who received cochlear implants prior to four years of age. Through the process of this dissertation study, several topics for future research emerged. They include: (a) using standardized assessment and language sampling to provide more rigorous determinations of receptive and expressive language and vocabulary abilities of focal children, (b) conducting a similar study that allows for recordings throughout the entire school year, (c) conducting a study comparing the adult communication exchanges of teachers in inclusive and self-contained classrooms, (d) conducting a similar study that allows for comparison of children receiving CIs prior to one of age, two years of age and after two years of age, and (e) investigating the effect of unilateral versus bilateral cochlear implantation. As discussed in this chapter, studies in each of these areas would clarify the effect of the specific factors on the conversational language development of young children implanted early in life. As the effect of each factor could be empirically explained, those results could facilitate improvements in pre-service and in-service professional development for educators working with young children using CIs. It is an accepted fact that the first three to five years of a child's life are crucial for learning language; in the case of children born d/hh and using CIs, it is critical that those years of essential learning are maximized with appropriate auditory and spoken language skills intervention.

As mentioned in the limitations of this study, the language and vocabulary abilities of the focal children using CIs were determined by teacher perception. While it appears the teachers' perceptions were accurate and allowed for appropriate matched peer selection, this would have been better approached from an empirical basis if standardized assessments and conversational language samples had been used. It would clearly add more to the body of research regarding the effectiveness of cochlear implantation in young children if a similar study was conducted in which the focal children using CIs and possible matched peer candidates were evaluated with standardized vocabulary and language assessment instruments as well as transcribed language samples. This could be achieved by using a vocabulary measure such as the Peabody Picture Vocabulary Test or the Receptive and Expressive One Word Picture Vocabulary tests, a language measure appropriate for the age of the focal children, and transcription of five minute conversational samples. Transcribed language samples for each focal child would allow for an analysis of the complexity of the utterances spoken, function of spoken utterances, and ability to initiate and maintain a conversational topic as well as contribute to the validity of the standardized assessment scores.

The current study was completed during the second half of the school year. A future research agenda would suggest implementing a similar study within the first month of school and continue it across the entire school year. Such a prolonged research agenda would provide more in-depth and comprehensive exploration of the conversational language growth of young children implanted early in life. Furthermore, it would enable the researcher to determine if the vocal behavior of the adults and the focal children change over time as rapport is developed and communication expectations in the classroom setting are established.

Another area for future research is to explore the conversational communication strategies of the adults and the setting in which they teach as it effects the overall communication of young children using CIs. The data reported on the preschool dyads in this study, indicated a difference in the adult word count as it related to the focal children with CIs and their typically hearing peers. As mentioned in the results chapter, both teachers had over six years of teaching experience, but their experience was gained in distinctly different classroom settings. Future studies investigating the communication behaviors of the classroom adults would also provide empirical data to guide professional and parental decision-making for classroom placement of young children using CIs. Currently, professionals on CI teams emphasize the need for the children to receive language training in self-contained settings (CASTLE, 2008), while early childhood educators support providing early intervention to all preschoolers in inclusive settings whenever possible (Grisham-Brown, Hemmeter, & Pretti-Frontczak, 2005). While the sample size of this study is small, the findings suggest that both perspectives may play a significant role in the language and communication development of young children using CIs. Specifically, further research is needed to determine if intense, teacher-directed language in self-contained preschool settings allows young children using CIs to communicate at levels with their hearing peers in kindergarten and subsequent school years.

The available body of professional research indicates that the age of cochlear implantation has a significant effect on the language and social outcomes of children. A future study with a larger sample size comparing the conversational language development of children implanted a various ages during the critical language development years of birth through five years would provide information to facilitate development of more early identification and intervention programs for children born d/hh. Additionally, it would provide more empirical information to guide professional recommendations and parental decision-making regarding cochlear implantation.

Finally, one of the unintended features of this study was that both focal children in the kindergarten setting who were d/hh used bilateral CIs. The two preschool children who were d/hh used unilateral CIs and one of those children used a hearing aid as well. Bilateral cochlear implantation of young children is rapidly increasing and available research investigating the magnitude of difference in the language development of young children using bilateral as opposed to unilateral implants is minimal. Based on the results of this study, it appears the children using bilateral cochlear implants in this study experienced conversational language opportunities in classroom settings that were similar to their peers. It was not possible to report on dyads of kindergarten children using unilateral implants. However, since the preschool students who were d/hh used unilateral CIs and did demonstrate conversational language differences with their typically hearing matched peers, the results suggests that such a study would be worthwhile.

Conclusion

The exploration of the conversational language skills of young children using CIs provided an opportunity to examine the effect of early cochlear implantation on the use of conversational language strategies with adults in the child's environment. Using quantitative methods to describe the relationship between the conversational language skills of young children using CIs and their typically hearing matched peers provided for the creation of a richer profile of the possibilities for intervention as well as language skills development and use for children implanted early in life. The small sample size in this study, four dyads, does not allow for generalization of the results from dyad to dyad or the larger population; however, it does suggest that cochlear implantation early in life with appropriate early intervention and conversational exchanges with others may significantly increase a child's potential to develop age appropriate conversational language.

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Appendix

Demographic Information for All Sites

Demographic Information for Site One (Kindergarten)

Site One Students							
Gender			Teacher Perceived Language and Vocabulary Skills (Number of students in each category)				
Male	Female	Race	Well Below Average	Below Average	Average	Above Average	Well Above Average
2	1	Asian			2	1	
4	3	Black		1	5	1	
5	4	Caucasian	1		5	1	2
0	1	Hispanic		1			

Demographic Information for Site Two (Kindergarten)

Site Two Students							
Gender			Teacher Perceived Language and Vocabulary Skills Number of students in each category)				
Male	Female	Race	Well Below Average	Below Average	Average	Above Average	Well Above Average
0	3	Asian				1	2
0	1	American Indian					1
9	2	Caucasian			4	3	4
0	1	East Indian			1		

Demographic Information for Site Three (Preschool)

Site Three Students							
Gender			Teacher Perceived Language and Vocabulary Skills (Number of students in each category)				
Male	Female	Race	Well Below Average	Below Average	Average	Above Average	Well Above Average
1	0	Black	1				
2	2	Caucasian	1	2	1		
0	1	Hispanic	1				

Demographic Information for Site Four (Preschool)

Site Four Students							
Gender			Teacher Perceived Language and Vocabulary Skills				
Male	Female	Race	Well Below Average	Below Average	Average	Above Average	Well Above Average
2	1	American Indian			2		1
3	1	Black	1	1	1		1
4	3	Caucasian		1	2	3	1
1	1	Hispanic	1		1		