

The Impact of Language Input on Deaf and Hard-of-Hearing Preschool Children Who Use
Listening and Spoken Language

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ABSTRACT

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The purpose of the study was to investigate the influence of the quantity of adult language input on their deaf and hard-of-hearing preschool children and to explore the effects, if any, on the child's quantity of language, vocabulary development, and basic concept understanding. Using audio recording and the Language ENvironment Analysis (LENA) software, the study involved 30 preschool children with hearing loss who used spoken language as their communication modality and 7 children with normal hearing. Their language and the language spoken to them in all waking-hours of a two-day period (16 hours per day) were recorded and analyzed quantitatively as adult word counts (AWC), child vocalizations (CVC), and conversational turns (CTC). These components were compared to the child's performance on the *Boehm Test of Basic Concepts* (BTBC-3) and the *Peabody Picture Vocabulary Test* (PPVT-4) to investigate if the quantity of language input had an effect on the child's usage of vocabulary and basic concepts. Correlations were found between the amount of adult words, child vocalizations, and conversational turns across weekends and weekdays, but not on BTBC-3 or PPVT-4 scores. Interestingly, there were no significant differences between adult word counts and child vocalizations as a function of the child's hearing loss, indicating parents of deaf or hard-of-hearing children are using as many words with their children as parents of children with normal hearing. Additionally, scores on the BTBC-3 and PPVT-4 were correlated with each other, but there wasn't a statistically significant difference between the mean scores for children with

normal hearing and the children with hearing loss, indicating both groups scored similarly on the assessment. Results from this study suggest the language used around children impacts their language use and the amount of interactions they have in their environment. This is significant because it identifies the influence of the quantity of adult language input on the child's language development.

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Chapter 1

Introduction to the Study

Social interactionist theory of child language development posits children learn language through the social interactions in their environment. Several factors influence language learning in those contexts including the child's ability to access the language use with auditory access (Cole & Flexer, 2007), environmental differences (socioeconomic status) (Hart & Risley 1995), and quantity of adult talk around *and* with the child (Huttenlocher, Vasilyeva, & Cymerman, 2001).

Due to changes in newborn hearing screening laws including improved access to cochlear implants and digital hearing aids, parents are choosing listening and spoken language options for their children with hearing loss (Yoshinaga-Itano & Apuzzo, 1998). Additionally, children with hearing loss have improved access to the auditory information in their environment, especially speech, than ever before. Although improved, the hearing abilities/challenges of a child with hearing loss can still affect their language use (Blamey, 2003; Connor, Craig, Raudenbush, Heavner, & Zwolan, 2006; Geers & Hayes, 2011; Spencer, Gantz, & Knutson, 2004; Spencer, Barker, & Tomblin, 2003; Svirsky, Robbins, Kirk, Pisoni, & Miyamoto, 2000; Yoshinaga, Sedey, Wiggin, & Chung, 2017), basic concept understanding (Bracken & Cato, 1986; Davis, 1974; Harrington, DesJardin, & Shea, 2009), vocabulary learning (Connor et al., 2006; Fagan & Pisoni, 2010; Odom, Blanton, & Nunnally, 1967; Paul, 2001; Walter, 1978), and literacy skills (Blamey, 2003; Luckner & Cooke, 2010).

There are known factors that influence the language input for children with normal hearing (as well as children with hearing loss) including familial factors such as parental education (Dollaghan, et al., 1999; Pancsofar & Vernon-Feagans, 2006) and socioeconomic status (Hart & Risley, 1995; Huttenlocher, et al., 2001). In Hart and Risley (1995)'s hallmark

study, they investigated the early language environments of 42 families who came from lower, middle, and upper socioeconomic backgrounds. They found adult words spoken to children in the first three years of life predicted almost all of the variance in the children's language ability and IQ when the children were preschool aged. They approximated the amount of words spoken between the families from lower SES and the families from higher SES as the difference of 33 million words. This suggests the environment the child is raised in has an influence on the language used in that environment.

Along with demographic differences, research has also shown the language use in the child's environment is a factor in a child's language skills. Hoff-Ginsberg (1994) found that mothers who talked more had children who talked more, indicating the more proficient a language user the child is, the more linguistic input the parent provides to the child. Likewise, studying 64 toddlers, Vigil, Hodges, & Klee (2005) claimed parents might adjust their conversation style to match the communicative ability of the child. Furthering that finding, Conti-Ramsden (1990)'s work suggested the child's language is related to the conversational turns between the parent and child. She studied 14 dyads of mothers and children with typical language and 14 dyads of mothers and children with language delays. She found less complex recasts for parents of children with language delays. Taken together, these studies underscored the relationship between parental language and their children's language.

Although limited, similar results have been described with children with hearing loss. Prior to newborn hearing screening and common usage of digital hearing aids and cochlear implants, researchers found hearing mothers spoke differently to their deaf children than how hearing mothers spoke to their hearing children (Cheskin, 1981; Lederberg & Everhart, 1998), yet these results should be interpreted with caution as the hearing abilities and communication mode available to those children were not clear. In more recent work with children using

cochlear implants who chose a listening and spoken language approach, researchers found the children's language to be positively associated to mothers' quantitative and qualitative linguistic input (DesJarden and Eisenberg, 2007) and mother's usage of higher-level facilitative language techniques (DesJarden et al., 2014). These studies highlighted the links between the activities conducted by parents of children with hearing loss, the quantity of adult words spoken through those activities, and their child's language skills.

With improved technology to measure linguistic interactions such as the Language ENvironment Analysis (LENA) system, there is a growing body of knowledge related to measuring language within the home. These studies underscore the importance in terms of adult words spoken, child words spoken, and adult-child interactions as factors in deaf children's language acquisition. One of the first studies (VanDam, Ambrose, & Moeller, 2012) using this technology found no difference between the amount of adult words and conversational turns between a group of children with hearing loss and a group of children with normal hearing. Although, the researchers described the effects of background noise on the deaf child's ability to access the same amount of linguistic input as their hearing peers. Using a larger population of children (n=156), Ambrose, Walker, Unflat-Berry, Oleson, and Moeller (2015) found there to be significant differences between caregiver input over a 3-year visit between the children with normal hearing and the children with hearing loss.

Another area of the research using LENA describes interventions used to improve adult-child interactions and the children's environment. There were positive findings from several different programs. An intervention program focusing on 'talking more, tuning in, and taking turns' found quantity variables to increase significantly for their study group compared to their control group (Suskind et al., 2016). Additionally, Sacks, Shay, Repplinger, and Suskind (2014) used the LENA device as a feedback tool to improve adult and child linguistic behaviors.

The purpose of the present study is to extend previous research by examining the influence of the quantity of adult language for preschool children who are deaf or hard of hearing and determine the extent, if any, the role of the amount of adult input has on the quantity of child language, vocabulary development, and kindergarten readiness, measured using an assessment of basic concept knowledge. The following section provides background describing the changed landscape within deaf education and its impact on children with hearing loss and their families. It also sets the context of the study within the framework of social interactionist theory.

Background

Since the inception of federally mandated newborn hearing screenings, the landscape of deaf education has changed. Two to three out of every 1,000 births is diagnosed with permanent hearing loss every year (NIDCD, 2014). Of those diagnosed, 95% of children with hearing loss are born to hearing parents (Mitchell & Karchmer, 2004). Along with the changes in legislature for diagnosing hearing loss, technological advances have also intensified the changing landscape. Assistive hearing technology such as digital hearing aids, cochlear implants, brainstem implants, and frequency modulated (FM) and Roger hearing assistance technology systems are available to parents who choose spoken language as a communication modality for their child with hearing loss. This technology affords the child with permanent hearing loss the possibility to hear within near normal limits and to speak orally with greater intelligibility. It also provides these children the opportunity to participate in general education settings with minimal services. Such outcomes are possibilities with intensive intervention from specialized providers and trained parents (Cole & Flexer, 2007).

Although the technology purports to provide these children with hearing near normal limits, there remains a discrepancy between the language acquisition of a child with normal hearing and a child with hearing loss (Cole & Flexer, 2007; Schorr, Roth, & Fox, 2008;

Schirmer, 2000; Svirsky et al., 2000). A child with hearing loss has a more complete access to sound, the phonemic sound system, and oral language only after the date they receive and consistently wear their amplification. In the United States, the FDA has approved cochlear implantation in qualifying children at 12 months of age and older. Thus, in many cases, these children are 12 months language delayed and struggling to close the gap to their hearing peers. The child's hearing loss affects his/her ability to interact with the language users in the environment. Extending the perspectives of Vygotsky and Tomasello to deaf and hard of hearing children (explored in the section below), the auditory deprivation and challenged interaction could contribute negatively to the child's language development.

Due to this auditory deprivation, children with hearing loss are at a significant disadvantage to developing age appropriate vocabulary and later skills related to literacy (Luckner & Cooke, 2010). The literature suggests children with hearing loss have smaller lexicons, acquire new words at a slower rate, and have a narrower range of understanding concepts (Cole & Flexer, 2007; Easterbrooks & Estes, 2007; Lederberg, 2003; Lederberg & Spencer, 2001; Luckner & Cooke, 2010; Marschark & Wauters, 2008; Paul, 2009; Rose, McAnally, & Quigley, 2004; Schirmer, 2000; Trezek, Wang, & Paul, 2010). These challenges could be attributed to the lack of language access in their environment and interactions.

To investigate how this struggle is being addressed for these students, it is relevant to investigate the environment around these children. Furthermore, it is relevant to investigate how parents are interacting with their children. Parent language input varies greatly from family to family based on several factors (Hart & Risley, 1995). Studies have indicated that hearing parents from lower socio-economic environments and those who are less educated, speak less to their hearing children; consequently, their children also speak less (Hart & Risley; Huttenlocher et al., 2001), indicating quantity of language input is related to child language. Similarly, the

more proficient of a language user the child is, the more linguistic input the parent provides the child (Hoff-Ginsberg, 1994), indicating the hearing child's language abilities also affect parental input.

These foundational studies (and others) are grounded in theory that children learn language through socially mediated interactions in their environment. For young children, the most natural environment being the home. For children with hearing loss enrolled in specialized schools, those environments are of home and school. This study seeks to extend social learning theory to children with hearing loss who are learning to listen and use spoken English. The history of social learning theory and its main tenets are described below.

Social Learning Theory

Lev Vygotsky, born in czarist Russia, developed several theories and formulated many ideas about child acquisition of language and learning. Due to his short life (36 years) and the historical/political challenges of the time (1920s Stalin banning his work), most of his ideas were not disseminated throughout the world until after his death. For these reasons, many of those ideas were not tightly organized or well-structured as those of other scholars (Berk & Winsler, 1995). Regardless, the below theories provide a portion of his perspective of how children learn and use language. These theories provide the theoretical framework of this dissertation.

The most notable contribution of Vygotsky's work was that of sociocultural theory, later refined to be interactionist theory (Vygotsky, 1962; 1987). This states that children are influenced by and learn through interactions in their environment, namely the language used with them and the culture around them (Ferryhough, 2008). To investigate this theory, Shirley Heath, an anthropologist, in 1983 and continued to 1989, investigated the interactions between Black parents of a small African American community of Trackton and their children at home, White teachers and the students of Trackton at school, and the White teachers' and their own children at

home. Initially, she found Trackton parents were uneasy about their children's discomfort communicating in the classroom, so she investigated how these families were communicating. She found White teachers using questions with their own children (50% of their utterances were interrogatives e.g., 'What's that?'), while Black adults posed instructional or knowledge-training questions (e.g., 'What's that like?') with their children, which called for elaborate responses similar to storytelling. The different types of questions in the classroom led by the White teachers were confusing to the Black children (Heath, 1983; 1989). This underscores the different experiences of language learning and language use within different social contexts and the effects it can have within a learning environment.

Not only is cognition and language mediated by the social interaction within a community, but how the individuals interact affects development, according to Vygotsky and his followers. He described that children gain knowledge through guided instruction within their zone of proximal development. The zone of proximal development is the cognitive space between where a child is currently functioning independently and where they can function with assistance from a skilled partner (Cohen, 2013). Vygotsky argued and presented evidence that the environment provided to the child and the interaction with a skilled language partner (the more knowledgeable other) shapes that child's language and cognitive thought.

While working within the child's zone of proximal development, the more knowledgeable other provides scaffolding to the child. An idea not coined by Vygotsky, but introduced by Jerome Bruner and others (Wood, Bruner, & Ross, 1976), refers to the metaphor of a scaffold around a building under construction. In the context of this study, the scaffold refers to the social environment around the child acting as a support system to help the child achieve a specific goal: learning age appropriate language.

To investigate the role of scaffolding between mothers and children completing tasks,

Diaz, Neal and Vachio (1991) videotaped fifty one 3-year-old children and their mothers as they worked together on story sequencing and classification tasks. The mothers were instructed to teach the task so the children could do it alone next time. Measurements were taken for amount and kind of maternal utterances and the context to which mothers and children physically manipulated the materials. They found the more mothers praised their children for competent performance, the better the children did when they worked alone. Children's task engagement was also positively associated with mothers' relinquishing control. The results highlighted the role the more knowledgeable other can have in development, and the importance to allow independence through the zone of proximal development.

In a more current context, yet influenced by the work of Vygotsky, Michael Tomasello (2003) developed his related theories of language acquisition. He posits language as a form of cognition that children develop from their interactions with other speakers. Intentionality, or *intention-reading*, as Tomasello coined, refers to the requirement that both speakers are engaged in joint attention to have successful interactions.

Tomasello and his colleague, Todd (1983), investigated the possibility that individual differences in the way dyads of mother and child established and maintained joint attention might be related to individual differences in children's early language development. They performed monthly observations for six dyads from the child's 12th month and 18th month of age. They found a very high correlation between the child's vocabulary at 18 months and the amount of time infants spent in joint attention with their mothers during the six visits. This provided some beginning evidence that the quality and quantity of the interactions between mother and child had an effect on the child's early learning.

These theories have been hypothesized as an explanation of how children learn language. Using these theories as a framework combined with the qualitative similarity hypothesis,

children with hearing loss should acquire language in a similar fashion as proposed by Vygotsky and Tomasello. The Qualitative Similarity Hypothesis posits deaf and hard-of-hearing children have the ability to learn language and literacy skills similarly to hearing children although it may be at different stages (Paul, Wang, & Williams, 2013). Although these children are diagnosed with a sensory disability, which affects their interaction with the environment, it is hypothesized the input adults provide to these children in their environment can mediate the impact of their disability.

Purpose of the Study

Many studies have sought to answer a question similar to, ‘Does a parent’s language have an effect on the child’s language?’ The repeated theme in those studies is that mere exposure to a large amount of words is not adequate for the language development necessary for later rigorous academic content. Children from families with higher socioeconomic status, parents with more sensitive responsiveness to children’s vocalizations, and enriched adult-child interactions were linked to better outcomes. Early theorists, i.e., Vygotsky and Tomasello, supporting interaction theories of language development claim children (with normal hearing) learn language through reciprocal conversations and meaningful interactions with those around them. Research also informs us that language input is related to children’s vocabulary development and later kindergarten readiness (basic concept skills) for children with and without hearing loss. To this end, there are no published studies examining the possible influence of the quantity of adult language on the quantity of language, vocabulary development, and basic concept development for children with hearing loss. It was the purpose of the current study to delve deeper into these relationships. It was also the goal of this research to identify other possible research and educational implications for educators and parents of children with hearing loss.

The present study sought to extend prior research by examining whether quantity of adult language input was related to the quantity of language for children with hearing loss.

Additionally, it was the purpose of this study to investigate the connection between the theory of social interaction and children with hearing loss. To further explore this relationship, the quantity of parent language input was examined in addition to their child's knowledge of basic concepts and vocabulary.

More specifically, the following research questions were explored:

1. Are the demographics (age, gender, degree of hearing loss, type of hearing loss, type of amplification, aided hearing thresholds, hearing status of parents, presence of additional disability, socio-economic status and parent education) of the participants a factor in the quantity of adult input, quantity of child language, child's vocabulary, and child's understanding of basic concepts?
2. Is the quantity of adult language input related to the quantity of child language, child's vocabulary, and child's understanding of basic concepts?

Significance of the Study

Primarily, the data from this study can be used to inform teaching and coaching practices that professionals use when working with parents of children with hearing loss. Although factors related to socioeconomic status and parental education level can be impactful on language skills, parents in challenged situations can be coached to best practices with the intention of mitigating those familial factors impacting children's success. Most times, educators, Speech Language Pathologists, and Auditory Verbal Therapists are instructing parents to 'embellish everyday conversations' to increase the frequency of talking to their children (Cole & Flexer, 2007). This study claims to investigate if more talking is enough for preschool children to acquire age appropriate language, vocabulary, and kindergarten readiness skills (basic concepts).

Additionally, much of the research on deaf child language acquisition is grounded in theory related to socially mediated interactions, where improved interactions result in improved language skills. Parents and educators are the ‘more knowledgeable other’ attempting to scaffold skills for children (Vygotsky, 1962; Tomasello, 2003). This study seeks to provide preliminary evidence about whether these theories can be applied and understood through the lens of a sensory disability, such as deafness. Do improved interactions result in improved language skills for children with hearing loss learning to listen and talk? Once known, practitioners can improve their teaching strategies and interventions to improve the interactions (more frequency) between adults and their child(ren) with hearing loss. If a relationship is found, the improved interactions and increased parent talk can have an impact on the child’s vocabulary skills and basic concept skills. This can have a profound impact on a child’s ability to have age appropriate language skills commensurate to their peers and be kindergarten ready once exiting preschool, which is a main tenet of the listening and spoken language approach.

Organization of the Study

Chapter 1 of the study presented the introduction, background, purpose of the study including the research questions, and the significance of the study. Chapter 2 provides an in-depth review of the literature and research related to this topic. Chapter 3 describes the participants, procedures for data collection, measures used, and an explanation of the data analysis. The results are presented in Chapter 4. Lastly, Chapter 5 contains a summary of the study results, discussion of the results, limitations of the study, and recommendations and plans for future research.

Chapter 2

Literature Review

Introduction

The purpose of this study was to examine the impact of adult language on the language development of their preschool child with hearing loss who is learning to listen and speak. The theoretical framework guiding this study is Vygotsky's (1962; 1978) theory of social learning, supplemented by concepts from other interactionist perspectives (Tomasello, 2003). This study sought to extend the current theories to a population of children who are deaf and hard of hearing. The first section reviews social learning theory in the context of child language development. Section two describes deafness and the current landscape for deaf education. It describes the benefits and disadvantages of the current hearing assistance technologies available for children with hearing loss. The third section delves into the historical perspectives of hearing loss including descriptions of the educational and language options available for children with hearing loss. Following that section is the research describing the language challenges and deficits (including basic concepts and vocabulary) children with hearing loss face in the current educational climate. Lastly, the final two sections examine research related to language input for children with normal hearing and for children with hearing loss. The disability of deafness is described in the below section.

Deafness

Hearing loss is a low incidence sensory disability affecting 2 to 3 children out of every 1,000 (NIDCD, 2014). Hearing loss can be described using three parameters: degree of loss, type of loss, and configuration of loss. Although there are categories for each parameter, in general, hearing loss is a heterogeneous disability. One of the first interventions is the acquisition of hearing aids, which amplify sounds that are attenuated by the hearing loss. If hearing aids do not

provide enough adequate amplification for speech sounds, a cochlear implant is pursued.

Cochlear implants bypass the impaired hair cells and provide a signal through an electrode to the auditory nerve.

Hearing loss. According to the United States Department of Education, deafness is categorized as a low incidence disability as it makes up 1% of the children aged 3-21 served under the Individuals with Disabilities Education Act (IDEA), Part B, in the 2013-2014 school year (USDOE, 2015). Hearing loss is described using three parameters: degree of loss, type of loss, and configuration of the hearing loss (Northern & Downs, 2002). The degree of hearing loss is measured in decibels (dB) across frequency ranges as normal (0-25 dB), mild (26-40 dB), moderate (41-55dB), moderately severe (56-70 dB), severe (71-90 dB), and profound (>90 dB). The standard range of audible sound ranges from 20-20,000 Hz, although the range related to an audiogram is from 125 – 8000Hz. The configuration of the hearing loss is the relationship of the degree of loss at each frequency point. The configuration can be described as sloping, reverse sloping, cookie bite, high frequency, or symmetrical/asymmetrical. The pure tone average of a hearing loss is calculated as the average of the hearing thresholds at 500 Hz, 1000Hz, and 2000Hz. Lastly, the type of hearing loss refers to the area of the ear where the auditory defunct occurs. It is described as conductive, sensorineural, mixed (conductive and sensorineural), or neural (often described as auditory neuropathy spectrum disorder) (Northern & Downs, 2002).

Hearing aids. For a child with hearing loss, the initial intervention is the acquisition of hearing aids to improve the child's hearing thresholds to levels adequate for hearing speech (Northern & Downs, 2002). The most common hearing aid today is fully digital and programmable to amplify specific frequencies at specific loudness levels depending on the child's individual hearing loss. When hearing aids do not provide enough auditory gain for access to speech sounds, a cochlear implant may be recommended (Maltby & Knight, 2000).

Cochlear implants. Along with federal legislation requiring newborn hearing screenings, and counties and states offering early intervention programs for children with hearing loss, advances in technology have equipped some profoundly deaf children with sensorineural hearing loss with the ability to hear within normal limits (Cole & Flexer, 2007). Through a detailed candidacy process including a hearing aid trial, CT scan, speech and language testing, and in depth parent counseling, a profoundly deaf child with sensorineural hearing loss can receive a cochlear implant. A cochlear implant is an FDA approved implanted hearing device. It consists of an electrode array, internal components and external components. An electrode array is surgically implanted into the cochlea, the organ of hearing, which bypasses the damaged hair cells within the cochlea. The electrode is tonotopically organized, which allows for frequency specific information to be transmitted by the eighth nerve to the brain. The internal magnet is implanted under the skin to allow communication to the external magnet and external coil. The external coil is connected to the external sound processor by an external wire, which houses the microphone and battery compartment (see Figure 1). The external sound processor processes incoming signals according to a specific strategy programmed by an audiologist. This entire system converts mechanical energy (sound) to electrical energy (nerve stimulation) and allows the user to detect, discriminate, and comprehend speech sounds to acquire spoken language despite having a dysfunctional cochlea (Stach, 2010).

Although access to a cochlear implant provides profoundly deaf children with the ability to hear the sounds of speech with greater improvement with hearing in noise and sound localization, the age at implantation and parent involvement produce wide variability in language outcomes (Conner et al., 2006; Moeller, 2000; Yoshinaga-Itano et al., 1998), and changes to the developmental plasticity of the central auditory system (Sharma, Dorman, & Kral, 2005). There is a sensitive period on the central auditory development of a child with hearing loss. Sharma

and colleagues (Sharma et al, 2005) electrophysiologically measured the morphology and latency of the P1 cortical auditory-evoked potentials (CAEP) of children (N=21) at the time of activation, 1-3 weeks later, 1 month later, 3-4 months later, 6-9 months later, and 12-24 months later. CAEP is a measure of brain activation caused by stimulations in the central auditory system. Their findings suggested that late-implanted children (mean age 11.7 years old) showed aberrant morphology and delayed P1 latency compared to early-implanted children (mean activation age was 1.77 years), suggesting there is a sensitive period to normal development of auditory pathways for children with hearing loss.

Prior to cochlear implantation, profoundly deaf children, who wanted to learn spoken language, relied on amplifying residual hearing by the use of hearing aids. Even the best hearing aid user did not consistently receive a clear signal of speech understanding for every phoneme in every environment (Levitt, 1993). These students struggled hearing in noise and localizing sound. Their speech was characterized as non-nasal ‘deaf sounding’ speech reducing intelligibility for inexperienced listeners (McGarr, 1983). Since the advent of cochlear implants, profoundly deaf children started performing better than their matched peers who used hearing aids (Gantz, et al., 2000; Geers & Moog, 1994; Tomblin, Spencer, Flock, Tyler, & Gantz, 2011).

Changing Landscape

In 2000 (reauthorized in 2010), the federal government passed the *Early Hearing Detection and Intervention Act*, which mandates every newborn to receive a hearing screening (Early Hearing Detection and Intervention Act of 2010). The screening consists of an otoacoustic emissions test (OAE) or an automated auditory brainstem response test (ABR). The OAE test consists of putting a small probe in the ear canal that produces a series of small sounds and records the movement of the outer hair cells within the cochlea. The ABR test consists of putting small sensors on the child’s head to measure brain activity when sounds are produced,

also measuring functionality of the cochlea. These tests afford the parents with knowledge of whether their newborn passed the screening or would be referred for further hearing tests. A ‘refer’ does not guarantee a hearing loss, reciprocally, a ‘pass’ does not guarantee hearing, but it provides information to the parent for follow up (Robertson, 2014). Prior to this mandate, only high-risk children would receive a screening, which would miss the 19-42% of children with severe to profound loss with no risk factors (Thompson et al., 2001). Even as early as 2001, these children would not be diagnosed until 19-36 months old (Mace, Wallace, Whan, & Stelmachowicz 1991), and historically, much later than that (Felisati, 2007). An undiagnosed hearing loss, no matter the degree of loss, has detrimental effects on a child’s cognition, language, social, and emotional development (Blamey, 2003; Chute & Nevins, 2006; Cole & Flexer, 2007; Robertson, 2014; Trezek, Wang, & Paul, 2010). With 90% of children with hearing loss born to hearing parents who use spoken language to communicate (NIDCD, 2014), these children would miss valuable critical auditory brain development (Cole & Flexer, 2007). Shortly after the act was passed in 2005, the average age at which a child with hearing loss was diagnosed declined to 3 to 6 months, which necessitated rich early intervention programs to provide services to this younger population (Cole & Flexer, 2007).

Communication Modality

Along with variability in hearing technology, parents can choose among a variety of communication options to use with their child. In some communities, there is controversy relating to what communication mode a family should chose for their child. There is a deep-rooted history in Deaf communities (Capital D) where members utilize a common language (American Sign Language) and share a set of beliefs related to their hearing loss (Dolnick, 1993). On the other end of the spectrum, there is a community of people who believe deaf children (lower case d) can learn to listen and talk (Auditory Verbal/Auditory Oral/Listening and

Spoken Language). Lastly, there are those who fit somewhere in the middle of spectrum who utilize a combination of both communication modes (Total Communication/Simultaneous Communication) (Schwartz, 2007). This study investigates the language use for families who have chosen listening and spoken English in an Auditory Verbal or Auditory Oral setting.

Auditory Oral / Auditory Verbal/ Listening and Spoken Language. Auditory oral/auditory verbal is an intervention approach for teaching listening and spoken language to children with hearing loss. It incorporates the philosophy of using therapists as coaches and parents as teachers for children. The family-centered focus includes guidance, therapy, education, advocacy, and family support. With early identification, aggressive audiological management, and early effective intervention, proponents of the auditory oral/auditory verbal approach believe children with hearing loss (even the most profound loss) can learn to listen and talk (Eastabrooks, 2012; Rhoades, & Duncan, 2014). The parents of the children in this study have chosen this methodology and practice for their children with hearing loss.

Early Intervention

Early intervention programs for children with hearing loss are available throughout the United States in public and private settings (Cole & Flexer, 2007). These programs cover the continuum of communication modes available to children with hearing loss, ranging from a visual approach (American Sign Language) to an auditory approach (Auditory Verbal/ Auditory Oral/Listening and Spoken Language), finally, to a combined approach (e.g., Simultaneous Communication/Total Communication/Sign Support). These early intervention programs afford children with hearing loss and their families the ability to learn language, communication skills, and pre-academic skills in a sequence similar to their hearing peers. In theory, a child with hearing loss would be identified by one month of age, diagnosed by three months of age, and receiving early intervention services by six months of age (Cole & Flexer, 2007), coined as the

1-3-6 perfect trifecta. These programs are dependent on high quality universal newborn hearing screening programs, timely audiological care, and the provision of targeted high quality early intervention services (Yoshinaga-Itano, 2014). These requirements have greatly changed the landscape of the deaf education by providing families with education and training to improve the language outcomes of their child with hearing loss.

The American Academy of Pediatrics (AAP) supports the position statement of the Joint Committee on Infant Hearing (JCIH, 1994), which endorses hearing screening and early intervention in newborns. In the Academy's paper, they delineate the five elements to an effective universal newborn hearing screening program including initial screening, tracking and follow-up, identification, intervention, and evaluation. An integral part of the process is the early intervention provided to families (AAP, 1999).

Long before mandated EHDI programming, researchers and experts in the field claimed early intervention to have positive effects on a child's language outcomes. In 1951, Wedenberg found auditory training and amplification provided as early as 18 months of age provided children with access to acquire speech more spontaneously than children who received services at a later age (Wedenberg, 1951). Of course, this was prior to the advent of accessible cochlear implants for children. Likewise, in their findings, McFarland et al. (1980) made similar claims that children will have better outcomes when provided with early intervention services.

Watkins (1987) found children who had received early home intervention (before 30 months) had slight advantages on measures of language, academic achievement, and social functioning than children who had received late intervention (after 30 months). She also found children who attended preschool had slight advantages on the above measures over children who did not attend preschool. Regardless of age of entering intervention, the data indicated children

who received any home intervention performed better on the above measures than children who did not receive any intervention.

Studying children with hearing loss in particular, Yoshinaga-Itano, Sedey, Coulter, & Mehl (1998) investigated the receptive and expressive language abilities of 150 deaf or hard-of-hearing children. Seventy-two of the children were identified by 6 months of age and 78 of the children were identified after 6 months of age. The children received early intervention services on average of 2 months after identification. They found the children in the former group demonstrated significantly better language scores than children in the latter group.

Two years later, Calderon and Naidu (2000) studied 80 children with hearing loss who were enrolled in the Early Childhood Home Instruction program in Washington State. Nine children entered the program before 12.5 months old, 39 entered between 12.6 and 24.5 months, and 32 were 24.6 or older when entering the program. Results indicated children entering before 24 months demonstrated significantly better receptive and expressive language compared to those entering after 24 months. This demonstrated earlier enrollment had a positive effect on language outcomes.

Current research (although limited) suggests early enrollment in early intervention programs improves language outcomes for children with hearing loss. Moeller (2000) conducted a study of 112 children with hearing loss who were enrolled at various ages into comprehensive early intervention programs. The children enrolled at an earlier age (11 months old) demonstrated better vocabulary and verbal reasoning skills by 5 years old than did later enrolled children, indicating early intervention had a positive effect on the language of children with hearing loss.

In 2001, a longitudinal study (Rhoades, 2001) of 40 children with hearing loss enrolled in an auditory verbal center-based program for a period of one to four years was conducted. The

average age for initiation of intervention services was 44 months old, with a range of 4-100 months. The data showed language age-equivalency scores significantly improved as a function of each year in therapy. Their scores showed closing of the gap between the chronological age and language age indicating they had a positive benefit from therapy services.

Similarly, a longitudinal study by Dorman, Hickson, Murdoch, Houston and Constantinescu (2010) investigated 29 children with hearing loss enrolled in an auditory verbal program age-matched with children with normal hearing between the ages of 2 and 6 years old. They measured speech and language scores over 50 months, and reading, mathematics, and self-esteem scores over the final 12 months of the study. The data showed there were no significant differences between the groups for speech, language, and self-esteem, indicating auditory verbal therapy was effective for the students with hearing loss as their gains were commensurate with their age-matched hearing peers.

Taken together the previous studies have demonstrated the effectiveness of early intervention services on the language outcomes for children with hearing loss, specifically indicating the earlier they enroll in early intervention services, the better they perform.

Language Deficits

Even with the perfect trifecta of opportunity: early identification, early implantation, and early intervention, many auditory oral children with hearing loss still struggle with language acquisition (Blamey, 2003; Connor, Craig, Raudenbush, Heavner, & Zwolan, 2006; Geers & Hayes, 2011; Spencer, 2004; Spencer et al., 2003; Svirsky et al., 2000; Yoshinaga, Sedey, Wiggin, & Chung, 2017).

For example, an early study (Svirsky et al., 2000) indicated over 50% of children with hearing loss (N=70) remained severely delayed even after more than 2 years of experience with their cochlear implants. Although children with oral communication had more intelligible speech

and higher levels of speech perception than children who utilized simultaneous communication (speaking and signing), their skills were still behind hearing peers.

In a later comparison study (Spencer et al., 2003) of age-matched (mean 118 months) prelingually deaf cochlear implant users (n=16) and hearing children (n=16), the former group produced shorter sentences with fewer conjunctions and more usage errors than the latter group. In another comparison study (Blamey, 2003), a group of cochlear implant users scored within 1 standard deviation (normal range) on measures of language comprehension, reading comprehension, and writing accuracy, although their written expression performance suggested a vulnerability to demanding language usage tasks compared to a group of hearing children.

The most notable effect on language is a deaf child's delayed receptive and expressive vocabulary development (Connor et al., 2006; Fagan & Pisoni, 2010; Odom et al., 1967; Paul, 2001; Walter, 1978) including basic concepts (Bracken & Cato, 1986; Davis, 1974; Harrington et al., 2009). These challenges are described below.

Vocabulary Development

Vocabulary development is an important factor to consider as it relates to later skills associated with literacy (Biemiller, 2006; Deniz Can, Ginsburg-Block, Golinkoff, & Hirsh-Panek, 2012; Cooper, Roth, Speece, & Schatschneider, 2002; Metsala, 1999; Nittrouer, Caldwell, Holloman, 2013; Rowe et al., 2012; Rvachew, 2006; Walker, Greenwood, Hart & Carta, 1994).

To validate that claim, in 2012 researchers (Deniz Can et al, 2012) published a long-term predictive validity study using seventy-six children whose vocabulary was assessed before age 2;7 (mean age=1;10) and language outcomes were assessed four years later (mean age=6;1). They found parental report on the *MacArthur Communicative Developmental Inventories-Short Form* (CDI-SF; Fenson, Marchman, Thal, Dale, Reznick, & Bates, 2007) accounted for a

significant, but modest amount of variance in expressive vocabulary, syntax, and semantics in kindergarten, explaining 17%, 11% and 7% in those skills, respectively. This indicated early vocabulary predicted later language skills.

In the same year, Rowe and colleagues (Rowe, Raudenbush, & Goldin-Meadow, 2012) found vocabulary development for children at 30 months predicted later vocabulary skills at kindergarten entry (54 months). For the 62 children in the study, they used longitudinal data and hierarchical linear modeling to examine how several predictor variables (SES, parent input, and child gesture) would predict a child's vocabulary. Using a theoretical model, they described how vocabulary growth trajectories predicted later language skills.

For children with hearing loss utilizing cochlear implants, studies of vocabulary development often reported slower rates of word learning (Connor, Craig, Raudenbush, Heavner, & Zwolan, 2006; Connor, Hieber, Arts & Zwolan, 2000; Yoshinaga, Sedey, Wiggin, & Chung, 2017). Whereas hearing children are expected to have one year of vocabulary growth in one year of time (mean rate of 1.0), children with cochlear implants are expected to show similar growth (mean rate of 1.0) or greater to close the gap in their language skills. Connor and researchers (2000) found that children with cochlear implants were shown to have 0.46 to 0.72 of vocabulary growth in one year. In a study of 147 children, the children who utilized auditory oral communication and simultaneous communication (signs in English word order) showed a rate of vocabulary growth less than that of the sample of normal hearing children, and that gap increased over time (Connor et al., 2006).

The participants in El-Hakim and colleagues study (El-Hakim, Levasseur, Papsin, Panesar, Mount, Stevens, & Harrison, 2001) fared better, although were unlikely to develop vocabulary knowledge skills commensurate to age-matched peers. The researchers investigated the expressive and receptive vocabulary growth curves of 112 children between ages 2 and 12-

years old using a derived measure, the gap index. As language improves, the gap index should approach zero. For the *Expressive One Word Picture Vocabulary Test* (EOWPVT; Gardner, 1983), over time, the older group (implanted after 5 years of age) had a gap index change of 0.47 to 0.38, while the younger group (implanted before 5 years of age) had a change of 0.43 to 0.37, both showing significance. This demonstrated vocabulary growth over time, although those children did not achieve age appropriate vocabulary skills.

When accounting for vocabulary growth based on hearing age (HA) rather than chronological age (CA), Fagan and Pisoni (2010) found children to be within the average range (mean = 100.48; SD = 22.32) on the *Peabody Picture Vocabulary Test-III* (PPVT-III; Dunn & Dunn, 1997). They calculated standard scores based on the years of cochlear implant use (mean HA = 6.6 years) for 23 profoundly deaf children of hearing parents (mean CA = 9.1 years). When measuring for standard scores using traditional standardized methods, the mean standard score based on chronological age was 78.96 (SD = 20.05). Although the children in this study were developing vocabulary skills equal to that of their listening experience, they were still behind their hearing peers.

Some studies indicated some word growth close to age matched peers (Connor et al., 2000; El-Hakim et al., 2001), but the age at which the deaf child receives their cochlear implant is a factor in that child's growth trajectory for language and vocabulary (Luckhurst, Lauback, & Unterstein, 2013; Geers et al., 2009; Yoshinaga et al., 2017).

Luckhurst et al. (2013) found the children (mean age 59.4 months) in their study to have vocabulary scores comparable to peers with normal hearing when they were implanted before 30 months old (mean age 19.2 months). Confounding factors such as chronological age and nonverbal IQ were matched between the groups, and the groups were homogenous in regards to socio-economic status, ethnicity, and gender. The researchers cited limitations including small

sample size (n=9 for cochlear implant group) and challenges with generalization for children attending programs other than that in the study.

Similar to Luckhurst et al. (2013)'s work but with a larger number, the language scores for 153 children with cochlear implants who utilizes an auditory oral approach were analyzed in Geers, Moog, Biedenstein, Brenner and Hayes (2009). Their results indicated 50% of the children reached age appropriate scores in receptive vocabulary, 58% in expressive vocabulary, 46% in verbal intelligence, 47% in receptive language, and 39% in expressive language. These data also indicated children who received their cochlear implants earlier, performed better on all language tests. Although nearly half of the children received age appropriate language scores, there were some areas of language that were still challenging. Specifically, when the vocabulary scores were analyzed, it was found children implanted before 4 years old were more likely to have expected expressive vocabulary skills within the normal range at 5 and 6 years old (gender, nonverbal IQ, and parent education held constant), yet those children required implantation by 2.5 years old to have expected receptive vocabulary standard scores as their age-matched peers. The children in this study were enrolled in highly specialized auditory oral programs staffed with professionals educated to teach spoken language and emphasize parent involvement.

For 3 – 8-year-old children who received their cochlear implant at 1-2 years of age, Duchesne, Sutton, & Bergeron (2009) found receptive single word vocabulary in the average range for 56% of the study sample and expressive single word vocabulary in the average range for 86% of the study sample. These were French speaking children with up to 6 years of experience with their implants. So, even with early implantation and extended implant experience, these children still struggled with acquiring age appropriate vocabulary skills. The children who missed the mark by age (as indicated above) or by lack of accessibility (indicated below) were at a significant disadvantage to acquire age appropriate vocabulary scores

commensurate to their peers. This was true even for children with good audibility and auditory access.

In 2014, Davidson, Geers and Nicholas (2014) characterized cochlear implant users in their study as having good audibility (GA) (aided pure-tone threshold of at least 20 dbHL) and poor audibility (PA) (aided pure-tone threshold of more than 20 dbHL) and compared their vocabulary performance to normal hearing children (NH) matched for chronological age. They found both groups (GA and PA) did not learn words at the same rate or achieve the same vocabulary levels as their NH peers suggesting the challenge was not an accessibility issue alone.

To determine whether receiving a second sequential cochlear implant (CI) is a factor in later outcomes, Geers and Nicholas (2013) investigated the vocabulary and language skills of 60 children at 4.5 years old and at 10.5 years old (approximately half received second CI between test sessions). They found mean standard scores on the *Peabody Picture Vocabulary Test* (PPVT: Dunn & Dunn, 2014) were more than 1 standard deviation below the mean of the age-appropriate normative sample at 4.5 years old. When tested at 10.5 years old, the mean standard scores were within 1 standard deviation of the normal hearing group. This suggested there were clear advantages for younger cochlear implantation on language outcomes, although there were no significant differences shown in mean performance when receiving a second CI.

Investigating the vocabulary outcomes of children receiving early intervention, in 2017 Yoshinaga and colleagues (Yoshinaga-Itano, Sedey, Wiggin, & Chung, 2017) published a study with 448 children with bilateral hearing loss. They used vocabulary quotients (VQs) calculated by dividing the child's vocabulary age by his or her chronological age and multiplying by 100, whereas a VQ of 100 indicated the child's vocabulary age was commensurate with the child's chronological age. Interestingly, the mean VQ for the 448 children was 74.4 (SD=20.3) indicating an overall delay in the deaf child's vocabulary skills. Over half of these children

(58%) met the 1-3-6 perfect trifecta of opportunity, and of those 258 children, 58% met stricter criteria of 1-month screening, 2-months identification, and 3-months intervention.

In her meta-analysis of vocabulary knowledge of children with cochlear implants, Lund (2016) cited several studies with mixed results (e.g., Connor et al., 2006; El-Hakim et al., 2001), although after using forest plots and effect size for comparison, children with cochlear implants demonstrated lower vocabulary knowledge than children with normal hearing. Her inclusionary criteria required the studies to have a comparison group to children with normal hearing matched for chronological age, the use of at least one cochlear implant device, and at least one validated vocabulary outcome measurement. The sample sizes ranged from 34 to 158 and the age of participants ranged from approximately 49 to 109 months. Using statistical modeling, it was determined that children with cochlear implants scored 11.99 points lower on measures of expressive vocabulary and 20.33 points lower on measures of receptive vocabulary than the comparison group.

Overall, these studies demonstrate that children with cochlear implants have challenges acquiring vocabulary skills commensurate with their age-matched peers. For success with later literacy skills and kindergarten readiness, children require age appropriate word knowledge at the single word level and in connected concepts, referred to as basic concepts (Boehm, 1982; Bowers & Schwartz, 2012).

Basic Concepts

Basic concepts refer to words that depict location (*'under'*, *'on top of'*), number (*'more than'*, *'less than'*), descriptions (*'big'*, *'little'*), time (*'old'*, *'young'*), and feelings (*'happy'*, *'sad'*). These words aid in following commands/directions, describing objects, quantities, ordering events, and regulating emotions and behaviors. They are also essential for making comparisons, sequencing, and classifying, which assist with higher order thinking skills.

Boehm and colleagues found basic concepts to be difficult for children because they have no constant referent. An animal that is shortest in one group may be the tallest in another group (Boehm, 1982; deVilliers & deVilliers, 1978). To further exacerbate the challenge, many basic concepts *are* function words or syntactically combined *with* function words. For instance, “*on top of the chair*” consists of the function words “*on*”, “*top*”, “*of*”, and “*the*”, but require the noun “*chair*” to complete the prepositional phrase. When presenting the prepositional phrase as a command (such as “*put the ball on top of the chair*”) and omitting the function words, the phrase is reduced to “*put ball chair*”, which does not direct the child as to where to put the object. A child’s understanding of basic concepts, and the function words that make them up, have important implications for language development and later reading skills (Bowers, 2012). These are concepts used by teachers to give directions within a classroom and for instructions on standardized assessments (Kaufman 1978).

Not only does knowledge of basic concepts assist a child with navigating the demands of teachers’ instructions, they are also apparent in language and literacy tasks (Bowers & Schwartz, 2013). In Dolch (1936)’s 220 critical sight words for reading, there are 50 basic concepts included. Similarly, Johnson (1971) provided a list of 306 vocabulary words necessary for early readers, of those, 100 were basic concepts. For children with hearing loss, there are few studies examining basic concept knowledge separate from other language use, although the research available suggests challenges for those students (Bracken & Cato, 1986; Davis, 1974; Harrington, DesJardin, and Shea, 2009)

In an early study, Davis (1974) examined the basic concept knowledge of 24 children with hearing loss aged 6-8 years old. Half of the children had pure tone averages between 35- 50 db HL and the other half had pure tone average between 51 and 70 db HL. The results showed 75% of the children in both groups scored below the 10th percentile, and 90% of the children in

the latter group scored below the 10th percentile. This implicates the challenges with basic concept skills especially for those children with severe hearing loss.

Bracken and Cato (1986) investigated the basic concept development of 17 deaf children (mean age = 6.0) and their age-matched peers (mean age = 5.96 months). Their data indicated deaf children scored approximately two standard deviations below their matched peers without hearing loss. While the normal hearing children scored within the average range on all subtests (mean=102.5), the children with hearing loss scored below (mean=63.7). This suggests children with hearing loss have a significant disadvantage to learning basic concepts.

In a more recent study, Harrington, DesJardin, and Shea (2009) administered language, cognition, and conceptual knowledge assessments to eight preschool children with hearing loss (mean age = 4.0 years) to investigate the relationship between early child factors (age at identification, age at enrollment into early intervention, and oral language skills), and school readiness (conceptual knowledge). They found a significant correlation between early oral language scores and basic concept understanding ($r = .86, p < .01$). The children who had a total language standard score on the *Clinical Evaluation of Language Fundamentals-Preschool* (Wiig, Secord, & Semel, 1992) of less than 70 at the time of initial testing also had a standard score of less than 70 on the measure of school readiness, indicating the connection between the child's language deficits and basic concept deficits. Conversely, children who had a good command of language use were able to apply that knowledge to not only basic concepts, but also abstract concepts, the researchers claimed.

To address the challenge of basic concept learning, a study (Nelson, Powell, Bloom, & Lignugariskraft, 2014) was conducted with nine preschool teachers of deaf. It measured several specific teaching strategies (i.e., positive examples, non-examples, continuous conversion, and isolating the concept) during direct instruction of basic concepts. It discovered that teachers were

primarily using the strategy of positive examples and did not consistently use the other three strategies. The researchers suggested teachers should incorporate the recommended strategies when teaching basic concepts to students who were deaf and hard of hearing to ensure kindergarten readiness.

As indicated above, the limited research currently available suggests students with hearing loss have demonstrated challenges when using and learning basic concepts skills. Since these skills are building blocks for later literacy, further investigation is warranted.

Language Input for Children with Normal Hearing

There is a plethora of research suggesting the effect of quantity of adult language input on the child's language (Bowers & Vasilyeva, 2011; Hart & Risley, 1995; Hoff-Ginsberg, 1994; Huttenlocher et al, 1991; Huttenlocher, Vasilyeva, Cymerman, & Levine, 2007; Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010; Rowe, 2012; Soderstrom & Wittebolle, 2013) and that the interactions within the environment have an influence on language input. Highlighted here are those studies where the parents and/or adults in the child's environment demonstrated behaviors or had factors that influenced the child's language development.

Challenging the previously common belief/theory that the rate of vocabulary growth was largely influenced by innate capacity (Piaget, 1924) rather than a function of the amount of speech the child was exposed to in his or her environment (Vygotsky, 1962), researchers (Huttenlocher et al., 1991) compared the vocabulary word tokens (frequency of words) of children (N=22) between 14 months and 26 months and found that the child's growth of vocabulary was a reflection of the parent's effect of language input. They found when the mothers spoke more, the children had larger vocabularies that grew faster than those of children whose mothers talked less. This indicated the quantity of parental language had an influence on the child's language growth.

In a later study, Huttenlocher et al. (2010) extended their previous work to investigate the role of caregiver speech on children's syntactic development. They recruited children aged 14-46 months old from 47 parent-child dyads of diverse socioeconomic backgrounds. Using a lagged correlations analysis with measurement four months apart, they evaluated the diversity of caregivers' and children's speech and the quantity of speech. Their results indicated substantial individual differences among children, and the diversity of earlier caregiver speech significantly predicted corresponding diversity in later child speech. In terms of vocabulary, child speech also predicted caregiver speech, suggesting mutual influence.

Over two decades after Huttenlocher et al. (1991)'s initial study, Rowe (2012) extended their work by investigating the quantity and quality of child-directed speech during several points in development to determine if different aspects of caregiver input mattered more at different intervals of time. In this longitudinal investigation, parent-child interactions were measured at the child's ages of 18-, 30-, and 42-months and examined in relation to vocabulary skills one year later (30-, 42-, and 54 months). Results showed that when controlling for SES, input quantity, and children's previous vocabulary skills, using a diverse and sophisticated vocabulary with toddlers (30 months) explained additional variation in later vocabulary ability. Similarly, using decontextualized language (e.g., narrative) with preschoolers (42 months) explained additional variation in later vocabulary ability. This suggests these two points (diverse vocabulary and decontextualized language) in a child's development show sensitivity to parental talk.

Wanting to investigate the differences in the amount of speech mothers produce with their children and the relation to mother's highest education level, Hoff-Ginsberg (1994) transcribed mealtime conversations between 63 mothers and their 1 ½ to 2-year-old children. The results suggested that differences in the amount that mothers talked to their children were a

function of both characteristics of mothers' language use (maternal education) and characteristics of their children's conversational participation. They found mothers who talked more had children who talked more, indicating the more proficient of a language user the child was, the more linguistic input the parent provided to the child.

Around the same time, Hart and Risley (1995) were conducting their own comprehensive longitudinal research studying language environments of young children. In their study, they collected 1-hour audio recordings and observations for 42 families described as lower, middle, or upper socioeconomic backgrounds. They began the collection when the children were 7-9 months old and continued until the children were 3-year-old. Their most cited result indicated the number of words spoken to children from infancy to age 3 predicted almost all of the variance in the children's language ability and IQ when the children were in preschool. By age three, the group of children from higher socioeconomic environments were exposed to approximately 33 million words and the group of children from lower socioeconomic environments heard approximately 9 million words, which suggested that the quantity of parental talk could be a modifiable variable related to several family factors, such as socioeconomic status.

In 2006, Pancsofar and Vernon-Feagans investigated the influence of parent level of education, total quality of child care, and parent language input on their child's language skills. They entered the homes of 92 children from families with dual income earners (mother and father married and worked full-time) and collected data during free play sessions that included the mother, father, and child (once at 24 months and again at 36 months). They found parent level of education (more educated), the total quality of child care (better quality), and different words spoken by the father at 24 months were significant predictors of child language at 36 months. This suggested fathers, in addition to mothers, had an influence on the child's language skills.

Another important factor influencing the language spoken to children was found to be age of the child, Blewitt (1983) recorded interactions between a group of teachers and their 2- to 4-year-old students, a group of mothers and their 18- to 30-month-old children, and another group of teachers and their 3- to 4-year-old students. She found basic level nouns were most frequently used by adults/mothers to the young children (70% to 89%) when investigating different taxonomic levels: subordinate, basic, or superordinate. In a related study, in the same paper, Blewitt conducted an experiment in which adult subjects were asked to write stories to an adult listener or to a 3-year-old child. Results indicated more basic level nouns were used in the story to the 3-year-old than subordinate nouns, whereas the opposite occurred with the adults. These data suggest adults alter (and reduce) their language complexity when speaking to younger children, indicating age is related to language in a child's environment.

Not only is age a factor, but the communicative ability of the child seems to influence parental talk. Vigil et al. (2005) researched the parental language input to 64 toddlers with a language delay and with typical language development. They found both groups of parents produced comparable amounts of linguistic input when in a free play setting measured as mean length of utterance, total number of utterances, and number of words, but differed on some quality measures, such as the use of expansions and gestures. The data suggested parents might adjust their conversational style to the communicative ability of their children. They also found parents of children with a language delay responded less often to their children than parents of children with normal language. To have a reciprocal conversation, the child needed to produce an utterance to which the parent could respond.

Due to this reciprocity requirement, parents of children with language delays respond differently to their children than parents of children with normal language development. Conti-Ramsden (1990) investigated how parents recast or reply to their child's utterances. Fourteen

dyads of mothers and children with language impairments and 14 dyads of mothers and children with typical language were observed. She found less complex recasts for parents of children with language delays, and those recasts used served the function of information request, assertion, or direction rather than responding to, or requesting clarification of their children's utterances. This suggested that a child's language was related to the conversational turns a parent and a child would have.

When examining parent's language input as a function of the child's language output, Tannock and Giraletto (1992) described in their book chapter an 'idiosyncratic feedback cycle' where the child's language delay influenced the parent's language. The parents provided less than ideal input as a direct result of the parent attempting to compensate of the child's deficits. This suggested a parent's language input could be causally related to the child's language abilities.

In conclusion, these studies surmise that the quantity of language input, and in some cases, the quality of language input, provided in children's environments have an influence on the early language development of those children. Additionally, there are environmental factors identified as being associated with parental input and children's language skills, with the most referenced being socioeconomic status or parental education level. Note, these are children with normal hearing without disabilities. Yet the contingency does not solely depend on the parent's input, there is evidence to suggest the children also play a role in their own learning experiences, as exemplified by links between child characteristics, caregiver/parent behaviors, and conversational engagement.

Language Input for Children with Hearing Loss

Fewer studies have explored the impact of quantity of adult language input for children who are deaf and hard of hearing, but similar results have been reported for this population.

In 1981, Cheskin studied the speech directed by three hearing mothers to their deaf children ranging from 1.6 years to 2.10 years old. Variables of quantity and quality were measured including, but not limited to, number of words spoken, mean length of utterance, type token ratio, and incidence of single word sentences. Compared to mothers of hearing children, the mothers of deaf children in this study spoke in short sentences that were usually grammatically complete, used a repetitious and restrictive vocabulary, and repeated utterances more frequently. Additionally, the mothers missed opportunities for turn taking and engaging their children in verbal interaction. This suggested that parents speak differently to deaf children than to hearing children.

Finding similar results, Lederberg and Everhart (1998) investigated the communication between 20 deaf and 20 hearing children when playing with their hearing mothers when the children were 22 months and 3 years of age. Compared to hearing children, the deaf children were severely language delayed, with deaf 3-year-olds using less language (speech or sign) than hearing 22-month-olds. The mothers of deaf children used more visual communication than mothers of hearing children, although the deaf children did not visually attend to much of their mothers' communication. The researchers suggested there should be a focus on intervention efforts to increase the quantity of perceived linguistic input by the child.

In 2000, the same researchers (Lederberg & Everhart, 2000) further investigated the communication between 20 deaf and 20 hearing children and their hearing mothers with a focus on pragmatic and dialogic characteristics of communication. They found deaf children to be less skilled at maintaining topics, and the pragmatic function of their communication was less clear than that of hearing children. On the other hand, from 22 months to 3 years old, deaf and hearing children's communication skills improved similarly across some dimensions. Namely, they increased the amount they communicated, became more responsive to their mothers' attentional

focus, and were responsible for initiating a higher proportion of the dyads' conversations. The researchers also furthered their suggestion from their 1998 study for improved intervention by claiming there should be a focus on fostering linguistic development and not general communication skills or changing maternal conversational control.

Investigating maternal vocal communication between Deaf or hearing mothers and their deaf or hearing infants at 9 months of age, Koester and colleagues (Koester, Brooks, & Karkowski, 1998) measured the amount of positive or negative vocalizations emitted by infants among four groups (Deaf mother/deaf infant, deaf mother/hearing infant, hearing mother/deaf infant, and hearing mother/hearing infant) and found no significant difference among the groups. These families utilized a variety of communication modalities where the Deaf mothers used American Sign Language and many of the hearing mothers used spoken English. This data suggests language input for 9 months old infants with hearing loss was similar to language input for 9 months old infants with normal hearing, no matter the hearing status or communication mode of the parents.

The above four studies were conducted prior to mandated newborn hearing screening and before the availability and common usage of digital hearing aids and cochlear implants for children, so caution should be taken when interpreting these findings.

Interestingly, a study by Bergeson, Miller, and McCune (2006) recorded normal-hearing (NH) mothers speak to their children, of which nine were hearing impaired (10-37 months old) and used a cochlear implant for 3 to 18 months, and eighteen were normal hearing (NH). The NH children were matched by hearing experience (n=9) and by age (n=9). The researchers found mothers of children with hearing loss spoke to their implanted children with a similar vocal style to the mothers of children with normal hearing when matched by hearing experience rather than chronological age. This suggests mothers were sensitive to the hearing experience and linguistic

abilities of their children and they might have attributed to the likeness of linguistic input between groups.

A later study, using a population of children with cochlear implants, DesJarden and Eisenberg (2007) explored the relationship between maternal contributions and oral expressive language skills for thirty-two mothers (mean age = 36.0 years) and their child(ren) with hearing loss (mean age = 4.8 years). The dyads were videotaped during free play and storybook interactions. Measurements for quantitative input (mean length of utterance [MLU] and number of word types) and qualitative input (facilitative language techniques – recast, expansion, open-ended question, comment) were analyzed. The mothers also completed a self-reporting tool measuring their sense of involvement and self-efficacy. Results indicated maternal involvement and self-efficacy related to children’s language development were positively related to mothers’ quantitative and qualitative linguistic input. Results also indicated, after controlling for age, mothers’ MLU and two language techniques (recast and open-ended questions) were positively related to children’s language skills. It is then suggested intervention efforts should be focused on enhancing caregivers’ involvement, self-efficacy, and linguistic input to improve the language skills of their children with cochlear implants.

When measuring joint book reading behaviors (engagement, literacy strategies, adult teacher techniques, interactive reading, and guided reading) between parents of children with hearing loss ($n=45$) and parents of children with normal hearing ($n=60$), DesJardin and colleagues (2014) found a significant difference between the groups. Out of the 105 dyads, parents of children with hearing loss presented with more literacy strategies (e.g., pointing to and labeling pictures) and teacher techniques (e.g., elaborating on child ideas) than parents of children with normal hearing. They hypothesized this was due to specific behaviors and techniques being taught by their child’s early interventionist related to joint reading skills. Parents of children

with normal hearing used higher-level facilitative language techniques with their children who had higher language skills. Higher-level facilitative language techniques were positively related to children's oral language abilities. This suggested that during some activities parents of children with hearing loss, with coaching, might have an increased quantity of adult words compared to children with normal hearing.

In an attempt to identify effective language strategies for parents to use with their deaf or hard-of-hearing child, Cruz and researchers (Cruz, Quittner, Marker, & CDaCI Investigative Team, 2013) assessed parent-child interactions of ninety-three children with cochlear implants. The children (≤ 2 years) were assessed at six implant centers prior to and for three years following their cochlear implantation. The parent and child interactions were videotaped, transcribed, and coded for lower-level and higher-level language strategies. The lower-level strategies included linguistic mapping, comments, imitation, and label), whereas the higher-level strategies included open-ended questions, expansion, expatiation, recast). Using bivariate latent difference score modeling, they found higher- versus lower-level strategies predicted growth in expressive language and word types predicted growth in receptive language over time. The researchers suggest these strategies should be used by parents to improve the language used with their deaf or hard-of-hearing child.

The majority of the research on language input for children with hearing loss was conducted prior to newborn hearing screening, which as stated earlier has further diversified the current heterogeneity of the population of children with hearing loss. With more time-conductive ways to record language input, such as the Language ENvironment Analysis device (LENA), a growing, yet very small, collection of research has been conducted on the quantity aspect of language input for children with hearing loss, children with other disabilities, and typically

developing children. Emphasized below are studies involving children with hearing loss and when applicable, children with normal hearing.

Language Input Studies Using LENA

Language ENvironment Analysis (LENA) was developed by LENA Research Foundation in Boulder, CO. It is a small (about the size of a small iPhone container) recording device worn on the child's chest in a pouch on a specifically designed vest. The child wears the LENA Digital Language Processor (DLP) for a continuous 16 hours. The audio recording from the LENA DLP is downloaded into the LENA software where a series of advanced algorithms and statistical modeling are used to automatically analyze and segment the audio data. The software outputs variables for adult word counts, conversational turns, and child vocalizations. Several studies have been published using LENA technology. The variables derived from the technology (adult word counts, conversational turns, and child vocalizations) have been used to demonstrate quantity aspects of language input, essentially providing a 'pedometer for words' (Suskind, D., Leffel, Hernandez, Sapolich, Suskind, E., Kirkham, & Meehan, 2013). These word counts have been used in many different ways to provide a corpus of data that show differing conclusions.

In one of the first studies to use full-day LENA recordings, Van Dam and colleagues (2012) examined whether 22 children with hearing loss and 8 children with normal hearing received similar amounts of exposure to adult words and conversational interactions. They found no difference in the number of adult word counts and conversational turns between the groups. For the group of hard-of-hearing children, the audiological variables, pure tone average (PTA) and speech intelligibility index (SII) were associated with levels of parental talk. Specifically, children with more auditory access engaged in more conversational turns. This may suggest that parents are sensitive to the degree of auditory access their child may have.

Interestingly, when comparing their data to the LENA normative sample (comprised of children with normal hearing matched for age and socioeconomic status), both of the groups in their study produced more adult words and conversational turns than the normative data. Although this seemed to be a positive finding, the researchers described the adult word counts as being within ‘earshot’ of the child, but for a child with hearing loss their ability to discern between background noises and meaningful talk is compromised due to the limitations of their hearing assistive technology. Overall the researchers recommended further studies investigate particular ways in which the linguistic and auditory environments of hard-of-hearing children might be modified to support language learning.

In a later study, the same authors, Ambrose, VanDam, and Moeller (2014), used LENA to note quantity of adult words, adult-child conversational turns, and electronic media exposure in deaf toddlers’ environments (n = 28) and to examine whether these factors contributed to the children’s language outcomes. They found that the deaf and hard-of-hearing children aged 2-3 years, who engaged in more conversational turns demonstrated higher linguistic outcomes as measured on the *Mullen Scales of Early Learning* (Mullen, 1995)(for 2-year-olds) and the *Comprehensive Assessment of Spoken Language* (Carrow-Woolfolk, 1999) (for 3-year-olds). There were reduced interactions measured for children who were exposed to higher amounts of electronic media in their environment. These data suggested that large quantity of language input, along with less exposure to electronic media, had a positive influence on the language of these deaf and hard of hearing toddlers. This helps to describe the requirements for an optimal language learning environment.

To investigate the outcomes of children enrolled in early hearing detection and intervention programs, Vohr et al. (2014) used LENA to measure natural home environments of 23 children with hearing loss and analyzed those variables in relation to comprehension scores

on the *Reynell* (Reynell & Gruber, 1990) assessment. They found, after adjusting for age of entry to early intervention and stay in the NICU, every increase in ten percentage points of language in the home was associated with 7.2 points higher comprehensions scores and 9.99 points higher expressive scores. They also found higher adult word counts were associated with more conversational turns and that increase in conversational turns resulted in higher verbal comprehension scores. These data suggested adult word counts, conversational turns, and the deaf and hard-of-hearing child's comprehension scores being related. Additionally, it further signified the importance of enriched language environments for children with hearing loss.

A larger population of children (n = 156) were studied in 2015 by Ambrose and colleagues to investigate the difference, if any, in the quantity and quality of caregiver talk between children who were hard of hearing (CHH) (n = 156) and children with normal hearing (CNH) (n = 59). Additionally, for the CHH children, they explored how caregiver input changed as a function of child age (18 months versus 3 years) and which child and family factors contributed to variance in caregiver talk. They used LENA to quantify the language spoken in a 5-minute semi-structured, conversational interaction between the caregiver and the child. The results indicated, at the 3-year visit, there were significant differences between the CNH and CHH for quantity variables and quality variables, with the CHH being exposed to fewer words and lower quality input. This suggested caregivers of children with hearing loss might require additional support to improve the language learning environments of their child(ren).

Since research suggests intervention is needed for children with hearing loss to acquire age appropriate language as their normal hearing peers, next steps would be to investigate what interventions, if any, would improve adult-child interactions and children's environments.

Suskind et al. (2016) investigated whether an intervention program (Talk more, Tune in, and Take turns) targeting 23 mother-child dyads of lower socioeconomic status would improve

their adult word counts, conversational turns, and child vocalizations. The intervention curricula composed of eight modules implemented across eight weekly home visits. The focus was on the ‘3Ts’, where ‘talk more’ was aimed to increase parental talk, ‘tune in’ was aimed to explore children’s interests, and ‘take turns’ was aimed to improve conversations. Using a control group and a study group, the results demonstrated all three variables (adult word counts, conversational turns, and child vocalizations) increased significantly during the intervention (but not post intervention) indicating the parents’ ability to increase their linguistic interactions with their children and improve the quantity of their communication.

Sacks et al., (2014) investigated if using the LENA device as a ‘quantitative linguistic feedback’ tool would improve adult and child linguistic behavior when paired with a behavior change program. They used a sample of 11 parents of children with hearing loss who were from typically underserved populations, such as families from backgrounds of low socioeconomic status or families who spoke English as a second language. Preliminary findings indicated the amount of conversational turns and child vocalizations improved from the pre-intervention condition to the post-intervention condition. These findings were similar to the study by Suskind et al. (2013) where improvement was measured after one intervention session with nonparental caregivers. Their work suggested a feedback tool could be a viable behavior change strategy to enrich parental and child linguistic behaviors.

In contrast to the positive results of the previous studies, Weil and Middleton (2010) studied the effectiveness of an intervention program (*It Takes Two to Talk: Hanen Program for Parents*) using LENA and found no statistically significant improvements in either adult word counts, conversational turns, or child vocalizations from pre-intervention to post-intervention. Note, this study had a small sample size ($n = 6$) and the intervention was only 4 weeks long.

When comparing daycare environments with home environments for 11 children with normal hearing, Soderstrom and Wittebolle (2013) found the number of child vocalizations were similar, however the two environments had important differences with respect to the specific effects of activity (playtime, travel time, story-time) and time of day (11am to 1pm). This indicated the need to collect data in two environments to determine the difference, if any, between the home environment and the school environment.

Additionally, in a study by Wiggin et al. (2012), there were differences found between the language environment at home and the language environment at school. For the 8 children with hearing loss studied, within a 3-hour time span the preschool experience provided language stimulation equivalent to the average language stimulation that a hearing child received in a 10 to 16-hour day. This suggested studies pertaining to the language environments of deaf and hard-of-hearing children should include both settings.

Most recently, Wang, Hartman, Abdul Aziz, Arora, Shi, & Tunison (2017) systematically reviewed the use of LENA technology in peer-reviewed educational journal articles. They investigated the types of studies that have been conducted, challenges that were experienced with the technology, and the implications for future research. They found a wide range of populations were studied using LENA technology including children with and without identified disabilities. The LENA technology was mostly used for the output measures of adult word counts, child vocalizations, and conversational turns, but it was also used for categorizing time as silence, noise, TV/radio media exposure, distant language, or meaningful speech. These measures were used by parents to concretely observe the language used around their child, while some researchers used the measures to estimate effectiveness of an intervention program. Some challenges described were the lack of nonverbal data gleaned from the LENA technology, especially for those children who were nonverbal. There were 38 studies where implications for

future research were mentioned, including using LENA as an intervention tool to inform families of the language they use with their child(ren).

In conclusion, LENA technology has provided researchers with a more time-conducive tool to study the language environment of children with and without hearing loss. Taken together, in general, these studies indicate that merely exposing children to a large quantity of linguistic input is not adequate for optimal language development. In most cases, the child's environment consisting of language rich, adult-child interactions had an influence in the deaf child's language skills. In the same vein, interventions focused on improving language environments for children by using feedback tools or parental coaching strategies had a largely positive influence in the deaf child's language skills.

In summary, there have been no studies that have empirically investigated the influence of adult talk on the language, vocabulary, and basic concepts skills of children with hearing loss. There have been a few studies investigating each variable separately, or in tandem with other variables, but the relationship between these variables has not yet been studied. It is the goal of this current study to use LENA technology to investigate whether improved interactions result in improved language skills with children with hearing loss. If a relationship is found, practitioners can modify their teaching strategies and interventions to improve the interactions between adults and their deaf and hard-of-hearing child(ren). These improved interactions and elevated language environments can have a profound impact on children with hearing loss acquiring age appropriate language, vocabulary, and basic concepts skills so they are kindergarten ready at kindergarten age, which is the main tenet of the listening and spoken language approach.

Research Questions

This study is guided by the following research questions:

1. Are the demographics (age, gender, degree of hearing loss, type of hearing loss, type of amplification, aided hearing thresholds, hearing status of parents, presence of additional disability, socio-economic status and parent education) of the participants a factor in the quantity of adult input, quantity of child language, child's vocabulary, and child's understanding of basic concepts?
2. Is the quantity of adult language input related to the quantity of child language, child's vocabulary, and child's understanding of basic concepts?

Hypotheses

Research question 1:

Age. It is hypothesized that there will be a statistically significant relationship between age and the quantity of adult language input indicating the younger a child is, the less their parents will talk to him/her. Blewitt (1983) found mothers of children aged 18-30 months spoke differently to their children than mothers of children aged 2-4 years old. Basic level nouns were the most frequently used. This suggests parents speak differently to their child depending on their age.

Gender. It is hypothesized that there will not be a statistically significant relationship between gender and the quantity of child language for the age group being studied. Although Huttenlocher, Haight, Bryk, Seltzer and Lyons (1991) found gender an important factor in the rate of vocabulary growth for toddlers, there were no gender differences after 2 years old.

Degree of hearing loss. It is hypothesized that there will be a statistically significant relationship between the degree of the child's hearing loss (without hearing aids/cochlear implants) and the quantity of adult language input indicating children with better hearing prior to implantation will have parents who will talk to them more. Hoff-Ginsberg (1994)'s research suggested the more proficient of a language user the child is (and the more access to sound they

have), the more linguistic input the parent provides the child. Research by Kishon-Rabin and colleagues (Kishon-Rabin, Taitelbaum-Swead, Ezrati-Vinacour, & Hildesheimer, 2005) suggested pre-implant hearing levels were also related to a child's auditory perception.

Type of hearing loss. There will not be a statistically significant relationship between type of hearing loss and quantity of adult language input. Peterson et al. (2003) investigated the outcomes of children with auditory neuropathy and children with other etiologies (types of hearing loss) and found no difference between the groups when measuring auditory perception and language gains based on parental questionnaires.

Type of amplification. There will be a statistically significant relationship between type of amplification and quantity of adult language input. Children with hearing aids will have exposure to more adult language than children with cochlear implants. This demographic variable is similar to the Degree of Hearing Loss variable in that a child with a cochlear implant will have to have had a severe to profound hearing loss to qualify for a cochlear implant (Cole & Flexer, 2007). Research by Tomblin, Spencer, Flock, Tyler and Gantz (2011) found 29 cochlear implant users performed better on language measures than 29 deaf children who used hearing aids. Geers and Moog (1994) found cochlear implant users exhibited faster language and communication skills when compared to matched groups of profoundly hearing impaired children using hearing aids or tactile aids.

Aided pure tone average. There will be a statistically significant relationship between aided pure tone average (average of the hearing thresholds at 500 Hz, 1000Hz, and 2000Hz with hearing aids/cochlear implants) and the quantity of adult language input indicating the more a child can hear, the more parents will talk to him/her. There will also be a statistically significant relationship between aided pure tone average and the quantity of the child's language indicating the better the child hears, the more he/she will talk. Van Dam et al. (2012) found audiological

variables such as pure tone average (measuring how much the child hears) and speech intelligibility index (measuring the amount of the speech spectrum auditorily available to the child) were associated with parental talk, suggesting that parents may be sensitive to the degree to which their children with hearing loss are able to access the parents' language.

Presence of additional disability. There will be a statistically significant relationship between the presence of an additional disability and the quantity of child's language. The children with an additional disability will perform poorer than children without an additional disability. Studies have shown having an additional disability can limit auditory perception development affecting language outcomes (Daneski & Hassanzadeh, 2007), affect the quality of speech (Nikolopoulos, Archbold, Wever, & Lloyd, 2008), affect interactions with others (Bruce, DiNatale, & Ford, 2008), and affect rate of progress, which is often slow and highly variable (Berrettini, Forli, Genovese, Santarelli, Arslan, & Chilosi, 2008; & Meinzen-Derr, Wiley, Grether, & Choo, 2009). More recently, in 2017, Yoshinaga-Itano found children have reduced vocabulary and lower language outcomes when an additional disability was present. Additionally, previous studies estimate 35-40% of all children who are deaf or hard of hearing to have disabilities in addition to deafness (Yoshinaga-Itano, Sedey, Coulter, Mehl, 1998).

Family income / socio-economic status. There will be a statistically significant relationship between the family's income and the quantity of adult language, indicating the higher the family's socio-economic status, the more they will talk. This is suggested by the hallmark study by Hart and Risley (1995), indicating the higher the family's income, the more they talked to their children. Huttenlocher and colleagues (2001) also found significant main effects for socioeconomic status (SES), indicating a parent's SES had an effect on child's language growth. Additionally, parents from lower socioeconomic situations used fewer word types and tokens, and these differences were predictive of child vocabulary (Hoff, 2003).

Parent education. There will be a statistically significant relationship between the parent's education and the quantity of adult language, indicating the higher the family's education level, the more they will talk to their child. Research by Dollaghan and colleagues (1999) suggested maternal education was statistically significantly related to mean length of utterance in morphemes, number of different words, and total number of words. Similarly, Hoff-Ginsberg (1994) found mothers with higher education (college) talked more to their children than mothers with a lower education level (high school). Most recently, Yoshinaga-Itano (2017) found children had better vocabulary and language outcomes with a higher maternal education.

Research Question 2. It is hypothesized that the quantity of adult language is related to quantity of child language, indicating the more a child talks, the more the parent talks and reciprocally, the less a child talks, the less a parent talks. This 'idiosyncratic feedback cycle' as described by Tannock and Giraletto (1992) may exist between parents and children with language delays. Since many of the children in this current study have language delays secondary to hearing loss, it is hypothesized the 'idiosyncratic feedback cycle' will affect the population of children with hearing loss similarly. It is also hypothesized that the conversational turns variable is related to the quantity of child language and the quantity of parent language, indicating the more language each have, the more they will be able to converse in a turn-taking fashion. Huttenlocher (1991) described how mothers of children with large overall vocabulary produced significantly more speech not only to their own children but also to other children with small vocabularies. Likewise, Vigil et al. (2005) and Conti-Ransden (1990) found parents of children with normal hearing had more conversational turns, most likely related to the fact that parents had more utterances to comment from their child with higher language abilities.

Chapter 3

Research Method

Participants

Thirty-seven children aged 3.0 through 4.11 were studied ($M = 47.35$, $SD = 7.707$ (see Table 3.1 and Table 3.2). The study included 30 children with hearing loss (degree of loss not specific) who utilized bilateral cochlear implants (60%), bilateral hearing aids (23.3%), bimodal amplification – one cochlear implant and one hearing aid (6.6%), unilateral hearing aid and contralateral ear unaided (3.3%), unilateral hearing aid and contralateral ear FM receiver (3.3%), and binaural unaided (3.3%), and 7 children with normal hearing, all of whom had listening and spoken English as a communication mode. The participants were recruited from non-public auditory oral schools in New York, California, and Missouri. A one-way ANOVA was conducted and revealed there were no significant differences between groups for conversational turns (CVC weekend) during the weekend ($F(2,29) = .568$, $p = .573$) indicating relative consistency across programs across states. To ascertain feasibility of the project, the researcher secured permission from the Executive Directors/Principals to recruit participants from the schools. The children with hearing loss were placed at the auditory oral school through an Individualized Education Plan (IEP) through their county or city school district. As part of their program plan, the children with hearing loss received speech language pathology services ranging from one day a week to five days a week. Other related services included physical therapy, occupational therapy, and family counseling. The majority (85.7%) of the children attended the school as a private preschool. Those who were not were siblings of children of hearing loss (but not siblings of participants in the study) or children of the staff in the same school. Those who were not (14.2%) attended the school as a private preschool. Only children from monolingual English families were recruited.

Table 3.1

Demographics for All Participants

Characteristic		Hearing Loss (n=30)	Hearing (n=7)	Total Participants (n=37)
Age (months)	Mean age (SD)	46.03 (7.42)	52.00 (6.66)	46.93 (7.56)
Sex %(n)	Male	60.0% (18)	42.9 (3)	53.7% (22)
	Female	40.0% (12)	57.1% (4)	46.3% (19)
Income	Less than \$10,000	0	0	0
	\$10,000-29,999	13.3% (4)	0	9.8% (4)
	\$30,000-49,999	3.3% (1)	0	2.4% (1)
	\$50,000-69,999	13.3% (4)	0	9.8% (4)
	\$70,000-89,999	13.3% (4)	14.3% (1)	12.2% (5)
	\$90,000-119,999	6.7% (2)	0	4.9% (2)
	\$120,000-139,999	3.3% (1)	0	2.4% (1)
	\$140,000 or more	23.3% (7)	14.3% (1)	24.4% (10)
	Decline to state	13.3% (4)	14.3% (1)	17.1% (7)
	Unreported	10% (3)	57.1% (4)	17.1% (7)
Highest education – father	Some high school	0	0	0
	High school	13.3% (4)	0	14.6% (6)
	Some college	20.0% (6)	14.3% (1)	17.1% (7)
	Associate degree	16.7% (5)	0	12.2% (5)
	Bachelor degree	23.3% (7)	0	19.5% (8)
	Masters degree	3.3% (1)	14.3% (1)	4.9% (2)
	Doctoral degree	6.7% (2)	0	7.3 (3)
	Post doctoral	0	0	0
Unknown	16.7% (5)	71.4% (5)	24.3% (10)	
Highest education – mother	Some high school	3.3% (1)	0	2.4% (1)
	High school	3.3% (1)	14.3% (1)	9.7% (4)
	Some college	30.0% (9)	0	24.4% (10)
	Associate degree	6.7% (2)	0	4.9% (2)
	Bachelor degree	30.0% (9)	0	24.4% (10)
	Masters degree	10.0% (3)	28.6% (2)	12.2% (5)

Doctoral degree	6.7% (2)	0	7.3% (3)
Post doctoral	0	0	0
Unknown	10.0% (3)	57.1% (4)	17.1% (7)

Table 3.2

Demographics for Participants with Hearing Loss

Characteristic		Hearing loss (n=30)
Age hearing loss identified (months)	Mean (SD)	7.53 (11.7)
Degree of hearing loss –right side	Mild	3.3% (1)
% (n)	Moderate	16.6% (5)
	moderately-severe	3.3% (1)
	Severe	16.6% (5)
	Profound	56.6% (17)
Degree of hearing loss – left ear	Mild	3.3% (1)
	Moderate	16.6% (5)
	moderately-severe	6.6% (2)
	Severe	10% (3)
	Profound	63.3% (19)
Type of hearing loss	Conductive	3.3% (1)
	Mixed	6.6% (2)
	Sensorineural	76.6% (23)
	Neural	10% (3)
Aided Pure Tone Average – right ear	Mean (SD)	24.0 (6.00)
Aided Pure Tone Average – left ear	Mean (SD)	24.4 (6.05)
Type of amplification – right ear	None	6.6% (2)
	Cochlear Implant	63.3% (19)
	Hearing Aid	26.6% (8)
	FM only	3.3% (1)
Type of amplification – left ear	None	3.3% (1)
	Cochlear Implant	63.3% (19)
	Hearing Aid	33.3% (10)
	FM only	0
Hearing status – mother	Hearing	96.6% (29)

	Hearing loss	3.3% (1)
Hearing status – father	Hearing	96.6% (28)
	Hearing loss	3.3% (1)
Presence of Additional disability	Yes	16.7% (5)
	No	83.3% (25)

Procedure

Institutional Review Board approval was attained from Teachers College, Columbia University Institutional Review Board (protocol number 15-258) on May 12, 2015 and renewed on February 29, 2016. Teachers and associated staff provided written informed consent (see Appendix A). Informed consent was provided by the parents for themselves and on behalf of their preschool children (see Appendix B).

Families were recruited through the school in which their children attended. All children and families fitting the inclusionary criteria were recruited and invited to participate in the study. Children with hearing loss of any degree or type and children with normal hearing aged 3.0 to 4.11 that used spoken English fit the inclusionary criteria. The data were collected from 2015 through 2017 by the Principal Investigator. A series of demographic questions were collected by cumulative file record review, parent interview, or parent interview including parent income, highest education earned by both parents, and members of the family living in the home (see Demographic Questionnaire in Appendix C). Parents were asked to complete a schedule of their day indicating the time they eat dinner for transcription purposes (see Appendix D).

The *Boehm Test of Basic Concepts Preschool-3* and *Peabody Picture Vocabulary Test-Version 4* were administered to all participants. The assessments were conducted in a child-friendly therapy room with reduced distractions. The parents and the child's primary therapy/teacher were invited to observe through a one-way mirror to not disrupt the assessment

procedure. It took 30 minutes to complete both assessments, which was the length of the child's scheduled daily therapy session.

Language was audio recorded through the Language ENvironment Analysis system (LENA). The parents and teachers were trained on the proper technique and usage to ensure recording (see Appendix E). The child wore the device for a contiguous 16 hours for two days including one weekday (including school hours) and one weekend day. Data was taken during the school day where most of the child's waking hours (average 6 hours at school) were with their teachers or therapists, and on a weekend to investigate the difference, if any, on the teachers' language input and the parental language input. Soderstrom and Wittebolle (2013) found child vocalization in the home environment was almost twice as much as in the daycare environment, indicating differences between home and other settings such as school.

No families returned the LENA device expressing concerns with the recording, but they were instructed they could if they so desired. To ensure participant confidentiality and privacy, every piece of data was password protected and only assessable by the researcher and her dissertation research team.

Measures

Boehm Test of Basic Concepts. The *Boehm Test of Basic Concepts 3-Preschool* (BTBC-3) (Boehm, 2001) is a criterion-referenced measure that assesses a child's understanding of 26 concepts, including size, direction, position in space, time, quantity, classification, and general. Each concept is tested twice. The child points to one of four picture options when given verbal directions such as, "Point to the dog that is on the box". There are 52 items tested for each age range: 3.0-3.11 and 4.0-5.11. The results can be reported as a raw score, percentile correct, performance range, and a percentile. The assessment is normed on a standardized sample of 660 children aged 3.0-5.11, evenly divided among gender and six different age groups.

The sample was stratified by age, gender, race/ethnicity, parent education level and geographic region to replicate the U.S. population based on the 1998 U.S. Bureau of Census demographics report. Although children with hearing loss were not specifically identified in the sample, 11% of the children were diagnosed with a disorder and/or were receiving special services.

The reliability was determined by checking internal consistency, standard error of measurement and test-retest reliability. The coefficient alpha ranged from .85-.92. The standard error of measurement ranged from 1.98 to 2.88, indicating overall low variability. The validity of the assessment was determined by test content, relations to other variables, and test criterion relationships. The correlation between the BTBC-3 and its predecessor, *Boehm-Preschool* was .84, providing evidence of their concurrent validity. The correlation between the BTBC-3 and the *Bracken Basic Concept Scale-Revised* (BCS-R, 1998), also a test of basic concepts, was .80 for 3-year-olds and .73 for 5-year-olds, inferring that both test measure many of the same aspects of the constructs of basic concepts.

This assessment was chosen because it is a widely used and accepted measure of a child's understanding of basic concepts for the specific age range being studied. The percentile rank was used as a variable in the present study.

Peabody Picture Vocabulary Test. The *Peabody Picture Vocabulary Test, Fourth Edition* (PPVT-4) (Dunn & Dunn, 2007) was used to measure children's receptive vocabulary. The PPVT-4 has two parallel forms, A and B. Either form was used in this study based on which school the participants attended. Each form contains training items and 228 test items, each consisting of four full-color pictures as response options on a page. The child points to a picture when given the prompt "Show me ____". The test covers a range of vocabulary content areas including actions, vegetables, tools, and parts of speech across all levels.

The PPVT-4 is a norm-referenced standardized measure, which is widely used in research and educational settings. The measure was standardized using a pool of 3,540 participants across ages 2 years 6 months through 90 years and older. The age-norm and grade-norm samples were designed to resemble the English-proficient U. S. population from ages 2:6 to 90+ and closely match 2004 U. S. Bureau of Census data for demographic variables (Dunn & Dunn, 2007).

The reliability was estimated using internal consistency, alternate form reliability, and test-retest stability. Measuring split-half reliability was calculated for each of the 28 age groups in the age norm sample and shown to be good to excellent, ranging from .89 to .97. Alternate form reliabilities are good to excellent, ranging from .87 to .93. The test-retest correlations range from .92 to .96, indicating performance is highly stable over time.

The validity was determined by test content, correlations with other tests, and studies with special populations. Content validity was addressed by reviewing over twelve published referenced works to include items on the basis of frequency and common usage to ensure an objective and appropriate appraisal of English vocabulary. Correlations between the PPVT-4 and *Expressive Vocabulary Test*, Second Edition (EVT-2; Williams, 2007) were high and uniform across ages, ranging from .80 to .84, PPVT-4 and the *Clinical Evaluation of Language Fundamentals, Fourth Edition* (CELF-4; Semel, Wiig, & Secord, 2003) were moderate to high, ranging from .67 to .74, and PPVT-4 and the *Peabody Picture Vocabulary Test, Third Edition* (PPVT-III; Dunn & Dunn, 1997) were consistently high, ranging from .81-.91, indicating there is a strong relationship between the assessments.

This assessment was chosen because it is a widely used and accepted measure of a child's receptive vocabulary for the specific age range being studied. The percentile rank was used as a variable in the present study.

Language ENvironment Analysis (LENA). The LENA Pro software measured the quantitative language input and outcome of the participants. The audio recording from the LENA DLP is downloaded into the LENA software where a series of advanced algorithms and statistical modeling were used to automatically analyze and segment the audio data. The software differentiates between adult and child speech, meaningful and distant sounds, and conversational turns between the child wearing the device and others around him/her.

A thorough Natural Language Study was conducted over several phases and several years to contribute to product development and normative data. LENA researchers attempted to collect a large corpus of full day spontaneous speech from households of infants and toddlers that was representative of the US population (Gilkerson & Anderson, 2008). The reliability of the speech processing algorithms was determined by comparing the segmentation of the LENA audio processing algorithms to the segmentation of professional transcribers. The average difference from the criterion rater was 1.3% (Gilkerson, Coulter, & Richards, 2008), indicating strong reliability.

The quantity of language input and outcome is a measure of the amount of words spoken by the parent/caregiver in the near presence of the child (approximately 6-10 feet) measured as adult word counts (AWC), number of linguistically relevant vocalizations (i.e. speech or babbly, but excluding vegetative noises) produced by the child measured as child vocalizations (CVC), and a count of the number of times there is an adult response within 5 seconds of a child response or vice versa measured as conversational turns (CTC). These data are given in raw values and projected values, which reflect the variance in recordings due to challenges at the end of the day. The participants recorded for a continuous 16 hours, although depending on the time of morning when they turned their LENA on (often later on the weekend), the recording could

carry over to the following day. The projected values accounted for these differences to provide one value for both days, so the projected values were used in the analyses.

Reliability

After completing the assessments, the principal investigator and a Ph.D. graduate from the Deaf or Hard of Hearing Program at Teachers College independently scored the BTBC-3 and PPVT-4 assessments, and coded the demographic questionnaire. Inter-rater reliability was calculated to be 100%.

Data Analysis

IBM SPSS Statistics for Macintosh, Version 24, was used to analyze the data, and all statistical analyses were conducted at the .05 level of significance.

For question 1, to determine if a participant's specific demographic was related to the quantity of language input and outcome as measured by AWC, CVC, and CTC, child's vocabulary as measured by PPVT-4, and child's understanding of basic concepts as measured by BTBC-3, a series of analyses were conducted. The specific demographics explored included age, gender, degree of hearing loss by ear (normal, mild, moderate, moderate-severe, severe, profound), type of hearing loss by ear (conductive, mixed, sensorineural, neural), type of amplification by ear (cochlear implant, hearing aid, FM only), aided hearing thresholds for each ear (using pure tone average), hearing status of parents, presence of additional disability, family income and parent education.

For the demographic variables that were categorical (i.e., gender, hearing status of parents, presence of additional disability) an independent samples *t*-test was conducted to compare the mean differences between the categories and the continuous variables: AWC, CVC, CTC, PPTV-4, and BTBC-3. For the demographic variables that were continuous (i.e., age and aided hearing thresholds), a Pearson correlation was conducted. For variables with three or more

grouping factors (i.e., degree of hearing loss, type of hearing loss, type of amplification), a one-way ANOVA was conducted.

For question 2, to test the correlation between quantity of adult language input (AWC, CTC) to the child's quantity of language (CVC, PPVT-4, and BTBC-3), a Pearson correlation analysis was conducted because all of these measures are continuous variables.

Chapter 4

Results

This chapter provides a description of the results. First, a preliminary analysis was conducted to examine for outliers and missing data. Next, each research question hypothesis was tested in a primary analysis. The first analyses were conducted to examine the effects of the demographic data on the quantity of adult language, quantity of child language, and the child's scores on the *Boehm Test of Basic Concepts Preschool-3* (BTBC-3) and *Peabody Picture Vocabulary Test-4* (PPVT-4). The second analyses examined the relationship, if any, between the parents' quantity of language and the child's language.

Preliminary Data Analysis

Before testing the study hypothesis, the data were examined for missing data. The data were also examined for outliers by an inspection of a box plot and some exist, but they were meaningful to the data (scores on BTBC-3 and PPVT-4). Assumptions have been met, as assessed using the Spiro-Wilk test and Levinne's homogeneity of variances. Alpha for all tests of significance was set at the .05 level (two-tailed).

Primary Data Analysis

Table 4.1 presents means, standard deviations, and range on all variables for participants with hearing loss and participants with normal hearing. Table 4.2 presents means, standard deviations, and range on all variables for all the participants.

Table 4.1

Means, Standard Deviations, and Range by Hearing Status

	Hearing				Hearing Loss			
	Mean	SD	Min	Max	Mean	SD	Min	Max
AWC weekday	17227	6489	8368	24536	17182	5776	4557	25533
AWC weekend	10875	4705	6055	17334	14308	5540	5924	25617
AWC both	27423	11032	18680	541870	31568	9274	12488	51150
CTC weekday	539	179	229	682	633	281	144	1236
CTC weekend	270	143	132	425	634	304	61	1230
CTC both	804	121	654	942	17992	5708	4885	26763
CVC weekday	2271	402	1966	2921	2483	966	563	4349
CVC weekend	1434	775	446	2151	2880	1165	270	4735
CVC both	3181	897	2442	4343	3530	1305	798	5808
PPVT-4	77	15	38	97	23	26	0.1	94
BTBC-3	64	29	12	95	24	29	1	90

Note. AWC = Adult Word Counts; CTC = Conversational Turns; CVC = Child Vocalizations; BTBC-3 = Percentile scores on *Boehm Test of Basic Concepts Preschool-3*; PPVT-4 = Percentile scores on *Peabody Picture Vocabulary Test-4*.

Table 4.2

Means, Standard Deviations, and Range by Hearing Status

	Total Participants			
	Mean	SD	Minimum	Maximum
AWC weekday	17189	5780	4557	25533
AWC weekend	13879	5496	5924	25617
AWC both	1033	9418	12488	51550
CTC weekday	619	269	144	1236
CTC weekend	588	312	61	1230
CTC both	1215	496	430	2214
CVC weekday	2452	904	563	4349
CVC weekend	2767	1214	270	4735
CVC both	5274	1817	1667	8957
PPVT-4	34	32	0	97
BTBC-3	32	33	1	95

Note. AWC = Adult Word Counts; CTC = Conversational Turns; CVC = Child Vocalizations; BTBC-3 = Percentile scores on *Boehm Test of Basic Concepts Preschool-3*; PPVT-4 = Percentile scores on *Peabody Picture Vocabulary Test-4*.

Research Question 1: Are the demographics (age, gender, degree of hearing loss, type of hearing loss, type of amplification, aided hearing thresholds, hearing status of parents, presence of additional disability, socio-economic status and parent education) of the participants a factor in the quantity of adult language input, quantity of child language, child’s vocabulary, and child’s understanding of basic concepts?

Age. Participants’ age was referred to the age at the recording and reported in months. A Pearson correlation test was conducted to determine whether there was a relationship between participants’ ages and quantity of adult language, quantity of child language, and scores on the BTBC-3 and PPVT-4. The adult word counts (AWC), conversational turns (CTC), and child vocalizations (CVC) were examined under the three recording conditions: 1) weekday, 2) weekend day, and 3) weekday and weekend day combined, labeled as ‘both’.

No significant correlation was found between age and AWC weekend, CTC weekday, CTC weekend, CTC both, CVC weekday, CVC weekend, CVC both, and PPVT-4. A positive correlation was found between age and AWC both, $r(31) = .368, p = .042$, and age and BTBC-3, $r(37) = .434, p = .007$. A strong, positive correlation was found between age and AWC weekday, $r(34) = .435, p = .010$.

Table 4.3

Correlations among age, AWC, CTC, CVC, BTBC-3, PPVT-4

Variables	Age
Age	1
AWC Weekday	.435*
AWC Weekend	.208

AWC Both	.368*
CTC Weekday	.315
CTC Weekend	.109
CTC Both	.246
CVC Weekday	.256
CVC Weekend	.157
CVC Both	.214
BTBC-3	.434*
PPVT-4	.319

Note. AWC = Adult Word Counts; CTC = Conversational Turns; CVC = Child Vocalizations; BTBC-3 = Percentile scores on *Boehm Test of Basic Concepts Preschool-3*; PPVT-4 = Percentile scores on *Peabody Picture Vocabulary Test-4*.

** $p < 0.01$

* $p < 0.05$

Gender. To determine the effects, if any, of gender an independent t test was conducted. The data indicated there were no significant differences between males and females for any of the variables.

Family income: A one-way ANOVA indicated there were no significant differences between groups.

Father's education: The data indicated there were significant differences between groups for AWC weekend: $F(6,20) = 3.692, p = .044$; AWC both: $F(6,19) = 2.974, p = .032$; CTC weekend: $F(6,219) = 4.918, p = .003$; and CTC both: $F(6,22) = 5.550, p = .001$, using and ANOVA analysis.

Mother's education: Analysis using a one-way ANOVA revealed there were significant differences between groups for PPVT-4: $F(6,23) = 2.504, p = .052$ only.

Degree of hearing loss right ear. For the participants with hearing loss, a one-way ANOVA was conducted to determine whether differences existed, if any, between the degree of the child's hearing loss in the right ear and AWC, CTC, CVC, BTBC-3 and PPVT-4. The data

indicated there were no significant differences.

Degree of hearing loss left ear. Similarly, a one-way ANOVA indicated there were no significant differences, for the degree of hearing loss in the left ear for the participants with hearing loss.

Type of hearing loss. Specifically regarding the participants with hearing loss, a one-way ANOVA indicated there were significant differences between groups for PPVT-4: $F(4,25) = 2.975, p = .039$. Post hoc analysis revealed participants with conductive hearing loss had higher scores ($M=94; SD=-$) on the PPVT-4, whereas participants with mixed hearing loss had lower scores ($M=17.15; SD=23.8$).

Type of amplification right ear. Investigating whether differences existed for children with hearing loss, a one-way ANOVA was conducted, and revealed there were significant differences between groups for the BTBC-3: $F(3,26) = 6.679, p = .002$; PPVT-4: $F(3,26) = 7.770, p = .001$. Although the groups are unequal, post hoc analysis revealed hearing aid users ($M=20.75, SD=27.64$) performed better than cochlear implant users ($M=17.42, SD=21.73$) on the BTBC-3. It should be noted, there is only one case of FM only.

Type of amplification left ear. Similar to the type of amplification worn on the right ear, the data indicated there were significant differences between groups (for children with hearing loss) for the BTBC-3: $F(2,27) = 4.689, p = .018$; PPVT-4: $F(2,27) = 6.610, p = .005$. Although the groups are unequal, post hoc analysis revealed hearing aid users ($M=36, SD=36.54$) performed better than cochlear implant users ($M=15.58, SD=18.87$) on the BTBC-3.

Aided hearing thresholds. Measured as PTAr and PTAl, using a Pearson correlation on the participants with hearing loss, no significant correlations were found between PTAr and AWC, CTC, CVC, BTBC-3, and PPVT-4. Likewise, no significant correlations were found between PTAl and AWC, CTC, CVC, BTBC-3, and PPVT-4.

A very strong positive relationship was found between PTAr and PTAl, $r(25) = .974$, $p = .000$ (See table 4.4).

Table 4.4

Correlations among PTAl, PTAr, AWC, CTC, CVC, BTBC-3, PPVT-4

Variable	PTAl	PTAr
PTAl		.974**
PTAr	.974**	
AWC Weekday	-.202	-1.63
AWC Weekend	-.179	-.176
AWC Both	-.195	-.163
CTC Weekday	-.167	-.179
CTC Weekend	-.274	-.260
CTC Both	-.265	-.264
CVC Weekday	-.045	-.089
CVC Weekend	-.326	-.331
CVC Both	-.277	-.312
BTBC-3	-.090	-.120
PPVT-4	-.201	-.176

Note. AWC = Adult Word Counts; CTC = Conversational Turns; CVC = Child Vocalizations; BTBC-3 = Percentile scores on *Boehm Test of Basic Concepts Preschool-3*; PPVT-4 = Percentile scores on *Peabody Picture Vocabulary Test-4*.

** $p < 0.01$

* $p < 0.05$

Hearing status of parents. Analysis on the parental hearing status of the participants with hearing loss was conducted through an independent t test. It revealed no significant difference between the father's hearing status for AWC, CTC, CVC, BTBC-3, and PPVT-4, but found significant differences for mother's hearing status for BTBC-3, $t(28) = -2.423$ $p = .020$, hearing: $M = 22.41$, $SD = 26.933$; hearing loss: $M = 90$, $SD = 0$ and PPVT-4: hearing: $M = 21.92$, $SD = 24.375$;

hearing loss: $M=82$, $SD=0$. It should be noted that only two participants reported a parent with hearing loss; therefore, the means for each variable were compared to the means of the total participants and they were found to be comparable to their peers with parents that reported no hearing loss.

Presence of additional disability. An independent t test indicated there were significant differences between having an additional disability and not having an additional disability (for children with hearing loss) for BTBC-3 scores: no: $M=28.2$, $SD= 30.6$; yes: $M=6.6$, $SD= 7.8$; $t(28)= 1.552$, $p=.017$, and PPVT-4 scores: no: $M=27.7$, $SD= 27.3$; yes: $M=4.6$, $SD= 5.1$; $t(28)= 1.864$, $p= .014$. Post hoc analysis revealed that the participants without an additional disability performed better on the BTBC-3 than those with an additional disability.

Research Question 2: Is the quantity of adult language input related to the quantity of child language, child's vocabulary, and child's understanding of basic concepts?

Yes, the quantity of adult language input is positively related to the quantity of child language for several variables as described below. A Pearson correlation test was conducted to determine whether there was a relationship between the AWC, CTC, CVC and scores on the BTBC-3 and PPVT-4 (see Table 4.5).

Investigating AWC weekday and AWC weekend, a positive correlation was found, $r(31)= .401$, $p= .025$ and strong correlations were found between AWC weekday and AWC both, $r(31)= .841$, $p= .000$, CTC weekday, $r(34)= .621$, $p= .000$ and CTC both, $r(31)= .561$, $p= .001$. AWC weekend had a positive correlation with CTC weekday, $r(31)= .430$, $p= .016$, and CVC weekend, $r(32)= .357$, $p= .045$, although a strong positive correlation was found between AWC weekend and AWC both, $r(31)= .832$, $p= .000$, CTC weekend, $r(32)= .768$, $p= .000$, CTC both, $r(31)= .732$, $p= .000$, and CVC both, $r(31)= .469$, $p= .008$.

The data indicated a positive correlation existed between AWC both and CVC weekday, $r(31) = .403, p = .017$, CVC both, $r(31) = .437, p = .014$, with a strong positive correlation found between AWC both and CTC weekday, $r(31) = .653, p = .000$, CTC weekend, $r(31) = .632, p = .000$, and CTC both, $r(31) = .771, p = .000$. CTC weekday and CTC weekend were positively correlated, $r(31) = .382, p = .034$. A strong positive correlation was found between CTC weekday and CTC both, $r(31) = .807, p = .000$, CVC weekday, $r(31) = .821, p = .000$, and CVC both, $r(31) = .615, p = .000$.

For CTC weekend and CVC weekday, a positive correlation was noted, $r(31) = .361, p = .046$. A strong positive correlation was found between CTC weekend and CTC both, $r(31) = .854, p = .000$, CVC weekend, $r(32) = .773, p = .000$, and CVC both, $r(31) = .754, p = .000$. A strong positive correlation was found between CTC both and CVC weekday, $r(31) = .708, p = .000$, CVC weekend, $r(31) = .637, p = .000$, CVC both, $r(31) = .828, p = .000$. A positive correlation was found between CVC weekday and CVC weekend, $r(31) = .396, p = .027$. A strong positive correlation was found between CVC weekday and CVC both, $r(31) = .789, p = .000$. A strong positive correlation was found between CVC weekend and CVC both, $r(31) = .843, p = .000$. A strong positive correlation was found between BTBC-3 and PPVT-4, $r(37) = .857, p = .000$.

Table 4.5

Correlations among AWC, CTC, CVC, BTBC-3, and PPVT-4

Variable	1	2	3	4	5	6	7	8	9	10	11
1. AWC Weekday	1										
2. AWC Weekend	.401*	1									
3. AWC Both	.841**	.832**	1								
4. CTC Weekday	.621**	.430*	.653**	1							
5. CTC Weekend	.297	.768**	.632**	.382*	1						
6. CTC Both	.561**	.732**	.771**	.807**	.854**	1					
7. CVC Weekday	.239	.339	.426*	.812**	.361*	.708**	1				
8. CVC Weekend	.181	.357*	.322	.252	.773**	.637**	.396*	1			
9. CVC Both	.265	.469**	.437*	.615**	.754**	.828**	.789**	.843**	1		
10. BTBC-3	.147	.317	.287	.028	.309	.218	.101	.165	.200	1	
11. PPVT-4	.197	.179	.209	-.073	.169	.078	-.057	.032	.062	.857**	1

Note. AWC = Adult Word Counts; CTC = Conversational Turns; CVC = Child Vocalizations; BTBC-3 = Percentile scores on *Boehm Test of Basic Concepts Preschool-3*; PPVT-4 = Percentile scores on *Peabody Picture Vocabulary Test-4*.

** $p < 0.01$

* $p < 0.05$

Conclusion

In conclusion, there were several demographic factors present when analyzing adult language input on a child's language input, including age, gender, type of amplification each ear, mother's education, mother's hearing status, and the presence of an additional disability. While controlling for these factors, there were many meaningful correlations between the amount of words adult use and the amount of child vocalizations, for example: AWC on the weekday and CTC on the weekday. This finding identifies the influence of the quantity of adult language input on the child's language development, which will be further explored in the below section.

Chapter 5

Discussion

Overview

Improved access to newborn hearing screening and availability of cochlear implants and digital hearings, along with parents choosing listening and spoken language for their child with hearing loss, has changed the landscape for deaf education (Yoshinaga-Itano & Apuzzo, 1998; Cole & Flexer, 2007). With these changes, children with hearing loss have improved access to the auditory information in their environment. Although access has improved, children with hearing loss may still present with challenges that affect their language use (Blamey, 2003; Connor, Craig, Raudenbush, Heavner, & Zwolan, 2006; Geers & Hayes, 2011; Spencer et al., 2004; Svirsky et al., 2000; Yoshinaga, Sedey, Wiggin, & Chung, 2017), basic concept understanding (Bracken & Cato, 1986; Davis, 1974; Harrington et al., 2009), vocabulary learning (Connor et al., 2006; Fagan & Pisoni, 2010; Odom et al., 1967; Paul, 2001; Walter, 1978), and literacy skills (Blamey, 2003).

Several published studies have investigated the effects of parents' language on their child's language skills. The repeated theme is that children require more than just exposure to a large amount of words in their environment. Better outcomes were linked to families from higher socioeconomic status, parents who presented with more sensitive responsiveness to their child's communication attempts, and enriched adult-child interactions. The works of Vygotsky (1962; 1978; 1987) and Tomasello (1983, 2003), highlighted that children (with normal hearing) learn language through interactions within their environment and through scaffolding with expert users of the language. Lastly, research informs us that increased language input is positively related to children's vocabulary development and later kindergarten readiness (here measured as basic concept skills). To this end, there are no published studies examining the possible influence of

the quantity of adult language on the quantity of child language, vocabulary development, and basic concept understanding for children with hearing loss. This study sought to investigate those relationships. It was also the goals of this research to identify other possible research and educational implications for educators and parents of children with hearing loss.

This study was structured around two research questions: (1) Are the demographics (age, gender, degree of hearing loss, type of hearing loss, type of amplification, aided hearing thresholds, hearing status of parents, presence of additional disability, socio-economic status and parent education) of the participants a factor in the quantity of adult input, quantity of child language, child's vocabulary, and child's understanding of basic concepts? (2) Is the quantity of adult language input related to the quantity of child language, child's vocabulary, and child's understanding of basic concepts?

Results of this investigation indicated that, overall, there were significant relationships between adult words spoken, conversational turns taken, and child vocalizations. There was a strong relationship for the amount of words adult spoken on the weekend and conversational turns taken on the weekend, as well as, for adult words spoken on the weekday and conversations on the weekday. This suggests adults were speaking to children at a similar quantity during school days and on weekends, and that frequency was related to how much the child vocalized/spoke. Basic concept knowledge and single word vocabulary skills were found to not be related to the amount of words spoken in the child's environment, nor were they related to the amount of words children said and used in interactions in the environment.

Extending these results to the works of early language acquisition theorists (Vygotsky and Tomasello), it is true the environments children live in have an influence on their language skills. The quantity of adult words in the environment and the interactions between the adult and

child are positively related to the child's vocalizations. In this study, this relationship was demonstrated for children with hearing loss and for children with normal hearing. For the remainder of this chapter, results related to each research question will be discussed. Educational implications will then be addressed, followed by study limitations. Finally, future directions for continued research are offered.

Summary of the Results

Research Question 1: Firstly, the demographics of the participants were found to be related to the amount of language adults use, the amount of language the child uses, and the child's scores on a vocabulary test and basic concept test. As expected, age (Blewitt, 1983), additional disability (Daneski & Hassanzadeh, 2007; Nikolopoulos, Archbold, Wever, & Lloyd, 2008; Meinzen-Durr, Wiley, Grether, & Choo, 2009), and parents' education (Dollagan, et al., 1999; Hart & Risley, 1995) had a significant difference on a child's language environment. Surprisingly, degree of hearing loss (Hoff-Ginsberg, 1994; Kishon-Rabin, Taitelbaum-Swead, Ezrati-Vinacour, & Hildesheimer, 2005), aided pure tone average (Van Dam, Ambrose, & Moeller, 2012), and family socio-economic status (Hart & Risley, 1995; Huttenlocher, Vasilyeva, Cymerman, & Levine, 2001) did not have a significant difference on a child's language environment.

Age was found to have a significant difference in the amount of words the adult(s) spoke around the child, the conversational turns the adult(s) and child participated in, and the child's understanding of basic concepts. The enriched language environment (or lack thereof) for these children could be influenced by their age, as research suggests (Birman, Elliott, & Gibson, 2012). Blewitt (1983) found mothers of younger children (18-30 months) spoke differently to their children aged 2-4 years old. The younger children were exposed to more basic level nouns and less words. By providing less words and more simplistic sentences, the children are not

exposed to as many function words (articles, prepositions, etc). This could provide some evidence as to why age influenced the child's understanding of basic concepts.

It was not surprising to find children with an additional disability scored lower on the language assessments. As research suggests, students with additional disabilities can present with a variable rate of progress, which is often slow (Berrettini, Forli, Genovese, Santarelli, Arslan, & Chilosi, 2008; Meinsen-Derr, Wiley, Grether, & Choo, 2009) and can affect language outcomes (Daneski & Hassanzadeh, 2007). In this study, the mean difference in percentile rank between the children with a documented additional disability and those without was 21.6 percentile for basic concepts and 23.1 percentile for receptive vocabulary. The language environments of these children were not compromised due to their additional disability, as the adult word counts did not have a significant difference. This suggests the children with additional disabilities had environmental access to a similar amount of words as children with deafness alone. Fortunately, their environment was not worse, although conversely, it was not better either. Some research (Bruce et al., 2008; & Luckner, & Carter, 2001) suggests students with hearing loss and additional disabilities may need specialized teaching, and the lack of this in their home environment (compared to children without additional disabilities) could potentially contribute to their reduced language scores.

The parents' highest education levels were analyzed and found to have significant relationships with the child's language environment. Receptive vocabulary was positively correlated with maternal education levels, while adult word counts and conversational turns on both weekday and weekend, and on weekends alone were positively correlated with paternal education. Although maternal education was positively related to some language variables, this in contrast to the research by Doolagan and colleagues (1999) that suggested maternal education

was related to mean length of utterance in morphemes, number of different words, and total number of words. It was found paternal education levels, not maternal, were related to more words being spoken around the child and in conversation with the child. It could be hypothesized that interactions between professional fathers, who often work during the week, were present on the weekends leading to higher adult word counts and conversational turns on the weekends. This study did not identify the primary caretaker during the week and/or weekend, although this could be an avenue to investigate in a future study.

Contrary to previous research (Hoff-Ginsberg, 1994; VanDam, Ambrose, & Moeller, 2012), in this study, the degree of the child's hearing loss and their aided pure tone average were not significantly related to the amount of words spoken around the child and the child's language. It was hypothesized the better the child heard prior to implantation (degree of hearing loss) and the better the child hears with amplification (aided pure tone average), the more linguistic input the adult will provide. This was not the case. The data suggest parents provide a similar language environment to their deaf and hard-of-hearing child without preference to the child's audition skills.

Research Question 2: Overall, the analysis of data collected by the LENA system found strong correlations among adult word counts, child vocalizations, and conversational turns across weekends and weekdays. True to the hypothesis, this indicated parents and teachers were relatively consistent in the language environment provided to their child(ren) at home and at school. It could imply parents are following strategies taught by the certified teachers of the deaf in their child(ren)'s classrooms to provide a language rich environment in their home similar to that provided at their specialized school.

Likewise, the adult word counts were positively related to the conversational turns suggesting the more the adult talks, the more the child talks, and vice versa. This 'idiosyncratic feedback cycle' is described in the research to exist between parents and children with language delays (Conti-Ransden, 1990; Tannock & Giraletto, 1992; Vigil, Hodges, & Klee, 2005). Since many of the children of this current study had language delays secondary to hearing loss, the feedback cycle was hypothesized to occur with children in this study as well. It proved to be true.

Scores on the PPVT-4 and the BTBC-3 were also strongly correlated, indicating children performed with similar accuracy on both language measures. It could be hypothesized, the fewer words the child understands as measured by receptive vocabulary, the less the child understands basic concepts. Similarly, the more words the child understands, the more concepts the child understands. This is impactful because the words within basic concepts are frequently in classroom directions (Bowers & Schwartz, 2013), critical sight words (Dolch, 1936), and vocabulary words for early readers (Johnson, 1971). Children struggling with these skills may also struggle with the academic language demands of a mainstream classroom. Interestingly, basic concept knowledge and single word vocabulary skills were found to not be related to the amount of words spoken in the child's environment, nor were they related to the amount of words children said and used in interactions in the environment. So, although basic concepts are present in rigorous academic work, those skills are may not be learned through incidental adult talk in the environment. Perhaps basic concepts require specific teaching, as Ellis et al. (1995), suggests, where teaching basic concepts will enhance knowledge of basic concept vocabulary.

Although the difference was not statistically significant, there was high variability in the children's scores on the language assessments. The deaf and hard-of-hearing children scored an average percentile rank of 23 (SD = 26) and 24 (SD = 29) on the PPVT-4 and the BTBC-3,

respectively; whereas, the hearing children scored an average percentile rank of 70 (SD = 22) and 64 (SD = 29), respectively. The lack of a statistically significant difference could be attributed to the structure of the assessment since it analyzed single word knowledge; whereas greater differences could have emerged with the use of more comprehensive language assessment tool analyzing language at the phrase or sentence level.

With research pointing to deaf and hard-of-hearing children acquiring vocabulary at a slower rate than their peers, and having a narrower range of concept understanding (Cole & Flexer, 2007; Connor et al., 2006; Easterbrooks & Estes, 2007; Paul, 2009; Rose, McAnally, & Quigley, 2004; Schirmer, 2000; & Trezek, Wang, & Paul, 2010), similar rates of exposure to adult talk may not lead to similar language outcomes. Even with the perfect trifecta of opportunity: early identification (by 1 month of age), early hearing loss confirmation (by 3 months of age), and early intervention (by 6 months of age), children with hearing loss are still at risk for language delays (Cole & Flexer, 2007). In order to close the gap between the deaf and hard-of-hearing children and their hearing peers, parents and educators must compensate for their child's language deficits or risk of language deficits. Therefore, researchers such as Aragon and Yoshinaga-Itano (2012) describe the need for a "super" language environment consisting of a higher frequency of adult words spoken and increased participation in conversational turns in order to improve language outcomes (p. 350). This study found that the language environments for both groups of children were statistically similar, indicating the possible need for professionals and parents to improve the language environment of their deaf and hard-of-hearing children.

Implications

The findings of this study, although limited to a small sample group, may provide some insight on how caregivers are talking to their children at home and how specialized teachers are talking to their students. The findings from this study indicate there were strong correlations among the amount of words adults use with children, the amount of vocalizations the children make, and the conversational turns between two talking partners for many of the weekend and weekday conditions. This information can be used to inform educators, speech language pathologists, auditory verbal therapists, and parents that talking to their children with hearing loss matters. The increased amount of talking is also positively related to vocabulary development and basic concept skills. This finding extends previous research which suggested language outcomes were related to early vocabulary knowledge (Rowe, Raudenbush, & Goldin-Meadow, 2012) and early language skills related to basic concept knowledge (Harrington, DesJardin, & Shea, 2009), and the finding connects these factors together for children with hearing loss. Keeping in mind new understandings about how language input affects later vocabulary knowledge and kindergarten readiness will arm parents and educators on the importance of communicating with children at a young age.

Additionally, the findings of this study can provide some preliminary evidence about whether socially mediated interactionist theories of child development (Vygotsky, 1962; Tomasello, 2003) can be applied and understood through the lens of a sensory disability, such as deafness. Since improved interactions (conversational turns) were found to be positively related to the amount of adult words spoken and the amount of child vocalizations made, parents and educators should be coached to improve meaningful interactions (more frequency). This recommendation is similar to the ‘embellish everyday conversations’ rhetoric that listening and spoken language specialists currently use with families (Cole & Flexer, 2007). An area of future

study is to investigate how those conversations are embellished by delving into the quality aspect of language similar to Huttenlocher et al. (2010).

Limitations of the Study

This study has limitations that could be addressed in the future work. First, the number of participants were low ($n=37$) even though they were recruited from several programs across the United States. Since deafness is a low incidence disability, it can be challenging to recruit a large number of families. There is a need for a large scale data management system in deaf education to combine program data together to increase the n in future studies. Second, the participants in this study were English-only speakers. To broaden the heterogeneity of future samples and to provide results that could be generalized to more families, it would be beneficial to recruit families that are culturally and/or linguistically diverse. In that same light, recruiting families from all socio-economic statuses would provide a more generalizable result. In the current study, there is a slight bias because families from lower SES had difficulty committing to all requirements of the study therefore not being represented. Third, a challenge with comparison were the unequal groups of children with hearing loss ($n=30$) and children with normal hearing ($n=7$) for some demographic variables, such as type of hearing loss where there were far fewer children with conductive or mixed hearing loss. Having more equitable groups would improve the conclusions to be drawn between groups on those specific variables. Fourth, this study did not delve into the language differences that could arise when looking at a student's 'hearing age' (time since receiving appropriate amplification) rather than their chronological age. A child's language could be impacted by the length of time it takes to receive appropriately fit amplification (Nicholas & Geers, 2007).

Another challenge is the mere presence of the LENA device could skew the amount of talk adults use with children who are wearing the device. Described as the Hawthorn effect

(Jackson & Callendar, 2014), parents may be influenced to alter their communication with their children if they view it as a reflection of their parenting (Wang et al., 2017). Although the LENA device was used as a positive intervention tool in Sacks et al. (2014)'s study as a 'quantitative linguistic feedback' tool, this presents as a limitation in the current study. The intention of using the LENA device was to capture 'a day in the life' of the language use around the children in the study. However, the recordings cannot be assumed with certainty to represent that environment. The LENA device also does not account for intonation or gestures, which can demonstrate communicative intent in conversation. Also, the children wore the LENA device for only two days. A longer wear time would provide more insight into the language variability within the children's homes and in their classrooms. Additionally, another limitation that was not accounted for in this study was the possible variance in wear time across participants i.e. sleeping (weekday: M=14, SD=1.3; weekend: M=12, SD=1.3). Although the LENA cannot capture every moment with absolute accuracy within the child's environment, as it becomes a more widespread measurement tool, it is hoped to improve the ability to study language in children's homes.

Future Directions

Although this study sought to expand current research on the impact of the quantity of language in a child's environment on their language skills, it does not evaluate the quality of the language. The logical next step in this research would be to investigate the types of language being used by adults around deaf and hard-of-hearing children. Using procedures and variables outlined by Huttenlocher et al. (2010), the quality of language could be evaluated at the lexical, constituent, and clausal diversity levels. This would provide researchers with the ability to compare quantity aspects and quality aspects. In that same light, other quality aspects of language could be investigated with the addition of video including non-verbal communication such as body movements, gestures, intonation, or facial expressions. Just the mere presence of

adult words in an environment does not guarantee engagement between the adult speaker and the child listener. Measurements of engagement, joint attention, and listener behavior could provide more data on the impact of language in children's environments. Additionally, identifying the role of the speaker during the recordings could help with analysis, so that connections could be made between who is providing the language to the child (caretaker, father, mother, grandparent, etc.) and at what time (weekday, weekend, school, etc.).

Wiggin et al (2012) (n=8) found the deaf and hard-of-hearing preschool experience provided language stimulation equivalent to the average language stimulation that a hearing children received in a 10-16-hour day. Using data in this study, an expansion of Wiggins' study could be conducted to investigate direct comparisons between specialized deaf and hard of hearing programs and typical preschool classrooms. This data could provide insight on the possible differences in the type of teaching occurring in both preschool environments.

In the present study, the measurement of language was obtained at the single word level on the *PPVT-4* and at the within sentence level on the *BTBC-3*. Another avenue to pursue could be an investigation on the impact of the study variables on the children's scores of a more comprehensive language assessment. It would be beneficial to include higher order thinking skills, like inferencing, which is an important facet of reading literacy. This could provide some evidence on whether the language used in a child's environment affects the child's later reading readiness skills.

Lastly, another avenue to pursue would be to follow up with these participants to investigate longitudinal effects of parental language input. Examining variables that could potentially predict later language or vocabulary success could help professionals with coaching parents to emulate those positive factors.

In conclusion, this study found relationships between the amount of words adult use around children, the amount of words children use, and the amount of conversational turns taken. There were also familial factors found to be associated with the aforementioned variables above, namely age, gender, type of amplification each ear, mother's education, mother's hearing status, and the presence of an additional disability. These results provide support for the idea that adult language input is positively related to children's language acquisition and language use. In this study, attempts at extending language acquisition theories to children with hearing loss are made. Continued research on the possible impact of different types of quality of language used with children with hearing loss is suggested.

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APPENDIX A

Informed Consent – Teacher

DESCRIPTION OF THE RESEARCH: You and a child in your class are invited to participate in a research study on the language development and language environment of preschool children living in English-speaking households. The child will wear a digital language processor called the Language ENvironment Analysis system (LENA) that will audio record adult and child interactions for 16 hours at a time for two days. It is a small device (about the size of an iPhone) that fits into a soft cotton vest onto the child's chest. The recording will be analyzed by the LENA computer software and the principal researcher, Ronda Rufsvold. The child's language will also be assessed using the Peabody Picture Vocabulary Test and the Boehm Test of Basic Concepts. These are standardized assessments that provide information on the child's vocabulary skills and understanding of basic concepts. A 30-minute snack time will be recorded, transcribed, and analyzed. You would be giving permission for the researcher to use your language instruction in the analyses.

RISKS: There are no known risks to you or to the child in this study other than the potential risks of conducting the typical activities in your daily life and preschool classroom. If you refuse to participate in the study, your recording will not be transcribed or analyzed. You may choose to refuse to participate or withdraw from the study at any time with no negative or positive consequences.

BENEFITS: The potential benefit of the study to you includes an analysis of the language you use in your classroom. You may gain a better understanding of the language you use with the children in your classroom.

PAYMENTS: There is no payment for your participation.

DATA STORAGE TO PROTECT CONFIDENTIALITY: The LENA device containing the recording is encrypted and can only be used by the LENA software, which is on a password-protected computer in the possession of the principal investigator or in a locked cabinet in the principal investigator's home. A backup of the data will be stored on an Internet cloud data storage website with password protection only accessible by the principal investigator and her dissertation advisor. The consent form, which contains name identification, will be kept in a different locked filing cabinet in the dissertation advisor's office. Computer files and hard files will be destroyed after the publication of the study, thereby ensuring the anonymity and confidentiality of the study participants. All names will be kept confidential by using numerical codes to identify the subjects and speakers in the recording.

TIME INVOLVEMENT: Your participation will take approximately 30 minutes of your snack time routine. The parent will place the LENA device on the child in the morning and he/she will conduct daily activities as usual. The device will record language spoken from and around the child for a continuous 16 hours including classroom instruction. The device will automatically turn off after 16 hours.

HOW WILL RESULTS BE USED: The results of the study will be used for the principal investigator's dissertation for her doctoral degree. The research may be presented at educational conferences and/or published in academic journals.

APPENDIX B

Informed Consent – Parent

DESCRIPTION OF THE RESEARCH: You and your child are invited to participate in a research study on the language development and language environment of preschool children living in English-speaking households. You will be asked to have your child wear a digital language processor called the Language ENvironment Analysis system (LENA) that will audio record adult and child interactions for 16 hours at a time for two days. It is a small device (about the size of an iPhone) that fits into a soft cotton vest onto your child's chest. The recording will be analyzed by the LENA computer software and the principal researcher, Ronda Rufsvold. Your child's language will also be assessed using the Peabody Picture Vocabulary Test and the Boehm Test of Basic Concepts. These are standardized assessments that provide information on your child's vocabulary skills and understanding of basic concepts. Lastly, you will be asked to provide demographic information about your child and your family.

RISKS: There are no known risks for child in this study other than the potential risks of conducting the typical activities in your daily life and preschool classroom. If you refuse for your child to participate in the study, his/her recording will not be transcribed or analyzed. If choose to participate and return the LENA device expressing concern with the recording for any reason, the principal investigator will delete the contents and allow you another opportunity to record data. You may chose to refuse to participate or withdraw from the study at any time with no negative or positive consequences.

BENEFITS: The potential benefit of the study to you and your child includes an analysis of your child's language development. You will receive your child's standardized score, percentile rank, and age equivalence on the Peabody Picture Vocabulary Test and Boehm Test of Basic Concepts. You may gain a better understanding of the language your child uses.

PAYMENTS: There is no payment for your participation.

DATA STORAGE TO PROTECT CONFIDENTIALITY: The LENA device containing the recording is encrypted and can only be used by the LENA software, which is on a password-protected computer in the possession of the principal investigator or in a locked cabinet in the principal investigator's home. A backup of the data will be stored on an Internet cloud data storage website with password protection only accessible by the principal investigator and her dissertation advisor. The consent form, which contains name identification, will be kept in a different locked filing cabinet in the dissertation advisor's office. Computer files and hard files will be destroyed after the publication of the study, thereby ensuring the anonymity and confidentiality of the study participants. All names will be kept confidential by using numerical codes to identify the subjects and speakers in the recording.

TIME INVOLVEMENT: Your participation will take approximately 16 hours for 2 days including one week day and one weekend day. You place the LENA device on your child in the morning and conduct your daily activities as usual. The device will record language spoken from and around your child for a continuous 16 hours. The device will automatically turn off

after 16 hours. Your child will require one 30-minute session with the principal investigator to conduct the two assessments (described above). This will take place during your child's school day.

HOW WILL RESULTS BE USED: The results of the study will be used for the principal investigator's dissertation for her doctoral degree. The research may be presented at educational conferences and/or published in academic journals.

APPENDIX C

Demographic Questionnaire

1. Child's Name: _____
2. Child's Birthdate (Month Day, Year) _____
3. Gender: _____
4. Birth order: _____
5. Date Hearing Loss was Identified: _____
6. Degree of Hearing Loss (each ear):

Normal mild moderate moderate-severe severe
profound

7. Type of hearing loss (each ear):

Conductive mixed sensorineural neural

8. Aided hearing thresholds (pure tone average) Please provide most recent aided audiogram.

right _____ left _____

9. Cause of hearing loss (if known): _____

10. Date of receiving amplication: _____ right _____ left

11. Make and Model of amplification (ex. Cochlear N5, Phonak Nios):

right _____ left _____

12. Date of CI surgery: right _____ left _____

13. Date of activation: right _____ left _____

14. Describe any additional surgery complications - including dates (ex. explantation, device failure, infections)

15. Hearing status of parents (hearing or degree of hearing loss):

Father: _____ Mother: _____

16. Total household income:

Less than \$10,000 \$10,000 to \$29,999 \$30,000 to \$49,999 \$50,000 to \$69,999
\$70,000 to \$89,999

\$90,000 to 119,999 \$120,000 to \$139,999 \$140,000 or more

17. Parents' highest education level:

Mother:

some high school high school some college associate degree
bachelor degree masters degree Doctoral degree post-doctoral
unknown

Father:

some high school high school some college associate degree bachelor
degree masters degree Doctoral degree post-doctoral unknown

18. Is there an additional diagnosed disability: Yes No

If yes, please indicate:

19. Siblings? Yes No

If yes, ages and presence of hearing loss.

Sibling 1- Age: _____ Hearing loss: Yes No

If yes, degree of loss: _____

Sibling 2- Age: _____ Hearing loss: Yes No

If yes, degree of loss: _____

Sibling 3- Age: _____ Hearing loss: Yes No

If yes, degree of loss: _____

Sibling 4- Age: _____ Hearing loss: Yes No


If yes, degree of loss: _____

APPENDIX D

Hourly Activity Log

LENA

Hourly Activity Log



LENA™

Every Word Counts

Date: _____

PLEASE RETURN THIS FORM TO RONDA RUFVOLD
 Filling out this form will allow you to compare your results with your recording day routine. This will allow you to see which events and activities resulted in increased language and interaction. Please complete this chart during your recording day, noting activities your child engaged in, such as:

Child care/preschool	Nanny/babysitter time	Play dates	Errands (grocery store, etc)
TV/video time	Naps	Group gatherings	Therapy sessions/interventions
Book reading	Car rides	Dressing times, meal/snack times	Outings (zoo, library, etc)

+

Time	Activity	Main Caregiver	Other People Present	Notes
5 AM - 6 AM				
6 AM - 7 AM				
7 AM - 8 AM				
8 AM - 9 AM				
9 AM - 10 AM				
10 AM - 11 AM				
11 AM - 12 PM				

The LENA Research Foundation is a nonprofit charitable organization (501(C)(3)).
 LENA Research Foundation • www.lenafoundation.org • 1.866.503.9917 • 5525 Central Avenue, Suite 100, Boulder, CO 80301-2820

Time	Activity	Main Caregiver	Other People Present	Notes
12 PM - 1 PM				
1 PM - 2 PM				
2 PM - 3 PM				
3 PM - 4 PM				
4 PM - 5 PM				
5 PM - 6 PM				
6 PM - 7 PM				
7 PM - 8 PM				
8 PM - 9 PM				
9 PM - 10 PM				
10 PM - 11PM				
11 PM - 12 AM				

APPENDIX E

How to record Booklet

Frequently Asked Questions

Q: I pressed the top button on the LENA DLP and now the screen displays "Sleeping." Is this okay?

A: Yes, this is fine! To begin recording, press and hold the REC button until the screen displays "Recording" (about 4 seconds).

☆☆☆

Q: I turned on my LENA DLP and forgot to press the REC button right away. The LENA DLP has shut off. How do I turn it back on?

A: 1) Press the TOP BUTTON until the screen displays "Sleeping" (about 4 seconds).

2) Press and hold the REC button until the screen displays "Recording" (about 4 seconds).

☆☆☆

Q: I'm ready to put the LENA DLP in the LENA Clothing, but the screen displays "Paused" instead of "Recording." What should I do?

A: Good Question! It is very important that the screen displays "Recording" before you put it in the LENA Clothing. If it displays "Paused," press the REC button until the screen displays "Recording" (about 4 seconds).

☆☆☆

Q: When the LENA DLP turned off after 16 hours, the screen displayed "Memory Full," but now the screen is blank. Is this okay?

A: Yes! The screen automatically goes blank 15 minutes after the recording is complete.



Step-by-Step Instructions

Materials Enclosed:

- Informed Consent Letter
- Parent Rights Letter
- 1 Digital Language Processor (DLP)
- 1 Item of LENA Clothing
- 1 Hourly Activity Log

Recording Day: Step-by-Step Instructions:



Your recording day starts when your child wakes up in the morning.

*** Do not turn on the LENA Digital Language Processor (DLP) until the morning of your child's recording session.**

1 Take the LENA DLP out of the pouch.

2 Begin recording by turning on the DLP:



* Press the POWER BUTTON  for about four seconds, until the unit powers on. When ready, the screen will display Sleeping.



* Press the REC button for about four seconds, until the screen displays Recording.

IMPORTANT:

- ☆ Screen must display **Recording** before you put the DLP in the LENA Clothing. If screen displays **Paused**, press the REC button for 3-4 seconds until it displays **Recording**
- ☆ Do not press the REC button after the recording has started

3 Place the DLP in the pocket of the LENA Clothing; Insert the DLP so the elephant goes in first and the screen faces out. Snap the pocket closed.



4 Dress your child in the LENA Clothing.

5 During the recording day, note your child's activities on the Hourly Activity Log.

6 Record for 16 hours, until the LENA DLP turns off on its own.

IMPORTANT:

☆ For safety reasons, you must remove the DLP from your child's LENA Clothing while he or she is in a car seat or any other safety harness. Keep the DLP close by to continue recording. **Put** the DLP back in the LENA Clothing once your child is out of the car.

☆ During naps, baths and bed times, take the LENA Clothing off your child. Leave the DLP in recording mode inside the pocket and keep the LENA Clothing nearby to continue recording your child's language environment. After nap or bath, put the clothing back on your child.



7 Your recording day is finished when your child goes to bed for the evening. Take the LENA Clothing off your child (with the LENA DLP in the pocket) and place it near your child to continue recording his/her environment when he/she is sleeping (just as you would do during nap time). Silence periods are an important part of our research.

8 The LENA DLP will turn off on its own after 16 hours of recording (screen will display Memory Full). After 15 minutes, the screen will go blank.

9 The morning after the recording, place the LENA DLP, the LENA clothing, and the completed Hourly Activity Log in the envelope.

If you have any questions, please contact the principal investigator at rondarufsvold@gmail.com or 1.408.528.4226.

Thank you!

APPENDIX F

Participant's Rights

- I have read and discussed the Research Description with the researcher. I have had the opportunity to ask questions about the purposes and procedures regarding this study.
- My participation in research is voluntary. I may refuse to participate or withdraw from participation at any time without jeopardy to future medical care, employment, student status or other entitlements.
- The researcher may withdraw me from the research at his/her professional discretion.
- If, during the course of the study, significant new information that has been developed becomes available which may relate to my willingness to continue to participate, the investigator will provide this information to me.
- Any information derived from the research project that personally identifies me will not be voluntarily released or disclosed without my separate consent, except as specifically required by law.
- If at any time I have any questions regarding the research or my participation, I can contact the investigator, who will answer my questions. The investigator's phone number is (408)528-4226.
- If at any time I have comments, or concerns regarding the conduct of the research or questions about my rights as a research subject, I should contact the Teachers College, Columbia University Institutional Review Board /IRB. The phone number for the IRB is (212) 678-4105. Or, I can write to the IRB at Teachers College, Columbia University, 525 W. 120th Street, New York, NY, 10027, Box 151.
- I should receive a copy of the Research Description and this Participant's Rights document.
- I () consent to be audio taped. I () do NOT consent to being audio taped. Only the 30-minute meal time will be transcribed and analyzed by the principal investigator.
- Written, video and/or audio taped materials () may be viewed in an educational setting outside the research . () may NOT be viewed in an educational setting outside the research.
- My signature means that I agree to participate in this study.

Participant's signature: _____ Date: ____/____/____

Name: _____

If necessary:

Guardian's Signature/consent: _____

Date: ____/____/____

Name: _____

Figure 1

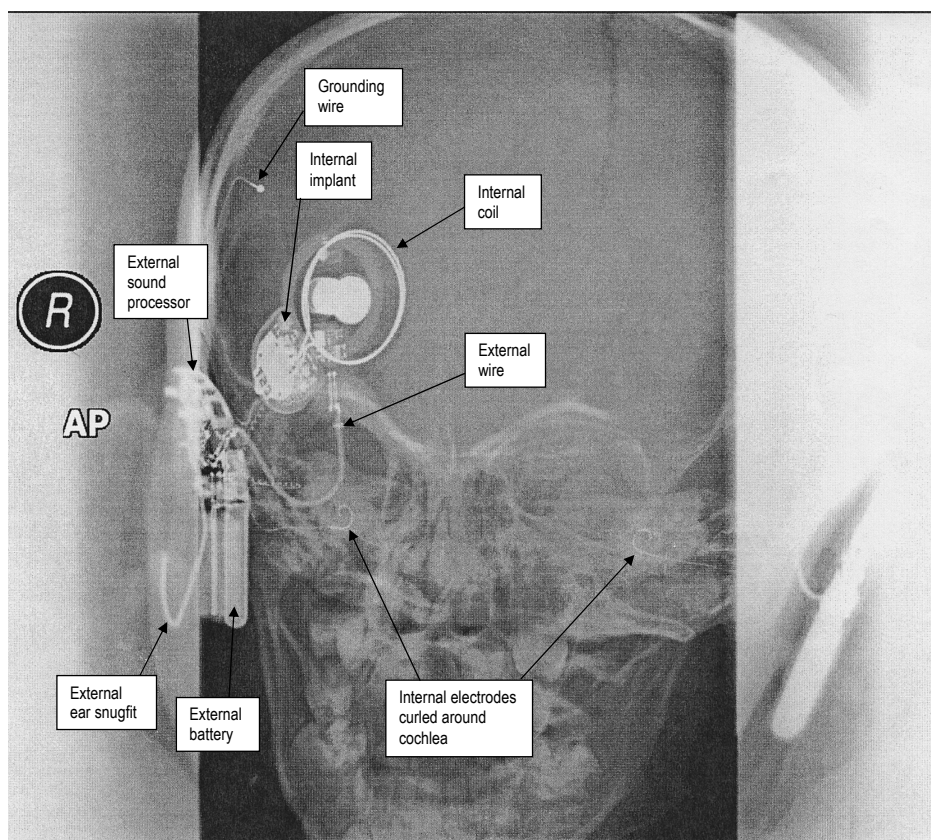


Figure 1. X-Ray of a 7 year-old with cochlear implant. Image was used with permission from Sarah Martin, mother. All rights reserved.