Quality and Quantity of Language Input and Its Relation to the Language Outcomes of Preschool Children With Hearing Loss Who Use Listening and Spoken Language

Sonia Bala Arora

Submitted in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy
under the Executive Committee
of the Graduate School of Arts and Sciences

COLUMBIA UNIVERSITY

2018

Abstract

Quality and Quantity of Language Input and Its Relation to the Language Outcomes of Preschool Children With Hearing Loss Who Use Listening and Spoken Language

Sonia Bala Arora

This study sought to examine the relationships between the adult language input, as measured by quantity and quality, and the child's language production in regards to quantity and quality, as well as their knowledge of basic concepts and vocabulary. LENA technology was used to audio-record the language environments of 26 preschool children with hearing loss over two days (weekday and weekend). This technology recorded up to 16 hours and analyzed the quantitative data associated with the adult word count (AWC), conversational turn count (CTC), and child vocalization count (CVC). Furthermore, one- hour meal times (30 minutes for the weekday/snack time and 30 minutes for the weekend/dinner time) was transcribed and coded for quality components of language defined as lexical diversity, syntactical complexity and clausal complexity. Additionally, the children were assessed on their knowledge of basic concepts through the *Boehm Test of Basic Concepts* (BTBC-3) and the *Peabody Picture Vocabulary Test* (PPVT-4).

Results indicated that there was a relationship between the adult language input and the child language production, but only in regards to quantity of language. More specifically, the CTC during each day was related to the CVC for each day; in other words, the more interactions adults and children had during the day, the more likely the child vocalized. Interestingly, the statistical analysis revealed that quality of adult language input was not significantly related to the child language variables. However, significant differences between the teachers and caregivers were reported in regards to the quality of adult language input. These results suggest

that the language input provided by adults in different environments (school versus home) is considerably different and warrants further investigation as how the potential influence on language outcomes of children with hearing loss.

Table of Contents

List of Tables

Acknowledgments

First and foremost, I would like to express my gratitude to my advisor and mentor, Dr. Ye Wang for her encouragement, support and inspiration. She has given me the opportunity to explore aspects of this field that I would have not have gained otherwise, I am forever indebted.

Additionally, I would like to thank the rest of my dissertation committee, Dr. Laudan Jahromi, Dr. Daniel Fienup, Dr. Stephen Peverly, and Dr. Lisa Son for their feedback and genuine investment in my research contributions and other scholarly achievements. Furthermore, I would like to thank my fellow doctoral colleagues for providing a safe place to share ideas and motivation as well as a shoulder to lean on during those hard times. Specifically, I would like to acknowledge and express my utmost gratitude to Dr. Ronda Rufsvold for her efforts in data collection as well as Elaine Smolen and Dr. Amanda Howerton-Fox for their hard work and time in coding this data. Additionally, to Dr. Maria Hartman, thank you for providing a constant ray of hope and positivity.

I would like to take advantage of this space to thank my family and friends for their never faltering love and support. Thank you for your understanding and patience as I navigated this interesting chapter in my life. Your steady presence has made this journey enjoyable as well as attainable. Lastly, I would like to thank my parents for their love, wisdom, encouragement, motivation, and confidence. This would have not happened, if it weren't for you, and for that there are not enough words to express my gratitude. Thank you for listening to my never-ending rambles, giving me hope through the rough times, showering me with wisdom and love as I pursued this incredible opportunity. Thank you for teaching me that anything is possible.

Chapter 1

Introduction to the Study

Exploring the components of language development is a heavily researched topic in regards to child development; however, our understanding of what influences language development remains less clear. The literature surrounding this topic is expansive and recent studies have underscored the importance of quantity and quality of language input. Some studies have emphasized that adults and caregivers need to increase the amount of language exposure they provide for children (Hart & Risley, 1995, 2003). The authors reported staggering results in which there is a significant difference in the amount of words children from low and high socioeconomic status (SES) families are exposed to. This leads to the suggestion that differences in language development are related to the quantity of adult language exposure. The implications of such findings have shaped the practices and research of child development. However, the number of words a child hears does not tell the whole story of language development; in fact, some researchers have stated that it is the density or diversity of the language exposure that has a stronger relationship to child language development than the quantity of language input (e.g., Hoff, 2003; Hoff & Naigles, 2002; Lederberg & Everhart, 2000; Vasilyeva, Waterfall, & Huttenlocher, 2008). Huttenlocher, Waterfall, Vasilyeva, Vevea, and Hedges (2010) called attention to the fact that quantitative measures of language input do not discriminate between the repeated use of language from the use of different elements. Therefore, Huttenlocher et al. (2010) defined diversity of speech as "…a more theoretically relevant measure of input, namely the diversity of the speech of individual caregivers, i.e., the variety of words, phrases, and clauses they produce" (p. 344). For the purpose of this dissertation, the diversity of language as

defined above is referred to as the *quality* of language. The quality of language variables that are examined in this study are *lexical diversity,* which accounts for the number of different words within a language sample, *syntactical complexity,* which entails the number of syntactical elements (e.g., adverbs, adjectives, prepositional phrases, etc.) in the language sample, and *clausal complexity*, which accounts for the number of various clausal combinations within the language sample (e.g., coordination, objective relative clause, object of the main clause, etc.). More details regarding these components are described in Chapter 3.

Findings from other studies have encouraged adults and caregivers to consider the quality aspects of language (e.g., Hoff, 2013; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Huttenlocher, Vasilyeva, Waterfall, Vevea, & Hedges, 2007; Huttenlocher et al., 2010; Rowe, 2012). In other words, the more diverse the adult language exposure is in terms of lexicon (Hoff & Naigles, 2002; Pan, Rowe, Singer & Snow, 2005) or syntax (Huttenlocher et al., 2010; Vasilyeva et al., 2008), the more likely the child is to internalize a richer language as well as utilize it for communicative intent. However, it remains unknown the characteristics of the language exposure pertaining to both quality and quantity components that has the strongest relationships to language outcomes in children, including those who are d/Deaf and hard of hearing (d/DHH). For the purpose of this study, d/DHH is inclusive of individuals with a wide range of hearing loss, from mild to profound. This range of hearing loss pertains to the individuals severity of hearing loss in terms of frequency, or pitch, and loudness. Additionally, the identification of *deaf* applies to the medical distinction of deafness whereas *Deaf* refers to the cultural identification of deafness. Deaf culture is often defined as individuals who utilize manual communication such as American Sign Language (ASL); whereas the medical identification of deafness pertains to perception of noise and/or structures of the ear. The

participants of the study were preschool d/DHH children who used listening and spoken language; therefore, language development of children who are d/DHH, in this study, refers to the spoken language development only.

Technology, such as hearing aids and cochlear implants, is a critical element in the development of spoken language among children who are d/DHH; however, there still remains a significant gap in language development compared to their hearing peers (Cole & Flexer, 2007; Trezek, Wang, & Paul, 2010; Wang, Kretschmer, & Hartman, 2008). This gap in language development is often reported to be in regards to vocabulary development; as children who are d/DHH tend to have smaller vocabularies than their hearing peers (Paul, 2001; Wang et al. 2008). Furthermore, Wang et al. (2008) highlight the notion, that stressing the grammatical structure of English as opposed to the lexical meaning that content words provide, function words are an aspect of vocabulary that children who are d/DHH struggle to acquire. Wang et al. defined function words to include the following: "determiners (*the, an),* prepositions (*in, on, by),* conjunctions (*and, but),* pronouns (*it, he, they),* and auxiliary verbs and copulas (*can, is,* would)" (pp. 61-62). Specifically pertaining to spoken language vocabulary, function words are typically unstressed which could pose difficulty for d/DHH children to perceive them auditorily.

This study implements a group-design to examine the language environments of d/DHH children in identifying quantity and/or quality aspects of language input and its potential impacts on the development of the child's language. Given the views of Vygotsky (1978) as well as the significant findings from Hart and Risley (1995, 2003) and Huttenlocher et al. (1991, 2010), it has become pertinent to examine the language models of children to further identify characteristics of a language environment that is related to successful child language outcomes.

The following section addresses the background of the d/DHH population and its risk factors that are associated with language development.

Background

The participants of this study are children who are identified as d/DHH. This specific population of children who are d/DHH is a subset of exceptional children that are considered to be "at-risk" in regards to language development.

Deafness or hearing loss, in general, is considered to be a low incidence disability as approximately two to three of every 1000 children are diagnosed with congenital hearing loss and often referred to as a heterogeneous population (Cole & Flexer, 2007). There are many variables that contribute to the heterogeneous nature of this population such as type of hearing loss, severity of hearing loss, age at diagnosis, type of amplification, communication modality, etc. Therefore, every hearing loss is unique to a child. Newborn hearing screenings have allowed for earlier detection and identification of hearing loss, which has highlighted the influence that permanent hearing loss, regardless of the type and severity, has on deficits in the development of academic, cognitive, socio-emotional and language skills over time (Cole & Flexer, 2007; Vohr, Topol, Watson, St. Pierre, & Tucker, 2013).

Approximately 95% of children with hearing loss are born to hearing parents; whereas the remaining 5% are born to d/Deaf parents (Cole & Flexer, 2007; Mitchell & Karchmer, 2004). This statistic becomes relevant in the discussion of communication modality as more families have decided on spoken language communication modality or more commonly referred to as listening and spoken language, as opposed to manual communication such as American Sign Language (ASL). Advancements in hearing technology such as cochlear implants (CI), hearing aids, and other assistive listening devices afford children with hearing loss the possibility of

perceiving auditory information similar to their hearing peers. Therefore, the advancements give these children more access to spoken language through audition and assist in the production of spoken language with increased intelligibility. However, despite these advancements in hearing technology, a gap between the spoken language acquisition of typically developing children and those with hearing loss still remains (Cole & Flexer, 2007).

Significance of the Study

Language Acquisition

Language development does not occur in isolation; therefore, the environment and social engagement that a child participates in has the ability to influence their language development. This study is grounded in the theoretical framework from Lev Vygotsky's socio-cultural views of cognitive development. Vygotsky presented the concept of optimal development and learning in which he labels "zone of proximal development" (ZPD; 1978). This zone is described to be where learning occurs with the guidance of adults or "more capable peers" (p. 33). In other words, child's language development occurs in the context in which adults or caregivers provide across environments, particularly school and home. More specifically, Vygotsky's concept of zone of proximal development emphasized the role of the adults or caregiver in child language development, which has been highlighted in later studies (e.g., Hart & Risley, 1995, 2003; Hoff, 2003, 2006; Hoff & Naigles, 2002; Hoff-Ginsberg, 1986; Hoff-Ginsberg & Shatz, 1982; Huttenlocher et al., 1991, 2010). Therefore, this study focuses on the language environments that are created and shaped by adults and how it is related to the child's language development.

In the aftermath of Vygotsky's contributions to the field, the works of Jerome Bruner (1983) and Michael Tomasello (1999) have continued to shape our understanding of how language environments influence language development. Bruner (1983) emphasized the function

of language acquisition as a result of negotiations between two people. Furthermore, “it is shaped to make communicative interaction effective- fine-tuned” (p. 39). This interactionist perspective highlighted the relationship that language models have on children learning to engage socially with the intent of communicating effectively. Tomasello (1999) identified the relationship between joint attention and cognitive development. The notion of joint attention stems from the realization that infants are social creatures; therefore, as development occurs, the role of joint attention fosters the development of cognition, namely language as they eventually become aware of others as ‘intentional agents'. As children interact with their environment and other individuals, joint attention emphasizes the desire to communication which brings awareness to language input as well as language production (Tomasello, 1999).

In regards to language acquisition, research has emphasized the link between language exposure and language acquisition for all children. As parents and/or caregivers are typically the consistent language models for children, particularly during the first few years of their life, examining parental language input becomes pertinent to further investigate language input and how it might influence the child’s language development. Language input and its relationship on the child’s language development has been established through previous studies examining the quantity of parental language input through the number of adult words spoken around the child (Hart & Risley, 1995, 2003). The studies conducted by Hart and Risley (1995, 2003) found a significant gap in the language exposure in children from different SES backgrounds. More specifically, children from higher SES households were exposed to significantly more words than their peers from lower SES households; which may imply that there is a link between the quantity of language input and language development. As a result, parents were encouraged to

"talk more" around their child in hopes of enhancing and shaping their child's language development.

However, additional studies have found that there is more to language exposure than the number of words that a child is exposed to, rather that the quality of language input (e.g., clausal density and/or lexical density) have also been linked to children's language development (Huttenlocher et al., 1991, 2010). The more verbally responsive, in regards to caregiver speech, or engaged a parent is with their child, the more language input they are providing which in turn could influence the child's language development (Hoff, 2006). The relationship between the quality of language exposure and SES has been emphasized; as parents/caregivers from a lower SES background are typically more directive in their speech and their utterances are not as varied grammatically and lexically (Hoff, 2013). More specifically, maternal lexical diversity was a strong predictor of child vocabulary use (Pan et al., 2005). In other words, the child is more likely to mirror the language they are exposed to, which stressed the importance of the amount of parental language (i.e., adult word count and number of conversational turns) and the use of syntactic structures that are dense and rich. As a result, parent-centered and/or teacher-centered intervention and education is important to highlight these relationships to further enhance child's language development in regards to quantity and quality.

While the research emphasized the adult role and responsibility in the parent-child interaction for enhancing language development for the children, it appeared that the quantity and quality of language input and its impact were dependent on the child's age among other characteristics. Rowe (2012) posited that quantity of parental language input had greater influence on child's language development at two years of age whereas the quality of parental language input, or more specifically, the lexical diversity of parental language input had greater

influence at three years of age. Therefore, Rowe suggested that at a point in the child's language development, after the age of three years old, both quality and quantity of language input were related to language development as well as other areas of development particularly academic skills.

Language Environments for Children With Disabilities

It is important to note that these previous studies emphasized the relationship between language input from hearing parents and language development of typically developing children. These studies also stressed the influence that SES has on language exposure, whereas, some research have observed that parental language input can vary in regards to children with disabilities (Thiemann-Bourque, Warren, Brady, Gilkerson, & Richards, 2014; Warren et al., 2010). For example, while the differences are not significant, the amount of adult language input was less for children with Down Syndrome than for the typically developing children; these differences over time can lead to significant differences in language input (Thiemann-Bourque et al., 2014). Additionally, differences in not only the amount of adult utterances but the length of the utterances were found to be shorter for adults with children who were diagnosed with Autism Spectrum Disorder (ASD) than those with typically developing children (Warren et al., 2010). These subtle differences can have lasting impacts on language development in children with disabilities. Language exposure, specifically type of language exposure (i.e., oral vs. manual communication), is a heavily researched topic regarding children with hearing loss. Relating the findings of how critical language exposure or input for children with and without disabilities such as hearing loss is a topic that needs more attention.

Language Exposure Among the d/DHH Population

Given the strong link between parental language input and child's language development, it is imperative that parents or caregivers become strong language models. While research suggests that strong language models are associated with adults who use language that is diverse in terms of quantity and quality (Huttenlocher et al., 2007, 2010), it remains unclear if the relationship exists among other populations such as d/DHH children. Consequently, there is a crucial need to examine the relationship between the quality and quantity aspects of parental language input and its influence on children's language development among the population of children who are d/DHH.

The gap between hearing children and d/DHH children in regards to spoken language acquisition can widen over time leading to a language delay (Paul, Wang, & Williams., 2013; Trezek et al., 2010; Wang et al., 2008). A diagnosis of hearing loss, on its own, does not determine the child's ability to acquire language; however, children who are d/DHH may have a harder time than their peers with normal hearing on vocabulary acquisition and development of syntactical knowledge of a spoken language. In particular, acquisition and comprehension of function words may impose additional difficulties for d/DHH children. Function words might have little lexical meaning but still play an important role in the grammatical structure of English and contribute to the comprehension of basic concepts; therefore, if d/DHH children have limited access or exposure to these words, comprehension and language development will be negatively influenced (Wang et al., 2008). Additionally, inadequate or poor acquisition of vocabulary has considerable implications for language and literacy development.

As children reach school age, there is a noticeable difference between the spoken vocabulary knowledge of their typically developing peers and children with hearing loss (Trezek et al., 2010; Wang et al., 2008). This difference, in part, could be due to the indirect, incidental

language that their typically developing peers had full access to. Language exposure encompasses both direct and indirect language experiences; therefore, it is important to consider the access children have to indirect language auditorily. As stated by Trezek et al. (2010), vocabulary learning can occur indirectly through experiences with both oral and written languages such as conversations with other individuals, listening to adults read as well as their own direct exposure to print through books. The indirect learning occurs through the language exposure and experiences that individuals have access to. For some children with hearing loss, limited access to these language experiences could exacerbate the difficulties of spoken vocabulary acquisition. Lederberg and Spencer (2009) suggested that some of the difficulties with indirect word learning could be attributed to more exposure to direct language input as well as early language exposure to develop the skills necessary for incidental language learning, which in some instances d/DHH children, depending on when they acquired access to or exposed to language, may not have had.

It is not contested that language exposure plays a large role in language acquisition; previous studies have emphasized the direct relationship between the quantity of language input and the child's language development within the d/Deaf population (Aragon & Yoshinaga-Itano, 2012; Vohr et al., 2013; VanDam, Ambrose, & Moeller, 2012). In particular, these studies have reported the findings that the number of conversational turns has been positively linked to linguistic outcomes for d/DHH children (Ambrose, VanDam, & Moeller, 2014; Aragon & Yoshinaga-Itano, 2012), suggesting that while quantity of language input is related to language development, conversational turns is an important factor as well. Additionally, VanDam et al. (2012) found that the number of adult words and conversational turns was related, in part, to the severity of the hearing loss and the speech intelligibility scores of hard of hearing children,

which suggested that parents/caregivers might have altered their language and interactions with their child with a hearing loss due to uncertainty of what the child's auditory and language processing abilities are. The current study provides a direct focus to the language and interactions that adults provide for children with hearing loss and in doing so, the goal is to have more data to support interventions and coaching that is provided to adults that interact with deaf or hard of hearing children.

Among the options for amplification, the most common are hearing aids and cochlear implants. When examining the differences between the two, it appeared that children with cochlear implants performed better on vocabulary measures than their peers with hearing aids, which also leads to better academic outcomes (Fagan, 2016; Yoshinaga-Itano, Baca, & Sedey, 2010). However, as acknowledged by Fagan (2016), this was restricted to a subset of children with profound hearing loss, who may not have benefitted from hearing aids. Additionally, there is limited research that examines and compares the language exposure of children with cochlear implants and hearing aids. By doing so, we propose drawing the link between language exposure and performance on measures such as vocabulary, which can be used to improve instruction and/or intervention.

Overall there is an imperative need for early intervention and parent education on how to provide adequate language exposure that can enhance language development for children who are d/DHH, regardless of the type or severity of the hearing loss. "It is the combination of quantity and quality in a child's early language environment that will lead to optimal cognitive and educational outcomes" (Suskind et al., 2013, p. 206).

Purpose of the Study

This particular study strives to highlight as well as reinforce the influence that quality and quantity aspects of adult language input has on the development of language, specifically for children who are d/DHH. There remains a lot unknown about language environments and its potential influence on language development; therefore, this study targets the gap in the previous research by investigating and identifying specific characteristics in regards to quantity (i.e., number of adult words, conversational turns, and child vocalizations) and quality components (i.e., lexical diversity, syntactical complexity, and clausal complexity) of language environments for children who are d/DHH. In doing so, the findings from this study have the potential to influence the interactions between adults and children in a variety of settings, especially in educational and home environments.

Language ENvironment Analysis (LENA) system is an innovative technology that allows researchers and educators to gather meaningful data from natural interactions a child engages in during their daily routines. LENA can be described as a small 'iPod' that fits into pouch that is sewed on to a vest or t-shirt. This technology has the capacity to collect up to 16 hours of continuous recording. Additionally, LENA produces comprehensive reports of the quantitative aspect of language through its ability to automatically calculate the adult word count (AWC), number of conversational turns (CTC), and number of child vocalizations (CVC) for the entire recording. Given the nature of the technology, LENA only captures and analyzes spoken language, which is not inclusive of gestures and body language that plays an integral role of language and communication.

The current study utilizes this technology to collect language samples from monolingual English-speaking preschool-aged children with hearing loss. The aims of this study target both the quantity and quality of language exposure and its relationship to the child's language as well

as their knowledge of basic concepts and vocabulary. The quantity component of this study will be taken from the data and reports generated by the LENA software, which includes the AWC, CTC and CVC. Specifically, AWC and CTC are associated with parent or adult language input and CVC corresponds to child language output.

To examine the quality aspects of the adult and child's language, the language samples are transcribed and further analyzed for lexical diversity which examines the number of word types, syntactical diversity to further observe the use of phrases (prepositional phrases, noun phrases, adjectives, etc.) and clausal density such as subject clause and objective relative clauses. Both the adult and child utterances are transcribed and analyzed using the coding mechanism described in Huttenlocher et al. (2010). Huttenlocher et al. (2007) conducted a study to examine the diversity and patterns of caregiver speech, particularly the diversity of lexicon, syntax and clauses, which served as a foundation for coding and analysis for a later study (Huttenlocher et al., 2010). Huttenlocher et al. (2010)'s study reported differences in the complexity of caregiver speech among those from different SES groups as well as changes in the complexity of speech as the children aged. Huttenlocher et al. (2010) put forth coding guidelines to "examine diversity at lexical, phrasal and clausal levels in both caregivers and children" (p. 344). The current study adapts this coding system (Huttenlocher et al., 2010) to examine differences in regards to quality among adults or caregivers as well as the child's spoken language output.

Furthermore, each of the participants is assessed on their knowledge of basic concepts such as time, quantity, and size through the *Boehm Test of Basic Concepts – Preschool* (*3rd ed.*) (Boehm, 2001) as well as their vocabulary through the *Peabody Picture Vocabulary Test* (*PPVT-4*) (L. Dunn & D. Dunn, 2007). It is impertinent to have vocabulary knowledge as a measure of child's language outcomes given that research has shown it is related to later literacy and

academic skills (i.e., Cartmill et al., 2013; El-Hakim et al., 2001; Fagan & Pisoni, 2010; Farran, Lederberg, & Jackson, 2009; Hoff, 2003; Lund & Schuele, 2015; Suskind et al., 2013). Furthermore, prior research has indicated that language environments (quality and quantity) have been strongly related to vocabulary development in children (i.e., Aragon & Yoshinaga-Itano, 2012; E. P. Bowers & Vasilyeva, 2011; Farran et al., 2009; Lederberg & Everhart, 2000 Rowe, 2012). In regards to basic concepts, while they are developed as a part of one's vocabulary knowledge, basic concepts are necessary for understanding directions and academic language, which are critical in early development (Boehm, 1967; Bracken & Cato, 1986; Kaufman, 1978; Steinbauer & Heller, 1978). Given the previous research that emphasizes the relationship between language exposure and vocabulary development, it can be argued that basic concept knowledge develops in relation to the language exposure or more specifically, adult language input.

This exploratory analysis of the LENA data, transcriptions and assessments hopes to emphasize the characteristics and relationships between that of adult language exposure and its relation with child language development. Furthermore, this study provides an opportunity to identify differences or similarities in adult interaction between children with hearing loss. Ultimately, the fundamental goal of this study is to bring awareness of challenges associated with d/DHH children and to further close the existing gap between them and their typically developing peers across all domains, especially language.

Organization

The organization of this dissertation adheres to the following order: Chapter Two addresses the relevant literature and findings that have been reported regarding this topic and those similar to it. Additionally, it aims to highlight the gaps in the literature, which reinforces

the imperative need to further investigate this topic. Chapter Three focuses on the methods employed to collect the data for this study, which includes description of the participants, assessments, and data collection procedures. The following chapter, Chapter Four, reports the results from the statistical analyses to answer each of the research questions outlined above. Finally, Chapter Five outlines the implications of the results, limitations of the study as well as suggestions for future research.

Chapter 2

Literature Review

The goal of the study is to examine the characteristics of individuals, the environment and what is related to the language development of children who are deaf and hard of hearing. Using group-design research methods, this study examines the characteristics and environments of adults and caregivers of children with hearing loss to identify whether quality or quantity components of language are related to in the development of the child's language. The theoretical foundation of this study rests on the idea of social interaction and social learning theories, which is put forth by Lev Vygotsky (1978). The work of Vygotsky underscores the theoretical framework of this study as well as his contemporaries such as Jerome Bruner (1983) and Michael Tomasello (1999, 2008). This literature review is organized by 4 major sections: 1) the role of social interaction in language acquisition, 2) the language exposure for children with and without hearing loss, 3) the vocabulary development for children with and without hearing loss, and 4) basic concept knowledge development in children with and without hearing loss.

Language Acquisition

Social Learning Theories

The theories of Lev Vygotsky emphasized the role of interactions in development and learning, in which he claimed that they were not one and the same: "…the developmental process lags behind the learning process; this sequence then results in zones of proximal development" (Vygotsky, 1978, p. 90). Vygotsky's theories of social learning provide the foundation for the theoretical framework surrounding the current study of language environments and language acquisition for children with and without hearing loss. Vygotsky

(1978) defined the zone of proximal development (ZPD) to be the space between what an individual can accomplish independently and what they are not able to accomplish without assistance. This concept of ZPD operates under the notion that humans are social beings, which facilitates learning; in fact, Vygotsky highlighted this notion by comparing the social nature of primates to that of humans, in which he posited that there were characteristics of *human* social interaction that promoted advanced learning that was not found among primates. More specifically, his theory of ZPD fueled the concept that individuals with more knowledge and/or skills could assist or foster advanced development in those less skilled.

Vygotsky (1978) applied the concept of ZPD to the development of language in children; moreover, he discussed how ZPD is effective among children with disabilities. He emphasized that these children can achieve abstract thinking if they are exposed to it; by limiting their exposure to concrete concepts, their ability to develop and learn remains confined. These concepts reinforced the notion that development and learning occurred within social interactions and cultural exposure. Language development occurs in children with the assistance of the adults and other peers as their language expands and grows as a result of the environment they are exposed to. As a result, Vygotsky argued that the environment (culturally and linguistically) shaped the child's understanding of the world and how to interact with others. In other words, we can hypothesize that the adults and/or caregivers in a child's life have tremendous influence in the child's development of language and thinking.

Inspired by the work of Vygotsky, Jerome Bruner's work reinforced the concept of language acquisition as a result of social interactions; moreover, he emphasized the active role that adults needed to have in aiding their child's language development. "The pragamatician's stress on intent requires a far more active role on the part of the adult in aiding the child's

language acquisition than that of just being a 'model'. It requires that the adult be a consenting partner, willing to negotiate with the child" (Bruner, 1983, p. 38). As an interactionist, Bruner (1983) subscribed to the understanding that language development occurred as a function to negotiate or in other words, communicate with others for a specific purpose or intent. In doing so, the negotiations shape language development so that communicative intent becomes effective and understood between both parties.

Prior to Bruner's work, Noam Chomsky suggested that individuals have a biological predisposition or "innate structure" to acquire language through what he defined as a Language Acquisition Device (LAD; Chomsky, 1967, p. 2). Furthermore, Bruner takes Chomsky's concept of LAD one step further to proclaim that this LAD cannot function without "...an adult who enters with him into a transactional format" (Bruner, 1983, p. 19); Bruner refers to this as a Language Acquisition Support System (LASS). Related to Vygotsky, Bruner asserted that language was a function of the culture in which individuals need to interpret and negotiate to further acquire and develop language. These concepts of LASS and negotiation, which are put forth by Bruner, still operate under the interactionist or constructivist philosophy that the mind is predisposed to certain traits that facilitate development but it occurs under the influence of social interaction and exposure to the environment. Therefore, the assumptions put forth by Vygotsky are noticeable under Bruner's understanding of child development, which highlights the potential influence that adults or skilled conversational partners may have in shaping children's language.

Given the influential nature of adult language input on child's language development, the input could be perceived as premeditated in the sense that the adults are conscious of the language they are providing so it is within reach of the child's capacity for understanding the linguistic information (Bruner, 1983). This particular theory posited by Bruner resembled

Vygotsky's (1978) ZPD in that the adults input could be guided by the child's linguistic understanding. Furthermore, Bruner (1983) mentioned four ways of how LASS, which emphasized the adults' active role in language acquisition, could help "assure continuity from prelinguistic to linguistic communication" (p. 40): 1) consistency in the interactions between the adult and child, 2) development of lexical and phrasal diversity, 3) encouraging language development through play, and 4) generalization.

Social learning theories have evolved from Vygotsky and Bruner to establish the assumption that the environmental factor, particularly the adults, play a large influential role in shaping the language development of the child as well as their understanding of how to interact or negotiate social interactions. The impact of parental language exposure is a key component of this study.

Joint Attention

One of Vygotsky and Bruner's contemporaries is Michael Tomasello, who viewed development as a social process. Like Vygotsky (1978), Tomasello (1999) has argued that humans have a cognitive processing skill that allows for an understanding of intent and causality, which is not found among non-human primates. This particular skill facilitates social learning and "cultural inheritance" (Tomasello, 1999, p. 25). The ability to perceive others as intentional beings develops in infants around 9 months of age, in which they incorporate cultural components of their environment to develop skills such as language (Tomasello, 1999). Additionally, his work identified joint attention as another key component that aided in language development.

Joint attention behaviors develop as a result of children gaining awareness of others as "intentional agents" (Tomasello, 1999, p. 15). This awareness brings into light the desire for

children to interact with the environment, which includes other beings, socially. As children become socially active within their environment, joint attention becomes pertinent to facilitate language development in order to communicate effectively with other intentional agents or communication partners (Tomasello, 1999). This notion of joint attention leads to what Tomasello (2008) referred to as "shared intentionality" (p. 6). Part of what makes human interaction so unique is the context in which humans engage in social interaction. "Skills and motivations for shared intentionality are, in the current account, direct expressions of the biological adaptation that enables children to participate in the cultural practices around them" (Tomasello & Carpenter, 2007, p. 124). As stated earlier, Tomasello (1999, 2008) has emphasized communication partners as *intentional agents*, by doing so, individuals are to discern their referential intention through joint attention as well as their social intention, both of which were established through what Tomasello (2008) referred to as *common ground*. Applying this to the interactionist perspective of language development, the intentional agents guide the social exchange, which contains cultural and language content.

The theories put forth by Vygotsky, Bruner and Tomasello give some explanation to how children acquire language through the interactionist perspective. In contrast to the interactionist perspective, nativist views emphasize individuals' innate qualities that facilitate language acquisition. Jean Piaget's work revolved around his theory of intellectual development, which highlighted the notion that all children follow a "fixed inevitable pattern" of developmental stages between birth and 14 years old (Cohen, 2013, p. 40). These entail the sensory motor period, the pre-operational period, concrete operational stage and formal operational stage. Additionally, Piaget stressed that while the sequence of development is fixed, the rate in which a child progresses through the stages is variable (Cohen, 2013; Miller, 2014). Furthermore, Noam

Chomsky put forth a theory that humans are born with a "mental organ" called a Language Acquisition Device (LAD) that predisposes children with the ability to comprehend and produce language (Bjorkland, 2012; Cohen, 2013). To summarize, the nativist perspective to language development emphasizes the biological, innate ability whereas the interactionist perspective favors the environmental factors to language development for children.

Given that the interactionist theories hone in on the development of language for the general population, it could be assumed that this can be applied to children who are deaf and hard of hearing. However, what eludes us is the uncertainty of the theory application for the reason that these children who are d/DHH may interact with their environment in a different manner given their sensory disability. This study aims to examine the interaction that occurs between children with hearing loss and their language environments created by adults/caregivers. The next section addresses language input for typically developing children as well as their peers with hearing loss.

Language Exposure

Language Input for Children With Normal Hearing

Hoff-Ginsberg and Shatz (1982) conducted a review of the literature that investigated the contributing factors to language acquisition. "For language acquisition to occur, certain conditions must be met by both the learner and the language-learning environment. No child has been observed to speak a human without having had a communicative partner for whom to learn" (Hoff-Ginsberg & Shatz, 1982, p. 22). This statement and their findings appear to support the interactionist views of language acquisition and development as opposed to the nativist views put forth by Jean Piaget and Noam Chomsky.

Quantity of language exposure for children with normal hearing. Discussing language input and its impact on child's language development, Huttenlocher et al. (1991) were among the first to provide evidence that adult language input had a direct effect on the development of the child's language. Huttenlocher and colleagues observed interactions between 22 middle-class mother-child dyads and reported that the amount of maternal speech was related to the vocabulary growth that was found over several time periods. Huttenlocher and colleagues questioned whether language development occurred from a nativist or an interactionist perspective; the results from their study led them to conclude that the vocabulary growth among the children was a direct result of adult language input as opposed to hereditary factors which reinforced the social learning theory put forth by Vygotsky and his contemporaries. While adult language input has an influence on language development, Huttenlocher and colleagues (1991) did not identify characteristics such as SES and parental education of the adults or their language that might moderate the relationship between amount of adult language and the child's vocabulary growth.

Hart and Risley (1995) conducted a well-known study targeting the core of this topic, which observed parent-child interactions (N = 42) from different SES backgrounds to further investigate the effect of language environments on child language development. The authors reported a significant difference in quantity of adult language input in regards to SES as children from higher-SES were exposed to more words than those from lower-SES households. This is often referred to the *30-million word gap* as by age 3, children from higher-SES or professional families heard approximately 30 million more words than those from lower-SES households. Additionally, the significant difference in language exposure was found to be related to the child's vocabulary, receptively and expressively. While SES was found to be a significant

demographic variable this study, the authors reported that parental education was a pivotal characteristic that was related to the amount of language input provide to the child. In other words, the more education the parents had, the more likely they were to engage and talk more around their child.

About a decade later, Pan and colleagues (2005) conducted a study to investigate maternal language input as measured by 'word tokens' (total number of words spoken), 'word types' (lexical diversity) and pointing gestures on the development of the child's vocabulary knowledge. They used a large sample size of 108 participants and found the lexical diversity of the maternal language input related to the child's vocabulary growth, especially when the child was two years old. Interestingly, the findings from this study regarding word tokens and child's vocabulary development conflicted with previous findings (Hart & Risley, 1995; Huttenlocher et al., 1991) as Pan and colleagues reported that the quantity of maternal language input was not related to the growth in the child's vocabulary knowledge. Additionally, Pan et al.'s study accounted for non-verbal means of communication through the use of gestures, in which the researchers reported that the number of pointing gestures was related to the growth in the child's vocabulary production (Pan et al., 2005). The findings suggested that there was more to the influence that language input has on child language development than just the quantity of language; however, Pan and colleagues only scratched the surface in the attempt to dig deeper into aspects of language input. By examining the lexical diversity of maternal language input, it warrants further investigation into the quality of language input and how that might influence child language development.

Greenwood, Thiemann-Bourque, Walker, Buzhardt, and Gilkerson (2011) sought to follow up the findings from Hart and Risley's (1995) study by collecting language samples over

a longer period of time (12 hours) and more often (weekly) to determine if there were differences in the findings from the previous study to what was collected more recently. Additionally, one of the most prominent differences in data collection was using a prototype device called LENA, which was developed to be used as an automated speech recording tool. While some of findings concurred with the results reported by Hart and Risley (1995), Greenwood et al. did not find significant differences in the amount of adult words among those from different SES levels, which was a contrast from previous findings. However, the authors encouraged further investigation into this variable with a larger population (N = 30) from more diverse SES households. Furthermore, Greenwood et al. reported a gender difference in adult language exposure; specifically, that mothers accounted for the majority of the adult language spoken around the child. In regards to language development of the children, the number of conversational turns and vocalizations appeared to be positively related to their performance on the preschool language assessment (Preschool Language Scale-4 [PLS-4]; Zimmerman, Steiner, & Pond, 2002), which indicated that engaging and encouraging conversational interactions may have a stronger influence on language development than just language exposure.

A later study conducted by Soderstrom and Wittebolle (2013) sought out to compare linguistic environments in two different settings: daycare and home. Using the LENA technology, the researchers collected language samples for 11 children whose ages ranged from 12-29 months in both settings. Furthermore, the researchers categorized the language samples into specific activities: playtime, storytime, mealtime, naptime, transition time, outside visits, travel time, TV and other. The results indicated that type of activity had strongest relationship to the quantitative measures, specifically, storytime and organized playtime. In other words, the structured activities of storytime and playtime facilitated higher levels of language exposure

from adults and interactions with the child as measured by AWC, CTC and CVC. Additionally, the researchers reported that there was no main effect of environment in regards to the quantitative measures. In other words, the daycare and home environments were quantitatively similar in terms of the number of adult words and child vocalizations. Therefore, the adults in both settings (educators and caregivers) were providing similar amounts of linguistic input.

The above studies have included populations in their study that are considered to be typically developing, which begs the question of how language exposure affects children that are not considered to be typically developing, such as those diagnosed with Autism Spectrum Disorder (ASD). A systematic review conducted by Wang et al. (2017) found that there were additional studies using the LENA technology, which were inclusive of populations that were culturally and linguistically diverse (e.g., Gilkerson, Richards, & Topping, 2015; Jackson & Callendar, 2014), infants and older adults (Caskey, Stephens, Tucker & Vohr, 2011; Caskey & Vohr, 2013; Li, Vikani, Harris, & Lin, 2014), those with ASD (e.g., Carr, Xu, & Yoshinaga-Itano, 2014) and those with hearing loss (e.g., Aragon & Yoshinaga-Itano, 2012; Sacks et al., 2013). Interestingly, the studies suggested that the number of conversational turns had a stronger relationship with language development as opposed to the number of adult words. This particular finding emphasized the importance of engaging *with* children to foster language development as well as further investigation into the child's language skills and how they may contribute to conversational engagement. Therefore, quantity of language exposure was not enough to create an optimal language environment that was related to the development of the child's understanding and use of language.

The review of the literature pertaining to the quantitative components of language exposure among children who are typically developing appear to agree and emphasize that

quantity of adult language input is an important factor in the language development of children. Moreover, the amount of engagement (as measured by the number of conversational turns) might be a stronger predictor of language development. Therefore, the implication for adult-child interactions is that conversational engagement with children is more effective in shaping language development than language input alone. However, what type of language input is used in these interactions, specifically what are the quality components to the adult language input? This particular area is addressed next.

Quality of language exposure for children with normal hearing. While many studies emphasized the relationship between quantity of language exposure and language development, Hoff-Ginsberg (1986) sought to examine the link between maternal speech and development of child's syntax. Hoff-Ginsberg (1986) reported a significant relationship between the frequency of maternal noun phrases and the child's "growth" in noun phrases. Additionally, Hoff-Ginsberg (1986) focused on investigating how children took advantage of their linguistic environment as it was reported that children could be perceiving patterns in the variations of the maternal speech. This particular finding of how children perceive language input highlighted the potential effect of the quality of language input on children's language development as opposed to the quantity of language input.

However, in a later study, Hoff-Ginsberg (1991) conducted a study to investigate maternal speech across settings and SES, which found that upper class mothers used less child directive speech and utterances were more contingent on the child's language and behaviors as opposed to their working-class counterparts. Moreover, the results demonstrated that the setting (dressing, mealtime, toy play, and reading) was related to the type of maternal speech; for instance, there was greater lexical and syntactical diversity during the reading setting. These

findings support the need to further examine lexical and syntactical characteristics of language input and development in the current study.

More than a decade later, Hoff and Naigles (2002) pondered how children develop their lexical knowledge through the language they were exposed to as well as pragmatic aspects to language as measured by social engagement and social-pragmatics. The results suggested that the extent to which mothers and their children interacted with each other had little influence on vocabulary development at 24 months of age; however, the authors noted that the lexical diversity and 'syntactic complexity' appeared to account for the variation in the children's expressive vocabularies. The results of Hoff and Naigles' study also suggested a developmental trajectory for which the social-pragmatics of language interaction be used during the early stages of vocabulary development and not employed during the later stages. Specifically, these aspects of language contributed more to the vocabulary development prior to 24 months of age, in which they identified as the "earliest stages of word learning" (p. 428). As Huttenlocher et al. (1991) called for further investigation into the lexical and syntactical aspects of adult language input and its potential influence, Hoff and Naigles (2002) observed that the children's rich vocabulary development was related to the lexical diversity *and* ample amounts of such diversity. Therefore, children benefitted from higher quantity of rich and diverse language input in regards to the adult lexicon as well as longer maternal utterances (measured by Mean Length of Utterances [MLU]) (Hart & Risley, 1995; Hoff & Naigles, 2002; Huttenlocher et al., 1991).

Hoff and Naigles (2002) included participants from high and mid-SES environments; however, it remained unclear the effects of SES on vocabulary development. Therefore, Hoff (2003) further investigated whether the variation in children's vocabulary development was accounted by maternal SES. Hoff reported that those from high-SES environments had more

expressive vocabulary growth than those from low-SES environments. In other words, SES status was a predicator of children's expressive vocabulary. Hoff also reported that there were SES differences in the maternal language input in regards to quantity, lexical diversity and sentence complexity.

The finding from the study conducted by Pan et al. (2005) supported Hoff (2003)'s study in that they also argued that quantity was not as strong of a factor as quality given that the maternal lexical diversity in their study had a positive effect on child's vocabulary development. Additionally, Pan and colleagues (2005) suggested that there was pragmatic association in language exposure and language acquisition that needed to be explored across SES groups as well as cultural backgrounds. This stemmed from previous findings that mothers from low-SES backgrounds had a communicative style that entailed more non-verbal gestures such as pointing and more directives (Hart & Risley, 1995; Hoff-Ginsberg, 1991; Pan et al., 2005).

While previous research found that parental lexical diversity was significantly related on child's vocabulary growth (Hoff, 2003; Hoff-Ginsberg, 1991; Pan et al., 2005); a longitudinal study conducted by Vasilyeva et al. (2008) examined the development of syntax in children among diverse SES background. The authors reported that there was no significant variation in the development of simple sentences across SES groups; however, in the development of complex sentences, the variation in development among the SES groups was more apparent. These findings suggested that the language exposure children from high-SES background were receiving from adults/caregivers provided them with the opportunity to internalize and use more sophisticated speech. In other words, children were more likely to mirror the language they were exposed to. This concept leads researchers to encourage adults/caregivers to create language environments that are naturally lexical and syntactically rich and diverse.

To further reinforce these findings, Huttenlocher et al. (2010) conducted a longitudinal study that systematically examined parent and child language for diversity in regards to lexicon, syntax and clauses. Similar to previous studies (Hart & Risley, 1995; Hoff, 2003; Hoff-Ginsberg, 1991; Huttenlocher et al., 2010; Pan et al., 2005; Vasilyeva et al., 2008), their study reported that SES appeared to be related to the child's language development. The diversity in early parental input was reported to predict the diversity in child's language later on, which assumed a significant influence as it relates to quality of language exposure. Additionally, the authors reported a relationship regarding vocabulary between child's language at the beginning of the study and later adult language. In other words, there appeared to be a *mutual influence* between the child's and the adult's language interactions. While the findings from this study were compelling regarding the quality of language input, it also reported that the quantity of adult language was related to the growth in child's language, which might suggest that both components (quality and quantity) be necessary for successful language development. Huttenlocher et al. (2010) plays a crucial role in the current study as the coding guidelines outlined are adapted to code the adult and child language samples for the quality of language. Greater details are discussed in Chapter 3.

The above studies highlight the significant role that quality of language input has on child's language development. Specifically, the diversity of the parental language input appears to have a strong relationship with the development of the child's language. The one thing that these studies have in common is that the population of children selected is inclusive of those who are considered to be typically developing. How does quantity and quality of language input influence language development for children who are d/DHH? This question is explored next.

Language Input for Children With Hearing Loss

The scope of the research pertaining to typically developing children emphasizes the importance of language exposure in both quality and quantity of language; however, considering the population of children with sensory disabilities such as those with hearing loss, their interaction with the environment may not resemble those who are typically developing. Therefore, there is an imperative need to consider how language exposure and environments look different and how they may impact language acquisition and language development for children who are d/Deaf or hard of hearing. The next section addresses previous research that investigates language input and the development of language for children with hearing loss.

Quantity of language exposure for children with hearing loss. In a study conducted by Farran et al. (2009), the authors sought to compare the interactions between hearing mothers of deaf children and hearing mothers of hearing children to examine whether hearing mothers of deaf children provided similar supports linguistically to foster vocabulary growth as found in the interactions of hearing mothers and their hearing children. The study (N=25) used video-recording and coding to analyze the language samples collected and reported that the linguistic information shared by hearing mothers was contingent on the vocabulary and language development of their deaf child. Furthermore, the mothers appeared to provide linguistic supports that resembled the methods used by hearing mothers and their hearing children.

The transcription, coding, and analysis of the data collected using the methods described in the above studies could be described as arduous and time-consuming. To address the valuable information that is available in collecting data related to language input as well as output, the LENA Foundation created a technological method to streamline and automate the calculation of the language environments. This technology has a capability to record up to 16 hours of continuous language as well as automatically calculates and produces graphical representations

of the number of adult words (AWC), number of child vocalizations (CVC), and number of conversational turns (CTC).

Since the introduction of this innovative technology, researchers have conducted numerous studies investigating characteristics of adults and the language environment they create as well as how it effects child's language development (i.e., Caskey & Vohr, 2013; Dykstra et al., 2012; Jackson & Callender, 2014; Soderstrom & Wittebolle, 2013; Thiemann-Bourque et al., 2014). More specifically, researchers have used LENA technology in the investigative efforts pertaining to children with hearing loss (Ambrose et al., 2014; Aragon & Yoshinaga-Itano, 2012; Carr, et al., 2014; Caskey & Vohr, 2013; Sacks et al., 2013; VanDam et al., 2012, 2015; Vohr et al., 2013; Wiggin, Gabbard, Thompson, Goberis, & Yoshinaga-Itano, 2012).

VanDam et al. (2012) were among the first to utilize the LENA technology to compare and examine the language environments of 22 hard of hearing children and 8 children identified with normal hearing. Compared to their hearing peers, the amount of adult language input was similar for those with hearing loss; however, specifically for those who were hard of hearing, the level of hearing loss as determined by pure tone average (PTA) and speech intelligibility index (SII) was related to the number of adult words. Moreover, the authors reported that language skills were related to auditory access; indicating that those with more auditory access performed better on the language assessment as measured by the *Mullen Scales of Early Learning* (*MSEL*; Mullen, 1995).

Around the same time, another study pertaining to the similar topic was conducted by Vohr et al. (2013), who examined only the quantitative variables reported by LENA and its potential relationship to language outcomes of the child. The authors of this study reported that

while the relationships between language environment and language outcomes was not statistically significant, they suggested that there was a "significant association between the language environment and child speech and language skills at school age" (Vohr et al., 2013, p. 67).

While Vohr et al. (2013) did not find a statistically significant relationship between the quantitative aspects of language and child language development, Ambrose et al. (2014) conducted a similar study in which they examined the quantitative aspects of language and how they are related to the child's linguistic outcomes. According to their results, the number of conversational turns was more predicative of language outcomes for the children who were identified as hard of hearing (N = 28) than number of adult words. Among the data collected by the LENA technology, amount of electronic media exposure was also reported; interestingly, Ambrose and colleagues reported that the amount of electronic media exposure was negatively associated with linguistic outcomes. In other words, the more electronic media exposure the children experience, the less likely the adults were engaging in conversational interactions which resulted in poorer outcomes regarding the child's language development. This particular finding advocated for linguistic environments that were rich in interactions between adults and children; whereas previous findings such as Hart and Risley (1995) encouraged more adult speech which might or might not be child-directed or in conversational engagement with the child.

One thing to note about the above studies is that the data collection procedures do not account for the quality of the language environment such as joint attention, body language, gestures and facial expressions as well as whether the CTC reflects meaningful interactions that contribute to successful linguistic outcomes (VanDam et al., 2012; Vohr et al., 2013). This study aims to highlight the CTC interactions by closely examining the quality components such as

lexical diversity, syntactical complexity and clausal complexity in the language expressed by the adult and child.

The LENA technology has served multiple functions such as exploratory analysis, intervention as well as assessment (see Wang et al., 2017, for a review). Exploratory analysis using LENA technology has emphasized the influence that the amount of adult language as well as conversational interactions measured by the number of conversational turns has on language development among children with hearing loss (i.e., Ambrose et al., 2014; VanDam et al., 2012; Vohr et al., 2013). In a study conducted by Aragon and Yoshinaga-Itano (2012), LENA was used as both an assessment and intervention tool. Furthermore, the researchers chose to focus on the population of d/Deaf and hard of hearing children in Spanish-speaking (n = 10) and English-speaking households (n = 24) as compared to typically developing children in Spanish-speaking (n = 10) and English-speaking households (n = 329). The families with children who were d/DHH participated in an early intervention program called Colorado Home Intervention Program (CHIP). For interventional methods, the LENA reports were used to provide parents or caregivers with feedbacks on the linguistic environment they were providing for their children; if reports identified characteristics that were lower than their 'parent goals', then the interventionist would help identify and implement strategies to help reach optimal levels of adult word count and number of conversational turns.

The results from Aragon and Yoshinaga-Itano's (2012) study reinforced previous findings that the number of conversational turns was strongly correlated with the scores on the standardized language assessments, stressing the importance of conversational interaction between adult and child in regards to language development (Ambrose et al., 2014; Aragon & Yoshinaga-Itano, 2012; VanDam et al., 2012; Vohr et al., 2013). Moreover, the successful

implementation of early intervention was reflected in the findings as the researchers noted that the amount of adult words for those who were d/DHH were higher than those who were typically developing (Aragon & Yoshinaga-Itano, 2012). It was unknown, however, how the d/DHH children performed on language assessments compared to their hearing peers given that the d/DHH children received more parent talk. It appeared that the number of adult words was not quite as influential as the authors originally thought (Hart & Risley, 1995); therefore, intervention tools for children with hearing loss might need to focus on adult-child *meaningful* interactions to foster stronger language development that was comparable to their hearing peers. While the population of interest was those with hearing loss, Aragon and Yoshinaga-Itano (2012) emphasized that even those who were typically developing were in need of quality early intervention to build a stronger linguistic environment that resulted in better language outcomes, both receptively and expressively.

Recently, Rufsvold, Wang, Hartman, Arora, and Smolen (2018) conducted a study that sought to investigate the impact of quantitative aspects of adult language input as measured by the LENA technology on child language output reported by the LENA variable as well as the child's knowledge of vocabulary and basic concepts. Rufsvold and colleagues examined the language environments of children with hearing loss who used listening and spoken language as well as children who were identified as typically developing. The recruitment of both groups of children was conducted through listening and spoken language programs across the U.S. The authors' preliminary analysis revealed that the language environments of the children with hearing loss and those who were typically developing (N = 41) were similar, in that the researchers did not find statistically significant differences between the number of adult words and conversational turns. However, among the participants who were d/DHH, type of

amplification was found to be related to the child's knowledge of basic concepts in that those with hearing aids performed better than their peers with cochlear implants. Rufsvold and colleagues acknowledged that listening age could be a factor but it presented a need for more investigation. The researchers used the LENA technology to collect recordings from a weekday, which captured school and teacher language, and a day during the weekend for each of the children. The number of words that were spoken by an adult around the child was reported to be highly correlated, indicating that the children were consistently exposed to similar linguistic environments in both school and home settings. Overall, interestingly, the quantity of adult language and conversational turns was not related to the child's language outcomes as measured by vocabulary or basic concepts. Rufsvold et al.'s study is pertinent to the current study in that a subset of the participants (only children with hearing loss) is the sample of the current study. Additionally, this current study utilized the language samples collected as part of Rufsvold et al.'s study which were analyzed and coded for the quality measures of lexical diversity, syntactical complexity, and clausal complexity.

Across the studies that explore the quantitative aspects of language exposure for children with hearing loss, the findings only indicate the amount of language the child is receiving. What remains unknown in this type of data collection is what that language looks like, are children consistently exposed to the same vocabulary and language structures? While researchers agree that quantity of language is related to the language development of children, the investigation of whether type or quality of language might be more influential warrants further analysis. The next section addresses the literature pertaining to the quality of language environments and its relationship to the linguistic outcomes of d/DHH-children.

Quality of language exposure for children with hearing loss. Lederberg and Everhart (2000) conducted a longitudinal study investigating the interactions between deaf children and their hearing mothers compared to hearing mothers with their hearing children (N = 40). This particular effort is an extension of Lederberg and Everhart (1998), which examined the quantity as well as the modality of communication of deaf and hearing children. Using video-tapes as the data collection method, the authors coded and analyzed all aspects of intentional communication which included linguistic and non-linguistic exchanges in addition to verbal and non-verbal communication (Lederberg & Everhart, 2000). The researchers and coders had to distinguish intentional communicative behaviors and those that were considered to be non-intentional. Additionally, conversational exchanges were coded according to topic (initiation of a topic or maintaining a topic) and pragmatic function which was defined according to its function or purpose: directive, question, statement, and unclassifiable (Lederberg & Everhart, 2000).

The results from Lederberg and Everhart (2000) indicated that the deaf children were more likely to use directives in their communication exchanges with their mother whereas hearing children were more likely to make statements, ask questions and imitate their mothers. Additionally, Lederberg and Everhart (2000) reported that while the deaf children demonstrated growth in their language development, they still lagged behind their hearing peers. Therefore, the authors examined the language input provided to deaf children by their hearing mothers and reported that the mother's language input is related to the child's linguistic abilities. In other words, the language that the hearing mothers used in conversational discourse with their deaf child was within their language abilities.

Vygotsky's (1978) ZPD theory could be applied to the findings of Lederberg and Everhart (2000) as the mothers were not operating within the zone that fostered development and

learning; rather they were maintaining the language skills that had been developed by matching their own language input with their child's language abilities. Lederberg and Everhart (2000) even acknowledged that the strategies and interventions for language development were unique to children with hearing loss; therefore, "the goal of making maternal communication to deaf children similar to maternal communication to hearing children seems inappropriate" (p. 321), suggesting that rather than providing the same amount of language or the same type of language, adult language input should be drastically different for children with hearing loss in order to close the gap between them and their hearing peers.

A later study conducted by DesJardin and Eisenberg (2007) furthered investigated the interaction and language models of hearing mothers to their deaf children with cochlear implants (N = 32). It examined three components of maternal linguistic input: 1) maternal involvement and self-efficacy, 2) quantity of linguistic input, and 3) quality of linguistic input. Self-efficacy was measured using a rating scale called the *Scale of Parental Involvement and Maternal Self-Efficacy* (SPISE); whereas, quantity of linguistic input was measured by number of word types and MLU. The authors examined the quality of language input through the strategies and methods that mothers used to facilitate language. These techniques included parallel talk, expansion, imitation, directive, recast, open-ended question, closed-ended question, comment, label and linguistic mapping.

DesJardin and Eisenberg (2007) reported that maternal involvement and self-efficacy were related to their use of facilitative language techniques in regards to child's language development. Furthermore, quantity of linguistic input as measured by MLU and word types was positively related to child's language development. Interestingly, the researchers reported a positive relationship between the recast facilitative language technique and the children's

receptive language skills as well as a positive relationship between the increased usage of open-ended questions and decreased usage of linguistic mapping, labels and directives in regards to the children's expressive language skills. While this quality measure differed from the previous study (Lederberg & Everhart, 2000), the implications of this research had the potential to influence early intervention and family centered education regarding language development for parents of children who were d/DHH.

Cruz, Quittner, Marker, DesJardin, and the CDaCI Investigative Team (2013) also examined the influence that facilitative language techniques as a measure pertaining to the quality of linguistic input had on child language development for deaf children with cochlear implants (N = 93). The facilitative language techniques that were examined in this study were the same as those included in DesJardin and Eisenberg (2007); however, the researchers included one additional technique called *expatiation*. Cruz and colleagues defined expatiation as similar to the expansion technique but the parents contributed new information to the child's utterance. Additionally, the researchers segmented the techniques into two distinct groups: lower-level and higher-level facilitative language techniques. Lower-level facilitative language techniques were further identified as: linguistic mapping, comment, imitation, label, directive and closed-ended question; whereas higher-level facilitative language techniques were: parallel talk, open-ended question, expansion, expatiation, and recast. Interestingly, researchers reported that the use of higher level facilitative language techniques predicated the growth in the children's expressive language skills but not for the children's receptive language development (Cruz et al., 2013).

Overall, the findings from previous studies suggest that there is a quality component of language exposure, such as noun phrases and facilitative language techniques, which is an important factor in language acquisition. Many studies also reinforce the notion that the quantity

of language exposure is crucial in language development; therefore, it begs the question of whether it is the quantity or quality of language input that is more influential on children's language development.

Vocabulary Development

Vocabulary Development for Children With Normal Hearing

It is generally expected that hearing children's vocabulary development increase at a rate of one year in regards to the age-equivalent scores on formal assessments such as the *Peabody Picture Vocabulary Test-4* (*PPVT-4*) (L. Dunn & D. Dunn, 2007). Additionally, vocabulary development has been linked to success in literacy and academic achievement (i.e., Cartmill et al., 2013; Farran et al., 2009; Lund & Schuele, 2015; Suskind et al., 2013). As language environment fosters vocabulary development (i.e., Hoff, 2003), it's the characteristics of that environment, which can predict later vocabulary growth and academic achievement. Hoff (2003) highlighted the influence of SES as well as the diversity of maternal speech in regards to the lexicon and complexity.

Additionally, while acknowledging the importance of rich language environments in terms of quality and quantity for language development, particularly vocabulary development, Rowe (2012) conducted a study that emphasizes the role of decontextualized language on children's vocabulary development. Rowe defined decontextualized language as "abstract language that is removed from the here and now" (p. 261). The findings indicated that parents varied the amount of decontextualized language they used with their child as well as decreasing the quantity of the decontextualized language as the child grew older. Furthermore, decontextualized language was found to be related to vocabulary growth as children that were exposed to more decontextualized language from their parents had larger vocabularies (measured

one year later). Therefore, the implications of the study encouraged parents to engage in more narrative and explanatory talk to promote vocabulary development.

While much of research focuses on the role of parental influence on language development and specifically vocabulary development; E. P. Bowers and Vasilyeva (2011) investigated the role of the teacher language input and vocabulary development of preschoolers. Bowers and Vasilyeva measured teacher input though quantity of input and structural complexity, which was the average number of words per utterance by a teacher. Based on the sample of 104 students, the authors revealed that quantity and structural complexity was not significantly related to the vocabulary growth of monolingual English speakers; however, interestingly, the authors found that both the quantity and structural complexity of teacher speech input was related to the vocabulary performance of ELL students. As the researchers accounted for lexical diversity, this was found to be significantly related to the vocabulary development of monolingual English students but not for those who were ELL students.

The findings from these studies indicate that the quantity and quality of language input was related to vocabulary development; however, the population of interest in the above studies is focused on those identified as typically developing. Therefore, this warrants an investigation on factors of vocabulary development among other populations such as those with hearing loss, which is discussed next.

Vocabulary Development for Children With Hearing Loss

Research has emphasized the role of language environments on language development, particularly for vocabulary development. However, children with sensory disabilities such as hearing loss may interact and perceive their linguistic environment differently than their typically developing peers. Having access to assistive technology such as hearing aids and cochlear

implants has afforded those with hearing loss the opportunity to access the auditory components of their environment (Cole & Flexer, 2007; Lund, 2016). Therefore, research investigating how children with hearing loss perceive and utilize their linguistic environment to foster vocabulary development is critical to continue to tailor and shape our interactions with children who are d/DHH in order to close the language gap between them and their hearing peers.

As adults and caregivers provide linguistic diverse and rich environments, it has been reported to have positive effects on the development of children's lexical and syntactical development (i.e., Aragon & Yoshinaga-Itano, 2012; Farran et al., 2009; Lederberg & Everhart, 2009). Lexical development is a critical component of not only expressive and receptive language use but for literacy development as well (El-Hakim et al., 2001; Fagan & Pisoni, 2010). As the National Reading Panel (2000) reported, vocabulary is one of five essential areas of intervention that is critical to successful literacy outcomes.

A study conducted by El-Hakim and colleagues (2001) investigated whether age at cochlear implantation affected vocabulary development. The study consisted of 112 children who received cochlear implants between 1988 and 1999; these children were split into groups labeled as: those who were implanted prior to the age of 5 years old and those who were implanted after 5 years of age. Furthermore, these researchers examined vocabulary development longitudinally through the children's performance on the *PPVT-4* and the *Expressive One-Word Picture Vocabulary Test* (*EOWPVT*). The findings indicate that the rate of vocabulary development for children with hearing loss was .93 for expressive and .71 for receptive vocabulary.

Additionally, El-Hakim and colleagues (2001) used what they referred to as the *gap index* to "measure the linguistic gap in relation to age at the time of testing (or to ideal score at the time

of testing). If language develops favorably the gap index should approach zero" (p. 1054). The use of the gap index revealed that over time the gap index significantly decreased from .62 to .55 for the older group of children regarding the *PPVT* and a significant decrease from .47 to .38 on the EOWPVT. The only significant change for the younger group was a decrease in the gap index from .43 to .37 on the EOWPVT. These findings indicate that while these children experience delays in vocabulary development compared to their hearing peers, there is an improvement in vocabulary development over time for children with cochlear implants (El-Hakim et al., 2001).

Similarly, Connor, Craig, Raudenbush, Heavner and Zwolan (2006) conducted a study using hierarchical linear modeling to examine growth curves of children (N = 100), who received cochlear implants between one-year to 10-years of age. In agreement with the findings from El-Hakim et al. (2001), the authors reported that across all age groups, the earlier the child received a cochlear implant, the greater the rate of vocabulary acquisition after implantation. To emphasize that point, results indicated that children who were implanted prior to 2.5 years of age had receptive vocabulary growth curves that were comparable to their hearing peers. These findings contributed to the notion of a critical or sensitive period for vocabulary development as the older children in this study did not demonstrate as strong of a 'burst' as the children who were implanted prior to 2.5 years of age. However, the method in which the researchers categorized the children allows for discrete conclusions, as if the ages included in each group was configured in a different fashion it may have led to different results.

Lederberg and Spencer (2009) conducted a study to examine the vocabulary acquisition in d/DHH children (N = 98) and categorized these children into three subgroups: slow word learners, rapid word learners, and novel mappers. The slow word learners struggled to internalize

new vocabulary but could associate object for familiar words. The researchers hypothesized that other disabilities as well as inconsistent language models could explain why these children struggle to build their vocabulary knowledge. Those who were identified as rapid word learners were able to internalize and label new words quicker than their peers in the slow word learner group; but they were only able to do so when their conservation partner was explicitly referring to the object and word. The researchers noticed that the conservation partners were often sensitive to the child's need to be explicit when referring to the object and word. Given the need to be explicitly taught the new vocabulary, these children struggled with learning vocabulary through incidental language exposure, in which the third group, novel mappers, were able to build their vocabulary knowledge through direct and indirect word learning. One characteristic that the researchers identified to be related to indirect word learning was the size of their lexicon prior to the study. Children that were associated with the novel mappers group had a larger lexicon than those in the other two groups, indicating that there was a critical "lexical size" (p. 57), in which children easily used indirect word learning to build their vocabulary knowledge.

Lederberg and Spencer (2009) suggested that by categorizing these children into three groups, adults (parents, educators, therapist) could tailor their language environments and input to match the vocabulary development needs of the children; for instance, those in the slow word learning group might need more explicit and direct references to the word whereas those in the novel mapping group could benefit from direct and in-direct contexts. However, it remained unclear the specific traits of the language environments of those identified as rapid word learners or the novel mappers as well as what lexicon size was average among the novel mappers group. This information could provide information related to why vocabulary learning differed among

d/DHH children. By establishing this 'criteria', it would further improve the assessment and intervention components to vocabulary development among children who are d/DHH.

Assistive technology such as cochlear implants has afforded the d/DHH population the opportunity to listen and learn spoken language. As children can receive implants at around 12 months of age (according to the FDA), they are trying to 'catch-up' to their hearing peers in regards to language development and vocabulary acquisition (Cole & Flexer, 2007; Lund, 2016). However, the research surrounding the vocabulary development in children with cochlear implants and whether it is commensurable to their hearing peers is unclear (Lund, 2016).

Fagan and Pisoni (2010) sought out to examine the vocabulary development of deaf children with cochlear implants by focusing on their *hearing age* (*HA*) as opposed to their *chronological age* (*CA*). Hearing age is identified as the years in which the child has exposure to auditory language as a result of hearing aid fittings or cochlear implantation. The study found that the receptive vocabulary knowledge of the deaf children (N = 23) was commensurable to that of their hearing peers with the same amount exposure to spoken language (HA) but it was considered to lag behind that of their age-matched hearing peers (CA). Therefore, the finding suggested that hearing experience reported by HA was critical to comparable vocabulary development to their peers; therefore, early identification, early implantation or fitting and early intervention were the pillars to successful receptive vocabulary development in deaf children with cochlear implants.

Lund and Schuele (2015) investigated the maternal language input (auditory and visual) in regards to vocabulary to children with cochlear implants and those who were typically developing. The researchers found that mothers provided similar auditory and visual input for children with cochlear implants and their age-matched hearing peers; however, there was a

difference in the input provided by the mothers of children with cochlear implants and those that were matched on chronological age. This indicated that a child with hearing loss might not be exposed to the same aspects to language such as auditory and visual cues compared to their hearing peers (Lund, 2016; Lund & Schuele, 2015).

Lund's (2016) meta-analysis examined vocabulary development in children with cochlear implant. Overall, the findings from the Lund's meta-analysis revealed that, on average, compared to their hearing counterparts, d/DHH children with cochlear implants had lower expressive and receptive vocabulary knowledge. Interestingly, the results from this meta-analysis indicated that the differences in vocabulary knowledge among those with cochlear implants were *not* related to age of implantation, duration of implantation or chronological age. While it addressed the variables at the child-level, the findings did not account for input or language environment. Therefore, while we can agree that d/DHH children with cochlear implants lag behind their hearing peers in regards to vocabulary development; there is an imperative need to examine why.

These studies highlight the role that linguistic input, more specifically, access to spoken linguistic input in the development of spoken vocabulary knowledge for children with hearing loss (Lederberg & Spencer, 2009; Lund & Schuele, 2015). Additionally, some studies emphasize the use of technology such as cochlear implants had on the acquisition of spoken vocabulary, noting that age of implantation (Connor et al., 2006; El-Hakim et al., 2001; Fagan & Pisoni, 2010) can be related to the rate and growth of vocabulary development. Given the findings from studies involving children who are d/DHH, there appears to be similarities in the influence that language environments have on spoken vocabulary development for typically developing children and those who are d/DHH.

Basic Concepts

Development and knowledge of basic concepts are crucial to the development of language and success in early education (Boehm, 1967, as cited in Steinbauer & Heller, 1978). These concepts can be found embedded in everyday language as they are terms that refer to direction ('*top*', '*left*'), quantity ('*empty*', '*full*'), time ('*next*', '*after*') and etc. Two of the most common assessments for basic concept knowledge are the Bracken Basic Concept Scale (Bracken, 1998) and the Boehm Test of Basic Concepts (Boehm, 2001). Research has indicated that basic concepts are developed as a part of a child's vocabulary as well as an important aspect of everyday language particularly for directions and academic language (Boehm, 1967; Bracken & Cato, 1986; Kaufman, 1978; Steinbauer & Heller, 1978).

Basic Concept Development for Children With Normal Hearing

Given that basic concepts are present within language and specifically vocabulary knowledge, the understanding of such concepts is critical for current and later academic success. Steinbauer and Heller (1978) conducted a study to examine whether performance of typically developing kindergarteners on the *Boehm Test of Basic Concepts* (*BTBC*) could be predictive of academic performance in 2nd and 3rd grade. The participants (N = 94) were assessed using the *Stanford Achievement Test* (*SAT*) to correlate their scores on the *BTBC*; if the scores were found to be correlated, the authors could argue that performance on the *BTBC* was a valid predicator of future academic achievement. The results from the study found that the performance on the *BTBC*, undisputedly, predicted later academic success as measured by the *SAT*. Therefore, the authors suggested that early identification and intervention on the understanding of these concepts set the child up for successful academic outcomes.

However, the population included in Steinbauer and Heller (1978) was a subset of individuals that were identified as upper-middle to upper-class households; therefore, as argued

above, the language environments that were provided to these children might have created advantageous conditions for their performance on both the *BTBC* and the *SAT*. Additionally, the study used the *SAT* as the solitary measure of academic achievement, which could be argued as biased since it was not a conclusive measure of academic performance across all domains. As basic concepts are often included in teacher or parent directions, daily language utterances, and so on, does a child's understanding of basic concepts affect their performance on assessments?

Boehm (1967; as cited in Kaufman, 1978) posited that children struggled to comprehend 'basic' concepts related to the instruction and/or directions provided by the teacher such as '*below*', '*beginning*', and etc. Kaufman (1978) argued that a poor understanding of such concepts can influence children's performance on testing. Specifically, Kaufman raised the question of: "to what degree do the directions spoken by the examiner assume the young child's knowledge of basic concepts?" (p. 207) This question led Kaufman to examine the construct validity of commonly used individual ability assessments such as the *Illinois Test of Psycholinguistic Abilities* (*ITPA*), *McCarthy Scales of Children's Abilities*, *Stanford-Binet Intelligence Scale*, *Wechsler Preschool and Primary Scale of Intelligence* (*WPPSI*). Kaufman found that the *WPPSI* referred to the largest number of basic concepts in its directions and assumed the child's understanding of such concepts, whereas the *ITPA* did not refer to any of the basic concepts identified by Boehm (1971). "Before a preschool child who has problems with basic concepts is given an individual ability test, he should be taught the basic concepts that are needed to understand the tasks" (Kaufman, 1978, p. 210). Therefore, an assessment of a child's basic concept understanding is necessary prior to ability testing in order to reach valid conclusions regarding a child's true level of functioning and/or knowledge.

These studies acknowledge that typically developing children can struggle with the acquisition and understanding of basic concepts, which poses a challenge regarding academic performance. This leads researchers to ponder if these difficulties arise among other populations such as those who are d/DHH. Given the findings discussed above regarding vocabulary development for children who are d/DHH, it is imperative to investigate and examine the basic concept development of this population to close the gap in regards to language and academic skills of their hearing peers.

Basic Concept Development for Children With Hearing Loss

It has been well established that children who are d/DHH struggle in regards to vocabulary development compared to their hearing peers. The deficits in vocabulary development include understanding of basic concepts (L. M. Bowers & Schwarz, 2013). There are only a handful of studies that have examined basic concept knowledge among children with hearing loss, which has indicated the children with hearing loss are at risk for developing understanding of basic concepts (Bracken & Cato, 1986; Davis, 1974; Harrington, DesJardin, & Shea, 2009).

Among the first to investigate basic concept knowledge in children with hearing loss was Davis (1974). The exploratory study consisted of 24 hard of hearing children and 24 age- and geographically-matched typically developing children. Its aim was to assess hard of hearing children on the basic concept knowledge considered to be critical for academic success in kindergarten, first, and second grade (Boehm, 1971). Overall, children who were hard of hearing performed considerably lower compared to their hearing peers, that is, 75% of the hard of hearing children scored below the 10th percentile on the *Boehm Test of Basic Concepts* (*BTBC*) (Boehm, 1971). Furthermore, it appeared that there weren't significant differences in the basic

concept knowledge between the older and younger hard of hearing children; therefore, it indicated that these children struggled to develop and improve their knowledge over time.

In a later study conducted by Bracken and Cato (1986), the researchers sought to compare the basic concept knowledge of deaf children to that of their hearing peers. Furthermore, the study uses a different measure of basic concept: *Bracken Basic Concept Scale* (*BBCS*; Bracken, 1984). The researchers observed that the children with hearing loss, on average, performed two standard deviations below the average performance of those who were identified as typically developing. The study reiterated previous research findings (e.g., Davis, 1974) that deaf children lagged behind their typically developing peers in their language development, specifically their understanding of basic concepts, which called for early language intervention.

Harrington et al. (2009) examined the relationship between early child factors (i.e., early identification, early intervention, and spoken language skills) and school readiness skills such as basic concept knowledge. The researchers conducted a longitudinal study with eight deaf preschool students. The measure used to assess basic concept knowledge was the *Bracken Basic Concept Scale* (*BBCS-R*; Bracken, 1998). The subtests used in the study as a measure of basic concept knowledge and school readiness were: direction, self-social awareness, texture, quantity, and time.

Harrington et al. (2009) found that the language skills of the participants were positively related to the child's basic concept knowledge. Furthermore, Harrington and colleagues supported the previous findings from Panter (2000; as cited in Harrington et al., 2009) in that performance on the basic concepts assessments was largely based on their receptive vocabulary knowledge. While previous research suggested that children with hearing loss struggle in

building their basic concept knowledge, Harrington and colleagues found these individual's performance in the range of average to above average on the basic concept measure (i.e., *BBCS-R*).

In summary, the review of literature has revealed that language environments can be instrumental in child's language development. The results have demonstrated that adult language input is indicative of child language development in regards to the amount of language, the complexity of the language as well as their knowledge of vocabulary and basic concepts (e.g., Aragon & Yoshinaga-Itano, 2012; Bracken & Cato, 1986; El-Hakim et al., 2001; Fagan & Pisoni, 2010; Farran et al., 2009; Harrington et al., 2009; Hart & Risley, 1995; Hoff-Ginsberg, 1991; Hoff & Naigles, 2002; Huttenlocher et al., 1991; 2010; Pan et al., 2005; Rowe, 2013). The literature has demonstrated different measures in regards to quality and quantity of language. For instance, in regards to quantity of language, some studies have utilized videotaping/audiotaping methods (e.g., Farran et al., 2009; Hart & Risley, 1995; Huttenlocher et al., 1991, 2010) while others have used technology such as the LENA for data collection (e.g., Ambrose et al., 2014; Caskey & Vohr, 2013; Dykstra et al., 2012; Jackson & Callender, 2014; VanDam et al., 2012). Studies that examined the quality of language used various measures such as number of word types or tokens for lexical diversity and examined the language transcriptions for the diversity of syntax and clauses (e.g., Hoff & Naigles, 2002; Huttenlocher et al., 1991, 2010), while others have examined the language facilitation techniques as a measure of how adults engage with children (Cruz et al., 2013; DesJardin & Eisenberg, 2007; Lederberg & Everhart, 2000).

Some studies have examined the language environments according to either quantity or quality in regards to children who are d/DHH. The results from these studies have indicated that there is a positive relationship between the quality and quantity of the language environment;

however, it remains unclear how impactful these components are together among those who are d/DHH. Therefore, there is a clear gap in the literature that examines the relationship of both quantity and quality of linguistic input on the quantity and quality of the child's language as well as their vocabulary and basic concept development. More research is needed regarding this topic.

Purpose of the Study

Given the need for more investigation in the linguistic environments of children who are d/DHH, this study seeks to provide more clarity and understanding as to how quantity and quality of adult language input can shape and foster child language development. Based on the previous research, one could argue that the variation in child language development is due to the language environments that are provided by the adults in a child's life. This is supported by Vygotsky's (1978) social learning theories and the understanding that language development is a construct that does not occur in isolation. Since the conception of the LENA technology, language environments have been of interest among researchers to better understand the processes and influencers of language development in children. Furthermore, this technology has made research regarding this topic less of an arduous process and easier to explore diverse populations.

This study focuses on the population of children who are d/DHH to identify characteristics of both the child and adults, which contribute to rich language environment and consequently successful language outcomes. Those who are d/DHH pose interesting characteristics that may influence how language environments are related to language development given their sensory disability and the way they perceive the input they are exposed to. Further investigation regarding this population and topic provides researchers, educators and

parents thorough and better understanding of what kind of language environment is necessary for successful language and academic outcomes.

Significance of the Study

By exploring and examining linguistic environments of children who are d/DHH, the results of the study have the potential to influence parent education, early intervention practices, educational instruction, and adult-child interactions. In doing so, this study has the potential to identify components to language environments that could lead to teacher and/or parent centered intervention aimed at closing the gap between children who are d/DHH and their hearing peers in regards to language development. In using LENA technology, this study examines spoken language as the primary communication modality in regards to language input. Therefore, this study targets a subset of the d/DHH population, who are exposed to spoken English and attend educational programs that focus on listening and spoken language. The results of this study can be used to improve educational practices implemented to these children with the listening and spoken language programs as well as informing parents and caregivers of best practices and how certain components of adult speech can shape their child's language development.

Research Questions

This study is guided by the following research questions:

1. What demographic characteristics (i.e., age, gender, type of hearing loss, type of amplification, aided pure tone average and degree of hearing loss, presence of additional disability, socio-economic status, and parent education) of the participants are related to the quality of adult input, quality of child language, child's vocabulary, and child's understanding of basic concepts?

2. Is the quantity and quality of adult language related to the quantity and quality of child's language as well as their knowledge of vocabulary and basic concepts?
    a. Is the quantity and quality of adult language related to the quantity of child's language?
    b. Is the quantity and quality of adult language related to the quality of child's language?
    c. Is the quantity and quality of adult language related to the child's knowledge of vocabulary and basic concepts?
    d. Is there a difference in teacher or caregiver input in regards to the quantity and quality of language?

Hypotheses

Research Question 1

Age. For this study, it is hypothesized that there will be a statistically significant positive relationship between age and the quality of the adult's language. The findings reported by Rowe (2012) suggest that quantity of language exposure is more influential in the 2nd year of the child's life whereas the diversity or complexity of the language becomes important in the child's 3rd year of life. Given that the ages of the participants in this study (3 years to 4;11 years old), there will be a statistically significant positive relationship between age and the quality of the adult language.

Gender. Previous research conducted by Huttenlocher et al. (1991) examined the relationship between language growth and gender, which appeared to indicate that gender is an influential factor until about 20 months of age. After which, the characteristic of gender

differences in vocabulary growth are not as significant. Given these findings, it is hypothesized that there will not be a significant relationship between gender and the quality of the child's language variables as well as their performance on the *BTBC-3* and *PPVT-4*.

Type of hearing loss. Cole and Flexer (2007) have emphasized the notion that technological advancements has afforded children with hearing loss more access to spoken language. Furthermore, children with hearing loss (regardless of conductive, sensorineural, mixed, etc.) may struggle with the development of vocabulary and syntax (Trezek et al., 2010; Wang et al., 2008). It is hypothesized that there will be significant differences among the type of hearing loss and the quality of adult and child language as well as their performance on the *BTBC-3* and *PPVT-4*.

Type of amplification. A longitudinal study conducted by Yoshinaga-Itano et al. (2010) examined the trajectory of language development in children who utilized cochlear implants or hearing aids. They reported that children with cochlear implants made bigger strides to closing the gap with their typically developing peers than the children with hearing aids did in the study. Therefore, it is hypothesized that there will be a significant positive relationship between type of amplification and the quality variables related to the child's and adult's language. More specifically, it is hypothesized that children with cochlear implants will be exposed to more language as well as more diverse language and perform higher on the measures of basic concepts and vocabulary.

Aided pure tone average and degree of hearing loss. Pure tone average (PTA) is calculated by finding the average of the thresholds at 500 hz, 1000 hz and 2000 hz. This particular variable was explored in a study by VanDam and colleagues (2012). They reported a relationship between the PTA and the levels of parental talk; indicating that "parents may be

sensitive to the degree to which their HH children are able to access environmental talk" (p. 413). It is hypothesized that there will be a statistically significant positive relationship between the PTA and variables related to the quality of the adult and child's language. Similarly, there will be a statistically significant positive relationship between degree of hearing loss and the quality of the adult language exposure. Moreover, the more access the child has to the spoken language around them, the higher quality of the language they will have compared to those with less access auditorily.

Presence of additional disabilities. While the differences are not significant, the amount of adult language input was less for children with Down Syndrome than for the typically developing children; these differences over time can lead to significant differences in language input (Thiemann-Bourque et al., 2014), which previous research has shown to influence language and academic outcomes. Additionally, differences in not only the amount of adult utterances but the length of the utterances were found to be shorter for adults with children that were diagnosed with Autism Spectrum Disorder (ASD) than those with typically developing children (Warren et al., 2010). This leads to the hypothesis that there will be a statistically significant negative relationship between additional disabilities and the quality of the adult language in this study; specifically, that those children with additional disabilities will be exposed to less language in terms of amount and diversity.

Income. Hart and Risley's (1995) study reported significant differences in the amount of language exposure in relation to SES; specifically, that individuals from lower SES households were exposed to fewer words than those from higher SES households. Hoff (2003) also examined the effects of SES on vocabulary growth and reported that there were distinct properties of the maternal speech that differed among the SES groups, which were related to the

amount of vocabulary growth over time. Additionally, Vasilyeva et al. (2008) found differences among SES groups in regards to syntax or more specifically, complex sentence structures; whereas the authors report similarity among SES groups in regards to simple sentence structures. Given the results from previous research, there will be a statistically significant positive relationship between income and the quality language variables of the adults and children. Moreover, it is also hypothesized that there will be a statistically significant positive relationship between income and the children's performance on the *BTBC-3* and *PPVT-4*.

Parent education. It is hypothesized that there will be statistically significant differences among the education levels and the quality of adult language exposure. In other words, parents with higher levels of education will talk more and their language will be richer and more complex.

Research Question 2

Research Question 2a. Based on the findings of Hart and Risley (1995, 2003) as well as Huttenlocher et al., (1991, 2010) as described above in regards to SES; there will be a statistically significant positive relationship in the quality and quantity of the adult language and the quantity of the child's language.

Research Question 2b. Additionally, it is hypothesized that quality, not quantity of parent language will be reported as a statistically stronger positive relationship with the child's language development (Hoff, 2006, 2013; Huttenlocher et al., 1991, 2010, Pan et al., 2005).

Research Question 2c. Steinbauer and Heller (1978) highlighted a relationship between the language environments of typically developing children and their understanding of basic concepts. Furthermore, Harrington et al. (2009) established a relationship between the child's language skills and their basic concept knowledge in children who were deaf. In regards to

vocabulary knowledge, several studies have supported the notion that language environment fosters vocabulary development among typically developing children (e.g. Hart & Risley, 1995; Hoff, 2003). More specifically, this has been reflected among the language environments of children with hearing loss (i.e. Aragon & Yoshinaga-Itano, 2012; Farran et al., 2009; Lederberg & Everhart, 2009). Therefore, it is hypothesized that there will be a statistically significant relationship positive between the quantity and quality of the adult's language and the child's knowledge of basic concepts and vocabulary.

Research Question 2d. In a study conducted by Soderstrom and Wittebolle (2013), the researchers compared the linguistic environments of daycare and home. They reported that specific activities were related to the amount of language exposure; whereas the type of environment or rather the type of adult (educator or parent) was not statistically significant in relation to the amount of language exposure. Therefore, it is hypothesized that there will not be a statistically significant difference to the quantity or quality of adult language variables.

Chapter 3

Method

Participants

The participants in this study consisted of 26 monolingual preschool children with hearing loss from listening and spoken language programs whose ages ranged from 3;0 years to 4;11 years. Participants were recruited from New York, NY; St. Louis, MO; and Sacramento, CA. The rationale for recruiting participants from three cities in the United States was that there were limited number of participants that fit the inclusion criteria (described below). Therefore, in order to have a sufficient number of participants in all groups the area of recruitment needed to be bigger than one city. Specifically, all d/DHH participants from the three sites were recruited from programs that focused on the same communication philosophy, which was listening and spoken language.

The participants were preschool children with hearing loss that met the following inclusion criteria. All of the child participants were from families that identified themselves as monolingual English speakers; therefore, families that identified themselves as bilingual were not included in the study. For child participants, the diagnosis of hearing loss was confirmed by examining their audiograms. Additionally, the audiological reports provided background information regarding age at diagnosis, etiology, type and severity of hearing loss. All families adopted the listening and spoken language communication modality as well as personal amplification in the form of hearing aids or cochlear implants. Table 3.1 reports the demographic characteristics of the participants.

Table 3.1

Demographics of the Participants

Characteristics		Participants (n=26)
Age (months)	Mean age (SD)	47.69 (7.883)
Sex %(n)	Male	50% (13)
	Female	50% (13)
Income*	Less than $10,000	3.8% (1)
	$10,000-29,999	7.7% (2)
	$30,000-49,999	7.7% (2)
	$50,000-69,999	11.5% (3)
	$70,000-89,999	11.5% (3)
	$90,000-119,999	7.7% (2)
	$120,000-139,999	0% (0)
	$140,000 or more	23.1% (6)
	Decline to state	26.9% (7)
Highest education – father	Some high school	0
	High school	11.5% (3)
	Some college	23.1% (6)
	Associate's degree	15.4% (4)
	Bachelor's degree	23.1% (6)
	Master's degree	3.8% (1)
	Doctoral degree	7.7% (2)
	Postdoctoral	0
	Unknown	15.3% (4)
Highest education – mother	Some high school	0.3% (1)
	High school	0% (0)

	Some college	26.9% (7)
	Associate's degree	11.5% (3)
	Bachelor's degree	30.8% (8)
	Master's degree	15.4% (4)
	Doctoral degree	3.8% (1)
	Postdoctoral	0
	Unknown	11.5% (3)
Age hearing loss identified (months)	Mean (SD)	7.38 (12.007)
Degree of hearing loss –right side % (n)	Normal	3.8% (1)
	Mild	0% (0)
	Moderate	30.8% (8)
	Moderate-Severe	3.8% (1)
	Severe	15.4% (4)
	Profound	46.2% (12)
Degree of hearing loss – left ear	Normal	0% (0)
	Mild	0% (0)
	Moderate	26.9% (7)
	Moderate-severe	7.7% (2)
	Severe	11.5% (3)
	Profound	53.8% (14)
Type of hearing loss-right ear	Normal	3.8% (1)
	Conductive	7.7% (2)
	Mixed	7.7% (2)
	Sensorineural	69.2% (18)
	Neural	11.5% (3)
Type of hearing loss-left ear	Conductive	7.7% (2)
	Mixed	3.8% (1)

	Sensorineural	76.9% (20)
	Neural	7.7% (2)
	Unknown	3.8% (1)
Type of amplification-right ear	None	7.7% (2)
	Cochlear Implant	53.8% (14)
	Hearing Aid	34.6% (9)
	FM only	3.3% (1)
Type of amplification – left ear	None	3.8% (1)
	Cochlear Implant	53.8% (14)
	Hearing Aid	42.3% (11)
	FM only	0
Hearing status – mother	Hearing	96.2% (25)
	Hearing loss	3.8% (1)
Hearing status – father	Hearing	96.2% (25)
	Hearing loss	3.8% (1)
Presence of Additional disability	Yes	15.4% (4)
	No	84.6% (22)

*Note: See adjusted income based on Cost of Living in Appendix A.

Due to the nature of the data collection using LENA technology, nonverbal language and gestures were not captured in the language samples; therefore, families and children that were exposed to or use a manual communication modality such as ASL were not included in the study. While nonverbal language or cues are a vital part of language exposure and language development, this particular study focuses solely on the elements of spoken language exposure and development.

Procedure

Data collection was done by a team of researchers including the lead author and other individuals in the Education of the Deaf and Hard of Hearing program at Teachers College, Columbia University, where Institutional Review Board approval was attained. Prior to collecting the language samples and testing, the parents filled out the demographic questionnaire (See Appendix B). The demographic questionnaire consisted of questions pertaining to the history of hearing loss, current hearing status, income, and parental educational history. The researchers administered the two formal assessments: *Peabody Picture Vocabulary Test-4* (*PPVT-4*; L. Dunn & D. Dunn, 2007) and *Boehm Test of Basic Concepts-3* (*BTBC-3*; Boehm, 2001) to the children during the school day at their individual schools. It took 30 minutes to complete both assessments, which was the length of the child's scheduled daily therapy session. Parents were given written and verbal instructions on how to put the vest on and turn on the LENA recording device. After each day of recording, the parents were instructed to bring the LENA device back to school. Then, a researcher from the team downloaded the data and language samples before reusing the device.

LENA technology was used to audio-record 32 hours of language over a two-day period (a week day for 16 hours and a weekend day for 16 hours) from each child. These audio-recordings were used to produce reports of quantitative aspects of language input and the language samples were transcribed for the quality of language input.

Data Collection

Quantitative Data From LENA: AWC, CVC and CTC

The Language ENvironment Analysis (LENA) system was used to collect language samples and quantitative data because of previous studies and analysis, which have found LENA technology to be reliable and accurate in regards to its calculation of language data (i.e.,

Ambrose et al., 2014; Dykstra et al., 2012). Xu, Yapanel, and Gray (2009) investigated the reliability of the LENA system within children's natural home environments; they reported that the correlation between human coders and the LENA was $r = .91$, $p < .01$, and child vocalizations were accurately reported 75% of the time. The LENA system consists of a digital language processor (DLP) that is about the size of a tape cassette, which fits into a small t-shirt or vest that is worn by the child. The technology of the DLP has the capacity to record up to 16 hours of continuous language before it becomes "full." At this point, the DLP can be connected to the LENA Pro computer software using an USB wire to download the data. This software analyzes the data over a number of hours using complex algorithms, typically 3-6 hours, and then automatically analyzes and segments the language samples into daily, hourly and 5-minute intervals. The software produces reports of the data pertaining to the number of adult words (AWC), number of child vocalizations (CVC), number of conversational turns (CTC) and amount of exposure to electronic media such as the TV and radio. Specifically, AWC and CTC are associated with parent or adult language input and CVC corresponds to child language development. For this study, the duration in which the LENA recorded language was noted. This data was then used to create a proportion score for AWC, CTC and CVC. For example, the AWC was divided by the duration of language for a given day (weekday or weekend). By doing so, it eliminated the variability in the wear time that each child had with the LENA devices.

Quality Data From LENA

To examine the quality of the adult and children's language, the language samples were transcribed and further analyzed for lexical diversity, which examined the number of word types, syntactical diversity (e.g., prepositional phrases, noun phrases, adjectives, and etc.) and clausal density (e.g., subject clause and objective relative clauses). Both the adult and child utterances

were transcribed and analyzed using the coding mechanism described in Huttenlocher et al. (2010) (see the details at below).

Experienced teachers of the deaf/hard of hearing (TOD) transcribed a total of one hour of language samples from each child (30 minutes for the weekday/snack time and 30 minutes for the weekend/dinner time). The *Systematic Analyses Language Transcript* (*SALT*) software is a transcription tool that has the capability to analyze language samples in regards to number of utterances, number of words, number of new words, MLU, and etc. For this study, SALT was used to calculate MLU for the child's utterances. For inter-rater reliability, a second TOD transcribed the recording. If discrepancies were found, a third researcher resolved the conflicting transcriptions. The language samples were further coded using the system outlined and used in Huttenlocher et al., (2010).

Lexical diversity. Huttenlocher et al. (2010) defined *lexical diversity* as the number of different word types used by adults and children. Therefore, in regards to lexical diversity, proper names and nicknames were treated as one-word type, including variations such as Ben/Benjamin. Proper names that consisted of more than one word were counted as one word type such BeautyAndTheBeast or TheCatInTheHat. All inflected types were treated as the same type (e.g., run/runs/running; dog/dogs = one type). Word types that had irregular inflectional morphology were treated as the same type such as buy/bought. Words that had different derivational morphology were treated as different word types such as slow/slowly. Once a word type had been counted in the coding, that specific word type was not counted again throughout the language sample. For instance, if the child's name was verbalized multiple times throughout the language sample, it was coded as one distinct word type as it related to lexical diversity. In

coding the transcripts, once a word type was accounted for, it would be highlighted and then crossed out for each occurrence thereafter.

Syntactical complexity. There were seven different forms that were associated with syntactical complexity (Huttenlocher et al., 2010). Adjectives (e.g., white rabbit, blue car) and adverbs modifying verbs (e.g., walk slowly, hard throw), and adverbs modifying other adjectives (e.g., very cool) were each treated as one type of syntactical complexity. There were four different types of phrases that were each treated as one type: 1) prepositional phrases (e.g., In the evening, Sarah is coming over), 2) noun phrases that occurred with no preposition and outside of argument positions (e.g., Last night we went to the store), 3) possessives (e.g., Mom's purse), and 4) quantifiers (units) for mass nouns (e.g., a sip of soda). To code the transcripts for syntactical diversity, the research team devised a color-coded strategy to account for the different components of syntax. Specifically, each component of syntactical diversity (adverbs, adjectives, prepositional phrases, noun phrases, possessives, and class) was given a different color, which was highlighted throughout the transcripts. For instance, the following sentence was coded as followed: *In the morning,* the dog ran *quickly*. This sentence contained an adverb that modified a verb (quickly) and a prepositional phrase (in the morning).

Clausal complexity. Clausal complexity was measured by the different ways of combining clauses. Clauses are defined as followed and each are treated as one type: 1) coordination in which two clauses are joined by *and*, *or*, or *but* (e.g., *He went to school and studied.*), 2) adjunct clause that precedes the main clause (e.g., *After you finish getting ready, pick up your toys.*), 3) adjunct clause that follows the main clause (e.g., *Pick up your toys after you finish getting ready.*), 4) subject relative clause that modifies the subject of the main clause (e.g., *My friend that you went to school with is getting married*), 5) objective relative clause

which modifies the object of the main clause (e.g., *I found the toy I want*), 6) the subject of the main clause (e.g., Finger-painting is fun), and 7) the object of the main clause (e.g., They said it's right here) (Huttenlocher et al., 2010). The research team applied the same color-coding strategy to code the clausal diversity of the transcripts. An example of the coding was as followed: "I said *you need to be at my table,* that's *why you fell down*."

Each of the language variables are reported under three conditions: 1) weekday, 2) weekend, and 3) weekday and weekend combined for a 'total'. Additionally, it should be noted that Huttenlocher et al. (2010) coded phrases that were considered to be "optional"; however, given the language delays and language development of children with hearing loss, this study coded all utterances made by adults and children.

The inter-rater reliability was conducted by having approximately 25% of the sample (6 language samples) coded twice independently and then assessed for agreement. The coding for adult lexical diversity was found to be 94.3% reliable, adult syntactical complexity was reported to be 78% reliable and adult clausal complexity was reported to be 94.3% reliable. In regards to the children's language samples, child lexical diversity was found to be 95% reliable, child syntactical complexity was found to be 83% reliable and child clausal complexity was found to be 86.7% reliable.

MLU. Further, average mean length of utterances (MLU) of the children's utterances was also calculated from the language samples collected and transcribed. Specifically, each of the child's utterances was broken down into morphemes. Then to calculate the MLU, the researchers added the total number of morphemes divided by the number of utterances.

Vocabulary measure. The study used the *Peabody Picture Vocabulary Test- 4th edition* (*PPVT-4;* L. Dunn & D. Dunn, 2007) as a measure of vocabulary knowledge. The *PPVT-4* is a

norm-reference and untimed assessment that consists of two parallel forms with 228 items each that are divided into 19 sets. These sets increase in difficulty throughout the assessments so that examiners can easily identify and administer the sets that are appropriate for the child's vocabulary knowledge. An easel, with pages that consists of four-color pictures arranged on each page, sits between the examiner and the child while the examiner administers the assessment. The language that is used by the examiner includes phrases such as "*Show me* _____", "*Point to* _____", or "*Where is*____". The content that is referenced in this assessment includes but not limited to: body parts, emotions, household objects, people, vehicles, etc.

As the *PPVT-4* is a norm-reference measure, L. Dunn and D. Dunn (2007) recruited the normative sample that consisted of 3,540 individuals which spanned the ages of 2 years; 6 months to 81 years old. The normative sample was chosen to closely match the U.S. population characteristics of each age and grade level as defined by the U.S. Census Bureau. Reliability for this assessment was measured using several types such as internal consistency, alternate form, and test-retest. Internal consistency was reported to fall between .94 and .95 on both forms. The reliability found using alternate form was reported to be very high as the mean for both forms was .89. Therefore, the assessment was used in this study as a measure of receptive vocabulary being found to be reliable and precise in its use to evaluate children's vocabulary knowledge (L. Dunn & D. Dunn, 2007). Additionally, this measure has been widely used in research pertaining to language development of children and often found to be an accurate measure of vocabulary knowledge among children who are d/DHH. The percentile rank was used as a variable in the present study.

Basic concepts measure. The *Boehm Test of Basic Concepts 3- Preschool* (*BTBC-3*, Boehm, 2001) is a norm-referenced assessment that measures the child's understanding of

concepts related to qualities of individuals (*tall, angry, small*), spatial relationships (*under, top, on*), time (*before, after*), and quantity (*more, few*). As the examiner administers the assessment, the child is presented with an easel that consists of four pictures on each page. The child is then prompted with a verbal direction such as "*Point to the box that is empty*". The test items are divided into two age groups: 3.0-3.11 and 4.0-5.11 with 52 test items for each age group. The normative sample for this assessment consisted of 660 children from age 3.0 to 5.11. The children in the normative sample were split into six age groups of 110 children in each: 3.0-3.5, 3.6-3.11, 4.0-4.5, 4.6-4.11, 5.0-5.5, 5.6-5.11.

Reliability for this measure was conducted using internal consistency, standard error of measurement and test-retest reliability. The internal consistency reliability was high as the coefficient alphas were reported to range from .85-.92. The standard error of measurement was reported to range from 2.08-2.88, which indicated low variability. The test-retest reliability coefficients ranged from .9 to .94. The reported high reliability indicated that this was an accepted measure of language comprehension, specifically in regards to children's understanding of basic concepts for the age range of participants included in this study (Boehm, 2001). The percentile rank was used as a variable in the present study.

Data Analysis

Using SPSS version 24, statistical analyses was conducted to further examine the aims of this study. Pearson correlations were used to find relationships between variables. ANOVA, independent sample t-test and paired sample t-tests were conducted to examine group differences.

Research Question 1

What demographic characteristics (i.e., age, gender, type of hearing loss, type of amplification, aided pure tone average and degree of hearing loss, presence of additional disability, income, and parent education) of the participants are related to the quality of adult input, quality of child language, child's vocabulary, and child's understanding of basic concepts? For research question 1, the variables of age and aided pure tone averages were examined using Pearson correlations. The variables of gender and presence of additional disabilities were examined using independent sample t-tests. Degree of hearing loss, type of amplification, income and parent education were coded as categorical variables; therefore, they were examined using one-way ANOVAs.

Research Question 2

Is the quantity and quality of adult language related to the quantity and quality of child's language as well as their knowledge of vocabulary and basic concepts? For research questions 2a-c, correlations between the quality and quantity of adult language as well as quantity and quality of child language, the child's understanding of vocabulary and basic concepts were examined using Pearson correlations given that these variables were continuous.

Research Question 2d

Is there a difference in teacher or caregiver input in regards to the quantity and quality of language? The statistical analysis for research question 2d was a paired sample t-test given that the measures of interest to this question were within subject variables.

Summary

This chapter describes the design and method of the study, which is to examine aspects of adult language and its influence on child language development using a between subject group design. This chapter outlines the characteristics of the participants, data collection procedures,

materials that were used; furthermore, it discusses the statistical analysis procedures for the research questions guiding the study. The methods and designs described in this chapter provide the foundation and rationale for investigating the quality and quantity of adult language and how they are related to child language development for children who are d/DHH.

Chapter 4

Results

This chapter provides the results of the data analysis pertaining to this study. The primary analysis outlined in chapter 3 was carried out first. The first analysis tested the hypothesis of the demographic data and whether or not it was related to the quantity and quality of the adult and child language variables as well as the *BTBC-3* and *PPVT-4*. The second analysis was conducted to examine whether the quality and quantity of the adult language was related to the quality and quantity of the child language and their performance on the *BTBC-3* and *PPVT-4*. Finally, the third analysis tested the hypothesis of the differences in the teacher or caregiver language exposure among the variables of quantity and quality of the child's language and their performance on the *BTBC-3* and *PPVT-4*.

Research Question 1

What demographic characteristics (i.e., age, gender, type of hearing loss, type of amplification, aided pure tone average and degree of hearing loss, presence of additional disability, income, and parent education) of the participants are related to the quality of adult input, quality of child language, child's vocabulary, and child's understanding of basic concepts?

The results for Research Question 1 revealed that age, gender, type of hearing loss, type of amplification in the left and right ear, presence of additional disabilities and maternal education were found to be positively related to the quality of the adults and child's language as well as the child's performance on the *BTBC-3* and *PPVT-4.* The following demographic variables were not found to be related: gender, aided PTA, degree of hearing loss, income, and paternal education.

Age

Age was referred to as the age of the child participant at the first recording and it was reported in months. Given that it was a continuous variable, Pearson correlation test was conducted to examine whether it was related to the quality of language variables associated with the adult and child as well as the percentile scores on the *BTBC-3* and *PPVT-4.* Strong positive correlations were found for the following variables: age and MLU weekday, $r(26) = .614$, $p = .001$; age and MLU weekend, $r(26) = .635$, $p < .001$; age and child lexical diversity weekday, $r(26) = .613$, $p = .001$; age and child lexical diversity weekend, $r(26) = .454$, $p = .02$; age and child syntactical complexity weekday, $r(26) = .599$, $p = .001$; age and child clausal complexity weekday, $r(26) = .598$, $p = .001$.

Statistically significant relationships were not found between the following variables: age and adult lexical diversity weekday, age and adult syntactical complexity weekday, age and adult clausal complexity weekday, age and adult syntactical complexity weekend, age and child syntactical complexity weekend, age and adult clausal complexity weekend, age and child clausal complexity weekend, age and adult lexical diversity weekend, age and *BTBC-3,* as well as age and *PPVT-4.*

Gender

To examine the effects of gender on the quality of language for both the adult and child as well as the child's performance on the *BTBC-3* and *PPVT-4*, an independent sample t-test was used. This t-test revealed that there was a statistically significant difference only in regards to adult clausal complexity weekday, $t(19.214) = -2.997$ $p = .007$ (equal variances not assumed). Post hoc analysis revealed that female children ($M = 90.23$, $SD = 36.058$) were exposed to

language that was more complex in regards to clauses than males (M = 55.62, SD = 20.843) on the weekday. See Table 4.1.

Table 4.1.

Group Differences Among Gender

	Female		Male	
	M	*SD*	*M*	*SD*
Adult Clausal Complexity Weekday	90.23	36.058	55.62	20.843

Type of Hearing Loss

To examine the effects of type of hearing loss, a one-way ANOVA was conducted and indicated that there were no significant differences among the categories of conductive, sensorineural, mixed, neural, and unknown regarding the quality of the language for both adult and child as well as performance on the *BTBC-3* and *PPVT-4*. Upon further examination, there appeared to be a difference in the types of hearing loss for the left ear in regards to the child lexical diversity weekend, $F(3,21) = 3.507$, $p = .033$. It should be noted that there are uneven groups among the types of hearing loss for the post-hoc analysis. The post hoc analysis revealed that children with conductive hearing loss (M = 184.50, SD = 40.305) had higher lexical diversity than those with mixed hearing loss (M = 85, SD = 0), sensorineural hearing loss (M = 70.80, SD = 53.549) or neural hearing loss (M = 31, SD = 11.314). See Table 4.2.

Table 4.2

Group Differences Among Type of Hearing Loss

	Conductive		Mixed		Sensorineural		Neural	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Child Lexical Diversity Weekend	184.50	40.305	85	0	70.80	53.549	31	11.314

Type of Amplification–Right Ear

A one-way ANOVA was conducted to assess whether or not there were group differences among the type of amplification in the right ear. This one-way ANOVA consisted of 4 levels: none, cochlear implant, hearing aid, FM only. The ANOVA test revealed that there were significant differences among following variables: type of amplification in the right ear and MLU weekday, $F(3,22) = 3.683$, $p = .027$; child lexical diversity weekend, $F(3,22) = 5.715$, $p = .005$; child syntactical complexity weekend, $F(3,22) = 9.299$, $p < .001$; adult clausal complexity weekend, $F(3,22) = 4.996$, $p = .009$; child clausal complexity weekend, $F(3,22) = 87.997$, $p < .001$; *BTBC-3* percentile, $F(3,22) = 5.284$, $p = .007$; and *PPVT-4* percentile, $F(3,22) = 4.259$, $p = .016$.

For this variable, it should be noted that there were unequal groups among the types of amplification and specifically, there was only one case of FM. Therefore, the post-hoc reports focused on the differences found between cochlear implants and hearing aids. Post hoc analysis found that hearing aid users ($M = 3.641$, $SD = 1.446$) had higher MLUs than cochlear implant users ($M = 2.31$, $SD = .621$) on the weekday; hearing aid users had higher lexical diversity on the weekend ($M = 67.56$, $SD = 50.195$) than cochlear implant users ($M = 57.5$, $SD = 40.567$); cochlear implant users ($M = 28.36$, $SD = 24.213$) had utterances that were more syntactically complex than hearing aid users ($M = 25.11$, $SD = 24.599$) on the weekend; cochlear implant users ($M = 44.64$, $SD = 38.638$) were exposed to utterances that had higher clausal complexity than the hearing aid users ($M = 36.67$, $SD = 34.875$) on the weekend; hearing aid users ($M = 6.89$, $SD = 8.328$) had utterances that were higher in clausal complexity than cochlear implant users ($M = 3.71$, $SD = 5.121$) on the weekend; hearing aid users ($M = 37.89$, $SD = 35.318$) performed higher on the *BTBC-3* than cochlear implant users ($M = 16.21$, $SD = 20.238$); and

hearing aid users (M = 36.144, SD = 32.94) performed higher on the *PPVT-4* than cochlear implant users (M = 19.65, SD = 19.65). See Table 4.3.

Table 4.3

Group Differences Among Type of Amplification in the Right Ear

	Hearing Aid		Cochlear Implant	
	M	*SD*	*M*	*SD*
MLU Weekday	3.641	1.446	2.31	.621
Child Lexical Diversity Weekend	67.56	50.195	57.5	40.567
Child Syntactical Complexity Weekend	25.11	24.599	28.36	24.213
Adult Clausal Complexity Weekend	36.67	34.875	44.64	38.638
Child Clausal Complexity Weekend	6.89	8.328	3.71	5.121
BTBC-3	37.89	35.318	16.21	20.238
PPVT-4	36.144	32.94	19.65	19.65

Type of Amplification–Left Ear

A one-way ANOVA was conducted to assess whether or not there were group differences among the type of amplification in the left ear. This one-way ANOVA consisted of 4 levels: none, cochlear implant, hearing aid, FM only. The ANOVA test revealed that there were significant differences among following variables: type of amplification and MLU weekday, $F(2,23) = 5.529$, $p = .011$; MLU weekend, $F(2,23) = 3.470$, $p = .048$; child clausal complexity weekday, $F(2,23) = 3.848$, $p = .036$; child lexical diversity weekend, $F(2,23) = 4.249$, $p = .027$; *BTBC-3* percentile, $F(2,23) = 5.116$, $p = .015$; *PPVT-4* percentile, $F(2,23) = 5.162$, $p = .014$.

Post hoc analysis revealed that hearing aid users (M = 3.59, SD = 1.315) had higher MLUs than cochlear implant users (M = 2.31, SD = .62) during the weekday; hearing aid users

(*M* = 2.99, *SD* = 1.186) had higher MLUs than cochlear implant users (*M* = 2.37, *SD* = 1.03) during the weekend; hearing aid users (*M* = 8.18, *SD* = 8.589) had utterances that were higher in clausal complexity than cochlear implant users (*M* = 1.71, *SD* = 2.3) on the weekday; hearing aid users (*M* = 83.55, *SD* = 66.267) had higher lexical diversity than cochlear implant users (*M* = 57.5, *SD* = 40.567) on the weekend; hearing aid users (*M* = 45.45, *SD* = 36.101) performed higher on the *BTBC-3* than cochlear implant users (*M* = 16.21, *SD* = 20.238); hearing aid users (*M* = 42.027, *SD* = 32.80) performed higher on the *PPVT-4* than cochlear implant users (*M* = 19.65, *SD* = 19.65). See Table. 4.4.

Table 4.4

Group Differences Among Type of Amplification in the Left Ear

	Hearing Aid		Cochlear Implant	
	M	*SD*	*M*	*SD*
MLU Weekday	3.59	1.315	2.31	.62
MLU Weekend	2.99	1.186	2.37	1.03
Child Clausal Complexity Weekday	8.18	8.589	1.71	2.3
Child Lexical Diversity Weekend	83.55	66.267	57.5	40.567
BTBC-3	45.45	36.101	16.21	20.238
PPVT-4	42.027	32.80	19.65	19.65

Aided Pure Tone Average

Pearson correlations were used to examine whether the aided pure tone average for the right ear were related to the quality of language variables for the adult and child as well as performance on the *BTBC-3* and *PPVT-4.* The data indicated that there were no statistically

significant variables that were related. Additionally, the same was revealed for aided pure tone averages for the left ear.

Degree of Hearing Loss

To examine the effects of the degree of hearing loss on the quality of language for the adult and child as well as their knowledge of basic concepts and vocabulary, a one-way ANOVA was conducted. This one-way ANOVA consisted of 6 levels: normal, mild, moderate, moderate-severe, severe and profound. The results revealed that there were no statistically significant differences, which indicate that there was no main effect of degree of hearing loss in this study.

Presence of Additional Disabilities

This demographic characteristic was coded as "0" for no additional disability reported and "1" for yes when there was an additional disability recorded. To examine the effect of additional disabilities, an independent sample t-test was conducted. This test revealed that there were statistically significant differences in regards to the performance on the *BTBC-3,* t(22.499) = 2.955, $p = .007$ (equal variances not assumed). Post hoc analysis indicated that individuals with no additional disability ($M = 34.91$, $SD = 34.07$) performed higher on the *BTBC-3* than individuals with additional disabilities ($M = 10.75$, $SD = 7.5$). See Table 4.5.

Table 4.5

Group Differences Among Presence of Additional Disabilities

	No Additional Disability		Additional Disability	
	M	*SD*	*M*	*SD*
BTBC-3	34.91	34.07	10.75	7.5

Income

The demographic characteristic of income was coded as "1" for less than $10,000, "2" for $10,000-$29,999, "3" for $30,000-$49,999, "4" for $50,000-$69,999, "5" for $70,000-$89,999,

"6" for $90,000-$119,999, "7" for $120,000-$139,999, "8" for "$140,000 or more. A one-way ANOVA was conducted to examine the effects of income, which revealed that there were no statistically significant differences in regards to groups associated with income. Cost of living was considered by referring to the index provided by Lafakis and Cochrane (2010). This index provided an index of the median cost of living for the regions and cities across the U.S. Using this index, an additional variable labeled as Adjusted Income was created to account for cost of living across in the cities in New York, Missouri, and California. After including this new variable in the analysis, there were no statistically significant differences among income levels accounting for cost of living.

Parental Education–Mothers

Parental education for both the mother and father was coded as: "1" for some high school, "2" for high school, "3" for some college, "4" for associates degree, "5" for bachelor's degree, "6" for master's degree, "7" for doctoral degree, "8" for post-doc, "9" for unknown. A one-way ANOVA was conducted to examine the effects of parental education for the mother which revealed statistically significant differences among the following variables: child lexical diversity weekend, $F(4,18) = 3.214$, $p = .037$; child syntactical complexity weekend, $F(4,18) = 6.763$, $p = .002$; adult clausal complexity weekend, $F(4,18) = 4.738$, $p = .009$, and child clausal complexity weekend, $F(4,18) = 60.208$, $p < .001$.

It should be noted that for this variable, the groups were unequal and there was only one case of "doctoral degree". Therefore, the post-hoc analysis excluded this value. Post hoc analysis revealed the following results: children with mothers that obtained master's degrees ($M = 116.5$, $SD = 86.087$) had higher lexical diversity than those with bachelor's degrees ($M = 61.63$, $SD = 38.075$), associate's degree ($M = 49.33$, $SD = 20.551$), and some college ($M = 65.29$, $SD =$

50.763) on the weekend. Additionally, children with mothers that obtained master's degrees (*M* = 45, *SD* = 39.657) had higher syntactical complexity than those with bachelor's degrees (*M* = 28.63, *SD* = 26.349), associate's degree (*M* = 13, *SD* = 8.185), and some college (*M* = 30, *SD* = 21.4) on the weekend. Mothers with bachelor's degrees (*M* = 55.75, *SD* = 48.834) had higher clausal complexity in their language exposure than those with master's degree (*M* = 39.25, *SD* = 40.426), associate's degree (*M* = 45, *SD* = 29.462), and some college (*M* = 23.43, *SD* = 12.067) on the weekend. Children with mothers that obtained master's degree (*M* = 12.25, *SD* = 10.34) had higher clausal complexity than those with bachelor's degree (*M* = 4.75, *SD* = 5.12), associate's degree (*M* = 3.33, *SD* = 4.163), and some college (*M* = 5, *SD* = 6.633) on the weekend. See Table 4.6.

Table 4.6

Group Differences Among Maternal Education

	Master's		Bachelor's		Associate's		Some College	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Child Lexical Diversity Weekend	116.5	86.087	61.63	38.075	49.33	20.551	65.29	50.763
Child Syntactical Complexity Weekend	45	39.657	28.63	26.349	13	8.185	30	21.4
Adult Clausal Complexity Weekend	39.25	40.426	55.75	48.834	45	29.462	23.43	12.067
Child Clausal Complexity Weekend	12.25	10.34	4.75	5.12	3.33	4.163	5	6.633

Parental Education–Fathers.

A one-way ANOVA was conducted to examine the effects of parental education for the father which revealed that there were no statistically significant differences in regards to groups associated with paternal education.

Research Question 2

Is the quantity and quality of adult language related to the quantity and quality of child's language as well as their knowledge of vocabulary and basic concepts? Pearson correlations were conducted to examine whether these variables were related.

There were three major results from Research Question 2:

1. Quantity of the adult language was positively related to the quantity of the child language; whereas, in regards to the quality of adult's language, there were no significant relationships to the quantity or quality of the child's language as well as their knowledge of basic concepts and vocabulary.
2. Examination of the adult language variables indicated that the lexical diversity, syntactical complexity and clausal complexity were all related to each other. The variables associated with the quantity of language, AWC and CTC, were related as well. Furthermore, the child language variables of quality were related to each other across the weekday and weekend. The quantity of child vocalizations and MLU appeared to be related across the days of the week (weekday and weekend). Performance on the *BTBC-3* and the *PPVT-4* was strongly related.
3. There appeared to be a statistically significant difference in the quality of adult language exposure between the weekday and weekend. Specifically, the teacher's language was more diverse than the caregiver's in terms of lexical diversity, syntactical complexity and clausal complexity. In regards to the quantity of the adult language exposure, there was

no significant difference in the number of adult words or the number of conversational turns for the teachers and caregivers.

Preliminary Analysis

Upon examination of the dataset, it appeared the adult variables associated with the quality aspects of language input (lexical diversity, syntactical complexity, and clausal complexity) were strongly related to one another for each of the days (weekday and weekend. For instance, adult lexical diversity weekday was positively related to adult syntactical complexity weekday, $r(26) = .714$, $p < .001$ and adult clausal complexity weekday $r(26) = .584$, $p = .002$. Additionally, adult lexical diversity weekend was related to adult syntactical complexity weekend, $r(26) = .886$, $p < .001$; adult clausal complexity weekend, $r(26) = .727$, $p < .001$.

The same pattern was noticed for the child variables associated with the quality aspects of language. Child lexical diversity weekday was revealed to be strongly related to child syntactical complexity weekday, $r(26) = .850$, $p < .001$; child clausal complexity weekday, $r(26) = .697$, $p < .001$. The variable of child lexical diversity weekend was found to be related to the following variables: child syntactical complexity weekend, $r(26) = .923$, $p < .001$; and child clausal complexity weekend, $r(26) = .719$, $p < .001$. Given these particular patterns for both the adult and child variables, a composite score was created for each of the child and adult variables on each day; which translated to adult quality weekday, adult quality weekend, child quality weekday and child quality weekend. These composite scores were used in the subsequent analyses.

Research Question 2a

Is the quantity and quality of adult language related to the quantity components of child's language? The Bonferroni correction for the *p*-value was used, which was .05/10 = .005. The data indicated that CTC weekday was strongly related to CVC weekday, $r(26) = .849$, $p < .001$ and CTC weekend was reported to be strongly related to CVC weekend, $r(26) = .717$, $p < .001$. See Table 4.7.

Table 4.7

Correlations Among Quantity and Quality of Adult Language Related to the Quantity of the Child's Language

	1.AQ WEEK DAY	2.AQ WEEK END	3.AWC WEEK DAY	4.CTC WEEK DAY	5.AWC WEEK END	6.CTC WEEK END	7.CVC WEEK DAY	8.CVC WEEK END	9.MLU WEEK DAY	10.MLU WEEK END
1	1									
2	.274	1								
3	.174	.184	1							
4	-.086	-.005	.685**	1						
5	-.004	.357	.241	.236	1					
6	.191	.409†	.414†	.351	.738**	1				
7	-.102	-.002	.450†	.849**	.140	.216	1			
8	.202	.215	.411†	.392†	.228	.717**	.453†	1		
9	.080	-.160	.365	.274	-.221	-.042	.423†	.365	1	
10	.185	-.059	.499†	.231	-.108	.128	.298	.370	.661**	1

Notes. AQ = adult quality; AWC = adult word count; CTC = conversational turn count; CVC = child vocalization count; MLU = mean length of utterance. ***p* < .001. **p* < .05; † refers to correlations with p − values that are < .05 but greater than the Bonferroni correction.

Research Question 2b

Is the quantity and quality of adult language related to the quality of child's language? The Bonferroni correction for the *p*-value was used, which was .05/8 = .00625. The data indicated that there were no significant relationships between the adult language variables and the child quality variables. See Table 4.8.

Table 4.8

Correlations Among the Quantity and Quality of Adult Language Related to the Quality of the Child's Language

	1.AQ WEEK DAY	2.AQ WEEK END	3.AWC WEEK DAY	4.CTC WEEK DAY	5.AWC WEEK END	6.CTC WEEK END	7.CQ WEEK DAY	8.CQ WEEK END
1	1							
2	.274	1						
3	.174	.184	1					
4	-.086	-.005	.685**	1				
5	-.004	.357	.241	.236	1			
6	.191	.409†	.414†	.351	.738**	1		
7	.186	-.136	.496†	.439†	-.142	.101	1	
8	.337	.267	.428†	.183	.052	.263	.604**	1

Notes. AQ = adult quality; AWC = adult word count; CTC = conversational turn count; CQ = child quality.
***p* < .001. **p* < .05; † refers to correlations with p − values that are < .05 but greater than the Bonferroni correction.

Research Question 2c

Is the quantity and quality of adult language related to the child's knowledge of vocabulary and basic concepts? The Bonferroni correction for the *p*-value was used, which was .05/8 = .00625. The data indicated that there were no significant relationships between the adult language variables and the child's knowledge of basic concepts and vocabulary. See Table 4.9.

Table 4.9

Correlations Among Quantity and Quality of Adult Language Related to the Child's Knowledge of Vocabulary and Basic Concepts

	1.AQ WEEK DAY	2.AQ WEEK END	3.AWC WEEK DAY	4.CTC WEEK DAY	5.AWC WEEK END	6.CTC WEEK END	7.BTBC	8.PPVT
1	1							
2	.274	1						
3	.174	.184	1					
4	-.086	-.005	.685**	1				
5	-.004	.357	.241	.236	1			
6	.191	.409†	.414†	.351	.738**	1		
7	.358	.058	.265	.112	.160	.313	1	
8	.296	.022	.307	.062	-.022	.247	.838**	1

Notes. AQ = adult quality; AWC = adult word count; CTC = conversational turn count; BTBC= Boehm Test of Basic Concepts; PPVT = Peabody Picture Vocabulary Test. ** $p < .001$. * $p < .05$; † refers to correlations with p-values that are <.05 but greater than the Bonferroni correction.

Additional Significant Correlations

Adult quality weekday was positively related to CTC weekend, $r(26) = .409$, $p = .038$. AWC weekday was strongly related to CTC weekday, $r(26) = .685$, $p < .001$ as well as CTC weekend, $r(26) = .414$, $p = .035$. CTC weekend was also related to AWC weekend, $r(26) = .738$, $p < .001$. CVC weekday was strongly related to CVC weekend, $r(26) = .453$, $p = .020$ as well as MLU weekday, $r(26) = .423$, $p = .032$. MLU weekday was related to MLU weekend, $r(26) = .661$, $p < .001$. The child quality variable on the weekday was related to the child quality variable on the weekend, $r(26) = .604$, $p = .001$. The *BTBC-3* was strongly related to the performance on the *PPVT-4*, $r(26) = .838$, $p < .001$.

The following correlations were found with p-values that are less than .05 but they were referred to as not significant under the Bonferroni correction: AWC weekday and CVC weekday, $r(26) = .450$, $p = .021$; AWC weekday and CVC weekend, $r(26) = .411$, $p = .037$; AWC weekday and MLU weekend, $r(26) = .499$, $p = .009$; CTC weekday and CVC weekend, $r(26) = .392$, $p = .048$; AWC weekday and child quality weekday, $r(26) = .496$, $p = .010$; AWC weekday and child quality weekend, $r(26) = .428$, $p = .029$; as well as CTC weekday and child quality weekday, $r(26) = .439$, $p = .025$.

Research Question 2d

Is there a difference in teacher or caregiver input in regards to the quantity and quality of language? Each participant had quantity *and* quality measures for teacher (i.e., weekday) and caregiver (i.e., weekend) language input; therefore, this was a within-subject measure, which allowed for paired-sample *t*-tests to be used to examine the differences between the teacher and caregiver language input.

Quality of language measures. The paired sample t-test revealed that there was a statistically significant difference between adult lexical diversity weekday (teacher; $M = 321.58$, $SD = 73.58$) and adult lexical diversity weekend (caregiver; $M = 233$, $SD = 105.56$), $t(25) = 3.949$, $p = .001$; adult syntactical complexity weekday (teacher; $M = 269.27$, $SD = 102.64$) and adult syntactical complexity weekend (caregiver; $M = 153.88$, $SD = 114.45$), $t(25) = 4.559$, $p < .001$; adult clausal complexity weekday (teacher; $M = 72.92$, $SD = 33.83$) and adult clausal complexity weekend (caregiver; $M = 48.35$, $SD = 46.46$), $t(25) = 2.370$, $p = .026$.

Quantity of language measures. The paired sample t-test found that there were no statistically significant differences between AWC weekday and AWC weekend as well as CTC weekday and CTC weekend.

Summary

The results of this study indicated that there were several demographic factors that were related to the quality of adult and child's language as well as the child's knowledge of basic concepts and vocabulary. Additionally, the quantity of language (as measured by number of conservational turns) was positively related to the quantity of the child's language (number of child vocalizations). Relationships between the quality of adult language and quality of child language was not observed. Moreover, significant differences in the quantity of adult language was reported among the teachers and caregivers.

Chapter 5

Discussion

Overview

Language development is a topic of interest regarding child development, particularly among children with sensory deprivation such as hearing loss. However, technological advances have redefined auditory experiences as well as educational outcomes in children with hearing loss (Cole & Flexer, 2007); therefore, it has become pertinent to evaluate the elements surrounding language development for these children such as the language environments. In terms of language environments, researchers have reported that quantity of language, or the amount of language, and quality of language, or the diversity of language, are two contributing factors that influence children's language development (e.g., Greenwood et al., 2011; Hart & Risley, 1995; Hoff & Naigles, 2002; Hoff-Ginsberg, 1986, 1991; Hoff-Ginsberg & Shatz, 1982; Huttenlocher et al., 1991, 2010, Pan et al., 2005; Soderstrom & Wittebolle, 2013; Vasilyeva et al., 2008). For children with hearing loss, similar results have been reported (e.g., Ambrose et al., 2014; Aragon & Yoshinaga-Itano, 2012; Carr, et al., 2014; Caskey & Vohr, 2013; Farran, Lederberg, & Jackson, 2009; Sacks et al., 2013; VanDam et al., 2012, 2015; Vohr et al., 2013; Wiggin et al., 2012). Given that language exposure has the potential to influence language development and later academic skills, it is imperative that researchers continue to explore facets related to language environments that can help enhance intervention tools and produces. As a result, the missing link in the literature to date, is the examination of both *quantity* and *quality* components to language environments through adult language input and the possible relationship

it has to the child's quantity and quality of language production and their knowledge of basic concepts and vocabulary.

The goal of this study is to explore these constructs within the population of children who are d/DHH and to identify characteristics that can inform educational and intervention practices to further close the gaps, across developmental domains, between children who are d/DHH and those who are typically developing. This study is guided by the following research questions: 1) What demographic characteristics (i.e., age, gender, type of hearing loss, type of amplification, aided pure tone average and degree of hearing loss, presence of additional disability, socio-economic status, and parent education) of the participants are related to the quality of adult input, quality of child language, child's vocabulary, and child's understanding of basic concepts? 2) Is the quantity and quality of adult language related to the quantity and quality of child's language as well as their knowledge of vocabulary and basic concepts?

Overall, the results indicate that adult language input is related to the language development of children who are d/DHH. More specifically, there appear to be a relationship between the quantity of the adult language and the quantity of the child language. Interestingly, the notion that the quality of language input is related to the quality of the child's language is not realized in this study. This chapter will continue to address the following: the results related to each research question, implications of the study, the study's limitations and then future directions for research.

Summary of the Results

Research Question 1

In this study, age, type of amplification in the left and right ear, additional disabilities, as well as parent education for the mothers and fathers were the demographics related to the quality

of the adult and child language in addition to the child's knowledge of basic concepts and vocabulary. Interestingly, type of hearing loss, aided PTA, degree of hearing loss, and income were not significantly related to the quality components of the adult and child language as well as performance on basic concepts and vocabulary assessments.

In contrast to the hypothesis mentioned in Chapter 2, there was also no significant relationship between age and the quality of the adult language. There was a significant relationship between age and the quality of the child's language as well as the quantity of the child's language. Rowe (2012) discussed the potential critical period in which quantity and quality of language may have a stronger influence in regards to language development among children with typical hearing. Given the results from this study, it could be inferred that due to potential challenges in language development that these children could be facing, the critical period that Rowe mentioned could arise at a later age compared to their hearing peers.

The results agreed with the hypothesis that there is no significant relationship between gender and the quality of the child's language as well as the performance on the *BTBC-3* and *PPVT-4*. However, interestingly, there was a relationship with the quality of adult language in regards to clausal complexity on the weekday. Given that there is only one significant component of the quality of adult language that is found to be related to gender, it is difficult to attempt at an explanation. Furthermore, in regards to type of hearing loss, the hypothesis was confirmed that there is a significant difference among types of hearing loss and the quality of the child's language. Specifically, this was only found for child's lexical diversity on the weekend. Similar to the results reported for gender, this is only one component of quality of language; therefore, it is nearly impossible to generalize these results as well as provide an explanation.

The results from this study confirmed the hypothesis in that there was a significant relationship between the type of amplification in the right ear and the quality of child and adult language. This indicated that the type of amplification might influence language environments and auditory perceptions of that environment; however, this study did not allow for conclusive statements to be made regarding the differences found among cochlear implants and hearing aids. Given that there were differences that did not support the hypothesis made regarding type of amplification, further investigation in future studies is pertinent to make sense of potential factors that might moderate the effect of language environments on language development in children who are d/DHH. Previous research (e.g., Yoshinaga-Itano et al., 2010) has indicated that children with CI have made bigger strides towards closing the gap between them and their hearing peers in regards to language development. The results from this study appeared to deviate from those findings, which could be due to age of implantation, hearing age, aided PTA, as well as amount and quality of intervention.

It is not surprising that presence of additional disabilities was significantly related to the child's language, but interestingly, it is only related to the performance on the *BTBC-3*. This particular finding could be related to the fact that additional disabilities may influence the perception of language and processing of concepts that even children who are typically developing struggle to acquire (Bracken & Cato, 1986; Boehm, 1971; Davis, 1974; Harrington et al., 2009). Additionally, the results regarding maternal education level was in line with the hypotheses listed in Chapter 2. The significant differences among the maternal education levels and the relationship in the quality of the language input as well as the quality of the child's language indicated that children from households that consisted of mothers with college education (e.g., bachelors, masters, and doctoral degrees) were more likely to be exposed to

more diverse language and to consequently produce diverse language in regards to lexicon, syntax, and clauses.

Research Question 2

The results aligned with the hypotheses listed in chapter 2, as the quantity of adult language was related to the quantity of the child language. Interestingly, the quality and quantity of the adult language was not related to the quality of the child language or to their knowledge of the basic concepts and vocabulary. The results highlighted and reinforced the literature in regards to the relationship between conversational turns and child's language (see review in Wang et al., 2017). Conversational turns refer to the amount of engagement, in other words, the back and forth conversation that facilitates language interaction, joint attention and, potentially, language development. The directional component to this relationship remains unclear in this study as we could theorize that conversational engagement led to more vocalizations by the child or that the more the child vocalized around the adult, the more the adult engaged and responded with language. Additionally, what separates this particular study from others is that it examines the relationship that quantity *and* quality has on the child's language development, given that quality of the adult language was related to the number of conversational turns indicates that amount of engagement can lead to higher quality language. Further investigation into this relationship is a pertinent.

This study examined differences in the language input of teachers and caregivers, which found that the language environments, in regards to the quality of language, were significantly different during interactions with teachers and caregivers. Comparable to the findings in Soderstrom and Wittebolle (2013) study, both language environments are quantitatively similar; however, the diversity and type of the language provide is what differs. This could be due to the

structured activity of snacktime; whereas, dinnertime for the families varied in terms of location and type of engagement. For instance, unstructured dinnertime that occurred while eating fast food in a car may look different in terms of interactions and language input compared to structured dinnertime sitting around a table. The opportunities to provide ample amounts of language and diverse language are presented but the structure of that time can influence the language environment.

Implications

The study has implications for teacher and caregiver interactions with children who are d/DHH. It highlights the understanding that language input, particularly engagement, plays a role in the development of the child's language. While this finding has been reinforced in past literature, this study maintains that engagement with children is critical even when other components of language input (i.e. diversity/complexity) are accounted for. This finding should encourage adults, especially teachers and caregivers, to be conscious of the amount of engagement or conversational interaction they have with children. By doing so, as supported by the findings in this study, the more opportunities the children will have to vocalize. As part of Tomasello's work (Tomasello, 1999, 2008; Tomasello & Carpenter, 2007), joint attention is a key facet of language development. As adults and children engage in conversational turns, this hones in on the key elements of joint attention as the individuals participating in conversations can provide language and vocalizations, which, with consistency, builds the child's language as well as their knowledge of basic concepts and vocabulary.

Furthermore, the study calls to attention the discrepancies in the diversity and complexity of the language provided by teachers and caregivers. This particular discrepancy is noted for the quantity of language components as opposed to the quality components of language. That is,

there was no significant difference between the amount (quantity) of language input for teachers (i.e., weekday) vs. caregivers (i.e., weekend); whereas there was a statistically significant difference between teachers and caregivers in terms of lexical diversity, syntactical complexity, and clausal complexity. Basically, although teachers talked to children in same amount of language as the caregivers, teachers used much diverse and complicated language. One consideration to note the effects of the setting may have on the language used by the adults. For instance, the academic setting of a classroom could be regarded as 'formal' in which the language may follow the formality of the setting or a certain pattern as suggested by Cullen (1998). In other words, the formal language used by teachers in this setting may lead to language that is richer in terms to the quality of language input such as lexical diversity, syntactical complexity and clausal complexity.

Most interestingly, although, not surprisingly, the quantity of adult language inputs positively related to the quantity of child language inputs, there was no relationship between quality of adult language inputs and the child's language, as it has been found in previous studies with typically developing children (e.g., Huttenlocher et al., 2010). It is possible that children who are d/DHH require different quality of adult language inputs than their typically developing peers. Or, it is possible that our adopted definition on quality of language from Huttenlocher et al. (2010), that is, lexical diversity, syntactical complexity and clausal complexity, might not be sensitive enough to catch the quality of language. For instance, Gámez and Levine (2013)'s coding guidelines and analysis indicated that the quality of the teacher's language was related to English language learners' expressive language skills. Inconsistency among the definitions and measures could explain the surprising results in the literature. Maybe, instead of the language diversity/complexity, it is the content of the adult language input, that is, sensitivity and

responsiveness to the child (e.g., Hirsh-Pasek et al., 2015) that really matters. For example, Leigh, Nievar and Nathans (2011) found that there was longitudinal component to how maternal sensitivity and responsiveness can impact later language development in children.

Another possibility to consider is that language ability of these children may factor into the potential impact that quality of language input has on their language development. Vygotsky's (1978) concept of ZPD reinforces the notion that language input that is provided within these limits creates an optimal language environment. Perhaps, given the language ability or skills that these children with hearing loss have, quantity of language is more influential than quality of language at this stage. Rowe (2012) purports that quantity of language input is significant during the child's 2nd year of life and then quality of language input becomes significant during the 3rd year of life. However, this statement is applied to individuals that considered to be typically developing. Therefore, among populations that are at risk for language delays, such as those with hearing loss, we may need to consider their language skills as opposed to their age.

Aragon and Yoshinaga-Itano (2012) suggested creating a "super language learning environment" to close the gap between d/DHH children and those who are typically developing (p. 350). The results in this study begs the question of in addition to or perhaps a precursor to "super language learning environment", that consistency across environments in terms to quantity and quality of language input may provide greater number of opportunities for children who are d/DHH to perceive and attend to language components that could affect their language development.

Limitations of the Study

Despite the interesting findings that were presented in this study, the limitations that need to be addressed include: 1) the number of participants, 2) the limitations of LENA technology, and 3) the measurement for quality of language. The number of participants in this study was low (n = 26) which highlighted a persistent issue in research pertaining to d/DHH. Given that this particular population of children is a low-incidence disability, it can be a challenge to recruit children and families that fit in to the inclusion criteria. As mentioned before, deafness presents itself heterogeneously among its population; therefore, recruiting participants for this study spanned three programs in three different states (NY, CA and MO). Furthermore, the sample of d/DHH included in this study were children who were monolingual English speakers, which by nature excludes a substantial amount of potential participants that identify themselves as culturally and linguistically diverse. This study should be replicated on a larger scale that is more representative of the larger d/DHH population.

Additionally, due to the nature of the LENA technology and its data collection procedures, only spoken language from the adults and children were recorded and examined. As a result, there is limited information to analyze in regards to language input and language development. For instance, the non-verbal components to language such as facial expressions, body language, sign language, gestures, eye contact, and etc. is not collected and remains a crucial component to language input as well as language perception and development. Therefore, the analysis presented in this study does not offer conclusive and definitive results pertaining to language input and language development. However, the results highlight key components to language development that need to be considered in improving outcomes across individuals and settings.

Last, as discussed previously, with its emphases on language diversity/complexity, our measurement for quality of language might not capture what really matters in adult language input; that is, what matters in the quality of adult language input might be the sensitivity and responsiveness to the child instead of language diversity/complexity.

Future Directions

Given the small sample size associated with this study, future studies should replicate it on a larger scale. In doing so, some of the hypotheses that were not found to be true in this study could have different results. Additionally, the LENA technology provides a convenient tool of collecting language samples, however, it limits the data to just verbal components. Future research should consider video components or other methodology that accounts for non-verbal elements of language. In doing so, the data gives a holistic approach to the language environment and encompasses facets to language interactions that have been missing in the previous literature such as body language, facial expressions, gestures, signs, and etc. Another component that could be explored and examined is to measure the quality of adult language by the sensitivity and responsiveness to the child instead of the language diversity/complexity.

Additionally, the findings from this study suggests differences in language input and language development among hearing aid and cochlear implant users, specifically in terms of the quality of language input, the quality and quantity of the child's language as well as their knowledge of basic concepts and vocabulary. Given the unequal groups and variations, the data is inconclusive regarding these differences, therefore this warrants further investigation in future studies. Within the comparison component of this study related to the teachers and caregivers, teacher demographics were not collected and reported in this study. Further investigation or comparisons of teacher and caregiver language environments should account for demographics

such as years of experience and hearing status. In doing so, the parent-centered intervention as well as professional development offered to educators can then provide tools and supports to enhance the educational experience and academic outcomes of children who are d/DHH.

References

Ambrose, S. E., VanDam, M., & Moeller, M. P. (2014). Linguistic input, electronic media, and communication outcomes of toddlers with hearing loss. *Ear and Hearing*, *35*(2), 139–147.

Aragon, M., & Yoshinaga-Itano, C. (2012). Using Language ENvironment Analysis to improve outcomes for children who are deaf or hard of hearing. *Seminars in Speech and Language*, *33*(4), 340–353.

Bjorkland, D. F. (2012). *Children's thinking: Cognitive development and individual differences* (5th ed.). Belmont, CA: Wadsworth.

Boehm, A. (1967). *The development of comparative concepts in primary school children*. (Unpublished doctoral dissertation). Columbia University, New York, NY.

Boehm, A. (1971). *Boehm test of basic concepts manual.* New York, NY: Psychological Corporation.

Boehm, A. (2001). *Boehm test of basic concepts—preschool* (3rd ed.). San Antonio, TX: Pearson.

Bowers, E. P., & Vasilyeva, M. (2011), The relation between teacher input and lexical growth of preschoolers. *Applied Psycholinguistics, 32*(1), 221–241.

Bowers, L. M., & Schwarz, I. (2013). Assessing response to basic concept instruction: Preliminary evidence with children who are deaf. *Communication Disorders Quarterly, 34*(4), 221–231.

Bracken, B. A. (1984). *Bracken basic concept scale.* Columbus, OH: Charles E. Merrill.

Bracken, B. A. (1998). *Bracken basic concept scale—revised.* San Antonio, TX: Psychological Corporation.

Bracken, B. A., & Cato, L. A. (1986). Rate of conceptual development among deaf preschool and primary children as compared to a matched group of non–hearing impaired children. *Psychology in the Schools, 23*(1), 95–99.

Bruner, J. S. (1983). *Child's talk: Learning to use language.* New York, NY: Norton.

Carr, J., Xu, D., & Yoshinaga-Itano, C. (2014). Language ENvironment Analysis Language and Autism Screen and the Child Development Inventory Social Subscale as a possible autism screen for children who are deaf or hard of hearing. *Seminars in Speech and Language 35*(4), 266–275.

Cartmill, E. A., Armstrong, B. F., Glietman, L. R., Goldin-Meadow, S., Medina, T.N., & Trueswell, J. C. (2013). Quality of early parent input predicts child vocabulary 3 years later. *Proceedings of the National Academy of Sciences of the United States of America, 110*(28), 11278–11283.

Caskey, M., Stephens, B., Tucker, R., & Vohr, B. (2011). Importance of parent talk on the development of preterm infant vocalizations. *Pediatrics*, *128*(5), 910–916.

Caskey, M., & Vohr, B. (2013). Assessing language and language environment of high-risk infants and children: A new approach. *Acta Paediatrica*, *102*(5), 451–461.

Chomsky, N. (1967). Recent contributions to the theory of innate ideas: Summary of oral presentation. *Synthese, 17*(1), 2–11.

Cohen, D. (2013). *How the child's mind develops* (2nd ed.). New York, NY: Routledge.

Cole, E., & Flexer, C. (2007). Children with hearing loss: Developing listening and talking birth to six. San Diego, CA: Plural Publishing.

Connor, C. M., Craig, H. K., Raudenbush, S. W., Heavner, K., & Zwolan, T. A. (2006). The age at which young deaf children receive cochlear implants and their vocabulary and speech-

production growth: Is there an added value for early implantation? *Ear and Hearing, 27*(6), 628–644.

Cruz, I., Quittner, A. L., Marker, C., DesJardin, J. L., & CDaCI Investigative Team. (2013). Identification of effective strategies to promote language in deaf children with cochlear implants. *Child Development, 84*(2), 543–559.

Cullen, R. (1998). Teacher talk and the classroom context. *ELT Journal, 52*(3), 179-187.

Davis, L. (1974). Performance of young hearing-impaired children on a test of basic concepts. *Journal of Speech and Hearing Research, 17*(1), 342–351.

DesJardin, J. L., & Eisenberg, L. S. (2007). Maternal contributions: Supporting language development in young children with cochlear implants. *Ear and Hearing, 28*(4), 456–469.

Dunn, L., & Dunn, D., (2007). *Peabody picture vocabulary test* (4th ed.). San Antonio, TX: Pearson.

Dykstra, J. R., Sabatos-DeVito, M. G., Irvin, D. W., Boyd, B. A., Hume, K. A., & Odom, S. L. (2012). Using the Language Environment Analysis (LENA) system in preschool classrooms with children with autism spectrum disorders. *Autism*, *17*(5), 582–594.

El-Hakim, H., Levasseur, J., Papsin, B. C., Panesar, J., Mount, R. J., Stevens, D., & Harrison, R. V. (2001). Assessment of vocabulary development in children after cochlear implantation. *Archives of Otolaryngology—Head and Neck Surgery, 127*(9), 1053–1059.

Fagan, M. K. (2016). Spoken vocabulary development in deaf children with and without cochlear implants. In M. Marschark & P. E. Spencer (Eds.), *The Oxford handbook of deaf studies in language* (pp. 132–145). New York, NY: Oxford University Press.

Fagan, M. K., & Pisoni, D. B. (2010). Hearing experience and receptive vocabulary development in deaf children with cochlear implants. *Journal of Deaf Studies and Deaf Education, 15*(2), 149–161.

Farran, L. K., Lederberg, A. R., & Jackson, L. A. (2009). Maternal input and lexical development: The case of deaf preschoolers. *International Journal of Language and Communication Disorders, 44*(2), 145–163.

Gámez, P. B., & Levine, S. C. (2013). Oral language skills of Spanish-speaking English-language learners: The impact of high-quality native language exposure. *Applied Psycholinguistics, 34*(1), 673–696.

Gilkerson, J., Richards, J. A., & Topping, K. J. (2015). The impact of book reading in the early years on parent-child language interaction. *Journal of Early Childhood Literacy.* Advance online publication. doi.org/10.1177/1468798415608907

Greenwood, C. R., Thiemann-Bourque, K., Walker, D., Buzhardt, J., & Gilkerson, J. (2011). Assessing children's home language environments using automatic speech recognition technology. *Communication Disorders Quarterly, 32*(2), 83–92.

Harrington, M., DesJardin, J. L., & Shea, L. C. (2009). Relationships between early child factors and school readiness skills in young children with hearing loss. *Communication Disorders Quarterly, 32*(1), 50–62.

Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Baltimore, MD: Brookes.

Hart, B., & Risley, T. R. (2003). The early catastrophe: The 30-million-word gap by age 3. *American Educator*, *27*(1), 4–9.

Hirsh-Pasek, K., Adamson, L. B., Bakeman, R., Owen, M. T., Golinkoff, R. M., Pace, A.,… Suma, K. (2015). The contribution of early communication quality to low-income child's language success. *Psychological Science, 26*(7), 1071–1083.

Hoff, E. (2003). The specificity of environmental influence: Socioeconomic status affects early vocabulary development via maternal speech. *Child Development, 74*(5), 1368–1378.

Hoff, E. (2006). How social contexts support and shape language development. *Developmental Review, 26*(1), 55–88.

Hoff, E. (2013). Interpreting the early language trajectories of children from low-SES and language minority homes: Implications for closing achievement gaps. *Developmental Psychology, 49*(1), 4–14.

Hoff, E., & Naigles, L. (2002). How children use input to acquire a lexicon. *Child Development*, 73(2), 418–433.

Hoff-Ginsberg, E. (1986). Function and structure in maternal speech: Their relation to the child's development of syntax. *Developmental Psychology, 22*(2), 155–163.

Hoff-Ginsberg, E. (1991). Mother-child conversation in different social classes and communicative settings. *Child Development, 62*(4), 782–796.

Hoff-Ginsberg, E., & Shatz, M. (1982). Linguistic input and the child's acquisition of language. *Psychological Bulletin, 92*(1), 3–26.

Huttenlocher, J., Haight, W., Bryk, A., Seltzer, M., & Lyons, T. (1991). Early vocabulary growth: Relation to language input and gender. *Developmental Psychology, 27*, 236–248.

Huttenlocher, J., Vasilyeva, M., Waterfall, H. R., Vevea, J. L., & Hedges, L. (2007). The varieties of speech to young children. *Developmental Psychology, 43*(5), 1062–.1083.

Huttenlocher, J., Waterfall, H., Vasilyeva, M., Vevea, J., & Hedges, L. (2010). Sources of variability in children's language growth. *Cognitive Psychology*, *61*, 343–365.

Jackson, C. W., & Callender, M. F. (2014). Environmental considerations: Home and school comparison of Spanish–English speakers' vocalizations. *Topics in Early Childhood Special Education*, *34*(3), 165–174.

Kaufman, A. S. (1978). The importance of basic concepts in the individual assessment of preschool children. *Journal of School Psychology, 16*(3), 207–211.

Lafakis, C., & Cochrane, S. G. (2010, May). U.S. metro cost of living index update. *Regional Financial Review,* pp. 26–84.

Lederberg, A. R., & Everhart, V. S. (1998). Communication between deaf children and their hearing mothers: The role of language, gesture, and vocalization. *Journal of Speech, Language, and Hearing Research, 41*(1), 887–899.

Lederberg, A. R., & Everhart, V. S. (2000). Conversations between deaf children and their hearing mothers: Pragmatic and dialogic characteristics. *Journal of Deaf Studies and Deaf Education, 5*(4), 303–322.

Lederberg, A. R., & Spencer, P. (2009). Word learning abilities in Deaf and hard of hearing preschoolers: Effect of lexicon size and language modality. *Journal of Deaf Studies and Deaf Education, 14*(1). 44–62.

Leigh, P., Nievar, M. A., & Nathans, L. (2011). Maternal sensitivity and language in early childhood: A test of the transactional model. *Perceptual and Motor Skills, 113*(1), 281–299.

Li, L., Vikani, A. R., Harris, G. C., & Lin, F. R. (2014). Feasibility study to quantify the auditory and social environment of older adults using a digital language processor. *Otology and Neurotology*, *35*(8), 1301–1305.

Lund, E. (2016). Vocabulary knowledge of children with cochlear implants: A meta-analysis. *Journal of Deaf Studies and Deaf Education, 21*(2), 107–121.

Lund, E., & Schuele, C. M. (2015). Synchrony of maternal auditory and visual cues about unknown words to children with and without cochlear implants. *Ear and Hearing, 36*(2), 229–238.

Miller, P. H. (2014). Piaget's theory: Past, present, and future. In U. Goswami (Ed.), *The Wiley-Blackwell handbook of childhood cognitive development* (2nd ed., pp. 649–672). Malden, MA: John Wiley & Sons.

Mitchell, R. E., & Karchmer, M. A. (2004). Chasing the mythical 10 percent: Parental hearing status of deaf and hard of hearing students in the United States. *Sign Language Studies, 4*(2), 138–163.

Mullen, E. M. (1995). *Mullen scales of early learning.* Circle Pines, MN: American Guidance Service.

National Reading Panel. (2000). *Report of the National Reading Panel: Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction.* Jessup, MD: National Institute for Literacy at EDPubs.

Pan, B. A., Rowe, M. L., Singer, J. D., & Snow, C. E. (2005). Maternal correlates of growth in toddler vocabulary production in low-income families. *Child Development, 76*(4), 763–782.

Panter, J. E. (2000). Validity of the Bracken Basic Concept Scale–Revised for predicting performance on the Metropolitan Readiness Test–Sixth Edition. *Journal of Psychoeducational Assessment*, *18*, 104–110.

Paul, P. (2001). *Language and deafness* (3rd ed.). San Diego, CA: Singular Publishing Group.

Paul, P., Wang, Y., & Williams, C. (2013). *Deaf students and the qualitative similarity hypothesis: Understanding language and literacy development.* Washington, DC: Gallaudet University Press.

Rowe, M. (2012). A longitudinal investigation of the role of quantity and quality of child-directed speech in vocabulary development. *Child Development, 83*(5), 1762–1774.

Rufsvold, R., Wang, Y., Hartman, M., Arora, S., & Smolen, E. (2018). The impact of language input on deaf and hard-of-hearing preschool children who use listening and spoken language. *American Annals of the Deaf, 163*(1), 35-60.

Sacks, C., Shay, S., Repplinger, L., Leffel, K. R., Sapolich, S. G., Suskind, E.,... Suskind, D. (2013). Pilot testing of a parent-directed intervention (Project ASPIRE) for underserved children who are deaf or hard of hearing. *Child Language Teaching and Therapy*. Advance online publication. doi:10.1177/0265659013494873

Soderstrom, M., & Wittebolle, K. (2013). When do caregivers talk? The influences of activity and time of day on caregiver speech and child vocalizations in two childcare environments. *PloS One*, *8*(11), e80646.

Steinbauer, E., & Heller, M. S. (1978). The Boehm Test of Basic Concepts as a predictor of academic achievement in grades 2 and 3. *Psychology in the Schools, 15*(3), 357–360.

Suskind, D., Leffel, K. R., Hernandez, M. W., Sapolich, S. G., Suskind, E., Kirkham, E., & Meehan, P. (2013). An exploratory study of "quantitative linguistic feedback": Effect of LENA feedback on adult language production. *Communication Disorders Quarterly, 34*(4), 199–209.

Thiemann-Bourque, K. S., Warren, S. F., Brady, N., Gilkerson, J., & Richards, J. A. (2014). Vocal interaction between children with Down syndrome and their parents. *American Journal of Speech-Language Pathology*, *23*(3), 474–485.

Tomasello, M. (1999). *The cultural origins of human cognition.* Cambridge, MA: Harvard University Press.

Tomasello, M. (2008). Origins of human communication. Cambridge, MA: MIT Press.

Tomasello, M., & Carpenter, M. (2007). Shared intentionality. *Developmental Science, 10*(1), 121–125.

Trezek, B., Wang, Y., & Paul, P. (2010). *Reading and deafness: Theory, research, and practice.* Clifton Park, NY: Cengage Learning.

VanDam, M., Ambrose, S. E., & Moeller, M. P. (2012). Quantity of parental language in the home environments of hard of hearing 2-year-olds. *Journal of Deaf Studies and Deaf Education, 17*(4), 402–420.

VanDam, M., Oller, D. K., Ambrose, S. E., Gray, S., Richards, J. A., Xu, D.,... Moeller, M. P. (2015). Automated vocal analysis of children with hearing loss and their typical and atypical peers. *Ear and Hearing*, *36*(4), e146–e152.

Vasilyeva, M., Waterfall, H., & Huttenlocher, J. (2008). Emergence of syntax: Commonalities and differences across children. *Developmental Science, 11*(1), 84–97.

Vohr, B., Topol, D., Watson, V., St. Pierre, L., & Tucker, R. (2013). The importance of language in the home for school-age children with permanent hearing loss. *Foundation Acta Paediatrica, 103,* 62–69.

Vygotsky, L. V. (1978). Interaction between learning and development. In *Mind and society* (pp. 79–91). Cambridge, MA: Harvard University Press.

Wang, Y., Hartman, M., Abdul-Aziz, N., Arora, S., Shi, L., & Tunison, E. (2017). A systematic review on the use of LENA technology. *American Annals of the Deaf, 162*(3), 295–311.

Wang, Y., Kretschmer, R., & Hartman, M. (2008). Reading and students who are d/Deaf or hard of hearing. *Journal of Balanced Reading Instruction, 15*(2), 53–68.

Warren, S. F., Gilkerson, J., Richards, J. A., Oller, D. K., Xu, D., Yapanel, U., & Gray, S. (2010). What automated vocal analysis reveals about the vocal production and language learning environment of young children with autism. *Journal of Autism and Developmental Disorders*, *40*(5), 555–569.

Wiggin, M., Gabbard, S., Thompson, N., Goberis, D., & Yoshinaga-Itano, C. (2012). The school-to-home link: Summer preschool and parents. *Seminars in Speech and Language*, *33*(4), 290–296.

Xu, D., Yapanel, U., & Gray, S. (2009). *Reliability of the LENA Language Environment Analysis system in young children's natural home environment.* (Technical Report LTR-05-2). Retrieved from: https://www.lena.org/wp-content/uploads/2016/07/LTR-05-2_Reliability.pdf

Yoshinaga-Itano, C., Baca, R. L., & Sedey, A. L. (2010). Describing the trajectory of language development in the presence of severe to profound hearing loss: A closer look at children with cochlear implants versus hearing aids. *Otology and Neurotology, 31*, 1268–1274.

Zimmerman, I.L., Steiner, V.G., & Pond, R.V. (2002). *Preschool language scale* (4th ed.). San Antonio, TX: Psychological Corporation.

Appendix A

Table of Adjusted Income Levels Based on Cost of Living

INCOME LEVELS	NEW YORK (COL INDEX:1.268)	MISSOURI (COL INDEX: .901)	CALIFORNIA (COL INDEX: 1.042)
< $10,000	<$7,800	<$11,100	<$9,560
$10,000-29,999	$7,800-23,660	$11,100-33,300	$9,560-28,790
$30,0000-49,999	$23,660-39,430	$33,300-55,490	$28,790-47,980
$50,000-69,999	$39,430-55,210	$55,490-77,700	$47,980-67,180
$70,000-89,9999	$55,210-70,980	$77,700-99,890	$67,180-86,370
$90,000-119,999	$70,980-94,640	$99,890-133,190	$86,370-115,160
$120,000-139,999	$94,640-110,410	$133,190-155,380	$115,160-134,360
>$140,000	>$110,410	>$150,380	>$134,360

Note. COL = cost of living.

Appendix B

DEMOGRAPHIC QUESTIONNAIRE

Principal Investigator: Sonia Arora, M.S.
Research Title: *The Impact of the Quality and Quantity of Language Input on the Language Development of Auditory Oral Preschool Children with Hearing Loss*
Address: 509 W. 121St Street #207, New York, NY 10027
Phone: 913-226-1877

1. Child's Name: _____
2. Child's Birthdate (Month Day, Year) _____
3. Gender: _____
4. Birth order: (first, second, third, etc.) _____
5. Degree of Hearing Loss:

   Normal mild moderate moderate-severe severe profound
6. Type of hearing loss:

   Conductive mixed sensorineural neural
7. Aided hearing thresholds (pure tone average) Please provide most recent aided audiogram.

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

   Father: _____ Mother: _____
9. 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

10. 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

11. Is there an additional diagnosed disability: Yes No

If yes, please indicate:

_____

12. 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:_____