

Photocopy and Use Authorization

In presenting this thesis in partial fulfillment of the requirements for an advanced degree at Idaho State University, I agree that the Library shall make it freely available for inspection. I further state that permission for extensive copying of my thesis for scholarly purposes may be granted by the Dean of the Graduate School, Dean of my academic division, or by the University Librarian. It is understood that any copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Signature _____

Date _____

Caregiver Input to Infants Who Are Typically Developing Versus Those at Risk

By

Rebecca Fost

A thesis to be

submitted in partial fulfillment

of the requirements for the degree of

Master of Science in the Department of Communication Sciences and Disorders

Idaho State University

May 2021

Committee Approval

To the Graduate Faculty:

The members of the committee appointed to examine the thesis of REBECCA FOST find it satisfactory and recommend that it be accepted.

Heather Ramsdell-Hudock, Major Advisor

Alycia Cummings, Committee Member

Gina Clarkson, Graduate Faculty Representative

Table of Contents

List of Figures.....	iv
List of Tables	v
Abstract.....	vi
Chapter 1: Introduction.....	1
Importance of Language Development	2
Caregiver Linguistic Input.....	4
Measurement of Quantity and Quality	10
Purpose	10
Chapter 2: Methods	13
Participants	13
Materials and Procedure	15
Design.....	17
Chapter 3: Results.....	18
Chapter 4: Discussion.....	20
Clinical Implications	23
Study Limitations	24
Future Directions	26
Chapter 5: Conclusion	28
References	29

List of Figures

Figure 1 Quantity and Quality of Caregiver Linguistic Input Directed to Infants.....	20
--	----

List of Tables

Table 1 Participant Information	14
Table 2 Average Number of Variables Across Infants Per Developmental Status and Age.....	18
Table 3 Summary Statistics and Results from MANCOVA	19

Caregiver Input to Infants Who Are Typically Developing Versus Those at Risk

Thesis Abstract - Idaho State University (2021)

Caregiver linguistic input to infants has been shown to predict later speech and language abilities. Children who receive more language exposure will show superior language abilities later in life in comparison to peers from language deprived environments. The purpose of this study was to explore similarities/differences in the quantity (total words and total number of utterances) and quality (number of different words and word types - nouns, verbs, and adjectives) of caregiver linguistic input to infants who were typically developing versus those who were at risk for speech/language delay/disorder given pre- or peri-natal difficulties, ear/nose/throat problems, swallowing complications, and/or familial history of speech and/or language disorders. With an archived dataset of 14 caregiver/infant dyads (7 infants who were typically developing and 7 infants who were at risk), we tracked caregiver linguistic input directed to each infant in monthly video recordings from 7 to 18 months of age. It was hypothesized that there would be differences in caregiver linguistic input to infants dependent upon infant developmental classification. Results indicated a statistical significance, with groups differing such that caregivers of infants who were at risk produced more words, different words, utterances, nouns, verbs, and adjectives than caregivers of infants who were typically developing. Findings can be used by speech-language pathologists to help strengthen caregiver education on the importance of linguistic input. Clinical implications, study limitations, and future directions will be discussed.

Key Words: caregiver linguistic input, infants, quantity, quality, typically developing, at risk

Chapter 1: Introduction

Caregiver Input to Infants Who Are Typically Developing Versus Those at Risk

The amount of caregiver linguistic input to infants has been shown to predict later language abilities in children (Ambrose et al., 2015; Bontinck et al., 2018; Brady et al., 2004; Chericoni et al., 2016; Goldstein & Schwade, 2008; Iyer et al., 2016; McDuffie & Yoder 2010; Weisleder & Fernald, 2013; Windsor et al., 2007), but caregiver input is not always effectively and independently implemented in the infant's natural environment (e.g., home). Caregivers who communicate often with their infants using a wide variety of vocabulary at home would provide linguistic input and a rich language environment. More exposure to child-directed speech provides children with exemplars for learning new vocabulary (Ambrose et al., 2015); thus supporting vocabulary learning (Weisleder & Fernald, 2013). Children who are not exposed to such language learning opportunities often show inferior language abilities later in life in comparison to peers from language rich environments (Windsor et al., 2007). Given the link between caregiver linguistic input and language growth, we chose to explore the quantity (number of total utterances and number of total words) and quality (number of different words and word types - nouns, verbs, and adjectives) of caregiver linguistic input directed to infants who are typically developing versus those who are at risk¹ for future speech/language delay/disorder. Is caregiver input different dependent upon infant development classification as typical or at risk? The response to this question could inform strategies to coach caregivers on how to interact with their infants to support development.

¹ For the purposes of this project, infants were considered at risk for a future speech/language delay/disorder if they experienced one or more of the following conditions prior to 7 months of age: pre- and perinatal problems; ear, nose, and throat problems; swallowing/sucking problems; and/or an immediate family history of speech and/or language problems (Brady et al., 2004; Goldstein & Schwade, 2008; McDuffie & Yoder, 2010).

Importance of Language Development

Speech-language pathologists (SLPs) provide services called early intervention to infants and toddlers from birth to 3 years of age who have or are at risk for a communication, speech and/or language, hearing, feeding, swallowing, and/or emergent literacy deficits. Clinicians and researchers emphasize the importance of early intervention to infants and toddlers who are at a high-risk and need to receive services. The earlier a child receives intervention, the greater the likelihood of communication development within normal limits (Paul & Roth, 2011). Woods and Wetherby (2003) stated that research has indicated early intervention before the age of 3 has a greater impact than providing services after the age of 5. The earlier a child receives intervention, the more likely they are to catch up to typically developing peers and perform within normal limits by school age, which will be paramount for academic success. These findings indicate the need to identify and provide intervention for children who are at risk for a speech/language disorder. For SLPs, increasing the evidence-based knowledge regarding factors that contribute to variability in language development could facilitate early identification at younger ages and more effective treatment approaches.

According to Duff and Tomblin (2018), development of speech and language skills are a child's most prominent accomplishments. Throughout school, they are expected to use language skills to help learn and communicate with peers. As such, the ability to learn and develop language are critical skills for spoken/written communication and social interaction during academic years. Children who struggle to develop these skills may experience "behavioral challenges, mental health problems, reading difficulties, and academic failure including high school dropout" (Prelock et al., 2008, p. 136). Further, young people with a history of language

difficulties are likely to enter adolescence with less social confidence than peers (Toseeb et al., 2017).

Moreover, determining early predictors of later reading skill is critical for academic success because children with poor reading skills in early elementary school rarely catch up to children with strong reading skills. In consideration of these issues, Durand et al. (2013) conducted a longitudinal study to explore speech, language, and cognitive skills in 223 children at 3 years of age in comparison to reading outcomes at 9 to 11 years of age. At age 3, the participants' receptive and expressive vocabulary, speech sounds, syntax, and cognition were measured with the *Peabody Picture Vocabulary Test-Revised* (Dunn, 1981), a conversational analysis, and the *McCarthy Scales of Children's Abilities* (McCarthy, 1972). From 9 to 11 years, the participants' ability to decode, oral reading fluency, and reading comprehension were measured with *The Woodcock Reading Mastery Test-Revised, Norms Updated* (Woodcock, 1987) and the median of words read in 1 minute. Speech, language, and cognitive skills at 3 years had a significant positive relationship with decoding skills from 9 to 11 years; all variables were related. Receptive vocabulary and expressive syntax also had a positive relationship with reading comprehension. Lastly, receptive vocabulary, expressive syntax, and speech sound maturity had a significant positive relationship with oral reading fluency. In conclusion, early speech, language, and cognitive skills are related to later reading abilities, such that those with superior early skill also demonstrate superior later skill. Accordingly, early detection of deficits, and associated support through treatment could prevent later reading disabilities (Durand et al., 2013), academic failure, and social deficits in children.

Caregiver Linguistic Input

Caregiver linguistic input to infants may provide a key factor contributing to variability in language development, and caregiver education related to the importance of infant-directed linguistic input could facilitate more effective treatment approaches for infants and young children. Windsor et al. (2007) considered the role of caregiver linguistic input indirectly through exploration of children growing up in environments deprived of linguistic input (institutional care facilities). Participants included 40 children from Romania who were 30 months of age; 10 raised in an orphanage, 10 in an orphanage for less than 5 months and later transferred to foster care, 10 in foster care for at least 1 year, and 10 raised by biological families. The children participated in 10 minutes of unstructured play activity using a standard set of toys. The 10-minute interactions were orthographically transcribed to determine lexical-grammatical skills and speech sound production. Lastly, biological caregivers and preferred or favorite caregivers in the orphanages (a certain caregiver identified as having a selective attachment to the child) completed a questionnaire called the *Receptive-Expressive Emergent Language Scale* (REEL; Bzoch & League, 1971) at 30 months in order to test the children's speech and language abilities from birth to 3 years. Results indicated that children who were raised in foster care or an orphanage showed substantial language delays compared to those who were raised by their biological family. Those children who were in foster care for at least a year showed similar outcomes to children who had never been in an institutional care facility (raised by biological family) for expressive and receptive language output, based on caregiver report from the REEL, but they showed lower expressive grammatical abilities (Windsor et al., 2007). Expressive grammatical abilities include total number of intelligible utterances, words, and consonants; number of different words; and mean length of utterance in words. In orphanages, opportunities

for social interaction were poor due to interactions only during diapering, bathing, and feeding. Further research is needed in order to determine the exact amount of language input children are receiving in such foster care or orphanage settings. Even though researchers do not know the amount of caregiver input received by children in these settings, the results indicated that children who were raised in an environment with less opportunities for interactions showed inferior language abilities compared to same age peers raised by biological families.

In addition to the quantity of caregiver linguistic input provided to infants, researchers have explored the quality of linguistic input directed to infants. Researchers sought to analyze the quantity and quality of a caregiver's input to children who are hard of hearing compared to children with normal hearing to help determine ways in which language input can contribute to differences in language outcomes (Ambrose et al., 2015). This study included 59 children (31 male, 28 female) with normal hearing and 156 children (85 male, 71 female) with bilateral, mild-to-severe hearing loss. At the age of 18-months and 3 years, each caregiver-child dyad engaged in a 5-minute structured conversational activity. For the activity, parents were given instructions to attract their child's attention to pictures in the room. After the parents introduced all of the pictures to their child, they were instructed to return their child's attention to their favorite and least favorite picture. The interactions between each dyad were then transcribed to look at the quantity and quality of the caregiver's language input. Quantity was a measure of the number of total utterances and number of total words spoken by caregivers, and quality was a measure of number of different words, mean length of utterance in morphemes, proportion of utterances that were high-level (e.g., terms of mental state or feeling such as "think", "guess", and "know"), and proportion of utterances that were directing the child's attention (e.g., "Look right here", "Say dog", "Count the balls", "No, don't touch that", etc.). In addition to the activity, at the 18-month

visit, parents completed the *Communication and Symbolic Behavior Scales- Developmental Profile, Caregiver Questionnaire* (Wetherby & Prizant, 2002) about their child's communication development. At the 3-year visit, a clinician administered the *Comprehensive Assessment of Spoken Language* (CASL; Carrow-Woolfolk, 1999) to assess semantic, syntactic, and pragmatic skills.

At the 18-month visit, caregivers of children who were hard of hearing directed more utterances to their children than caregivers of children with normal hearing. At the 3-year visit, there were similar numbers of utterances directed by caregivers to children in both groups, but a significant difference for number of total words. Children with hearing loss were exposed to fewer total words. Also, all qualitative variables were significantly lower for children who were hard of hearing at 18-months and 3-years. From the 18-months and the 3-year visit, children who were hard of hearing were exposed to fewer different words, shorter utterances, lower proportions of high-level utterances, and greater proportions of directing utterances. Children with a hearing loss were exposed to less quality interactions since they were exposed to utterances that were directing their attention, rather than high level utterances. The children with a hearing loss who were exposed to greater proportions of directing utterances at the 18-month visit had weaker language abilities at the 3-year visit compared to children with lower amounts of directing utterances (Ambrose et al., 2015). There was an inverse relationship between directing utterances at 18-months versus language abilities at 3-years such that as the proportion of directing utterances increased, the child's language abilities decreased. In conclusion, the researchers discovered that children with a hearing loss appeared to have a decreased ability to learn language, and that more quality exposure during child-directed speech at 18-months helps develop new vocabulary at 3 of age (Ambrose et al., 2015). Clinically, this study showed the

difference between caregiver communication to those who are hard of hearing versus those who are typically developing. To ensure that children who are at risk are exposed to quality linguistic input, clinicians need to educate caregivers of the importance of providing their children to high quality interactions and help create conversations that elicit language.

Children also play an integral role in encouraging caregiver input through engagement or attention. Previous researchers have discovered that in the first 3 years of a child's life, joint engagement emerges between a caregiver and child (Adamson et al., 2004). Joint engagement is defined as including the use of communicative acts to engage a communication partner's attention through eye contact, gestures, or affective expression to an object with the intent to communicate and share the experience (Mundy & Neal, 2001; Tomasello, 1995). Multiple researchers, including Klinnert et al. (1993) and Adamson et al. (2004), have stated that during an infant's first year of life, joint engagement is learned by infants focusing "their attention from caregivers to objects in the environment by responding to and imitating object-directed gaze and affective social referencing" (Cejas et al., 2014, p, 1831). As joint attention skills develop, children begin to increase their period of time on joint engagement, which facilitates the reciprocal sharing of objects and events with a caregiver (Adamson et al., 2004; Bakeman & Adamson, 1984). Children with atypical development (e.g., autism spectrum disorder and hearing loss) exhibit delayed development and execution of joint engagement (Adamson et al., 2012; Mundy et al., 1990; Prezbindowski et al., 1998; Tasker et al., 2010). "Given that children with hearing loss have significant delays in oral language and difficulties with parent-child communication (Bergeson, 2011; Cruz et al., 2013; Quittner et al., 2013), the development of symbol-infused joint engagement is likely to be disrupted" (Cejas et al., 2014, p. 1832). Furthermore, Marschark mentions that linguistic interactions with parents from an early age

support social, cognitive, and language development for children who are deaf (Marschark, 1993). Although researchers have shown that joint engagement is a critical step for developing language, prior literature as to why caregivers do not engage with children with a lack of joint engagement has not directedly been tested. It is hypothesized that infants who talk less are less engaging, therefore, parents are less motivated to talk with them. Clinically, caregivers of infants who are at risk can be informed about the importance of earlier exposure to linguistic input and the potential effect of child engagement on this input.

Given previous research findings, the importance of language rich environments and quality interactions is clear. Researchers have further explored whether or not exposing children to early language can result in positive speech/language outcomes. They sought to address two questions. Does early language exposure from caregivers correlate to development of language processing in children between 19 and 24 months? In other words, does communicating directly with your infant, rather than the infant listening to overheard communication, increase the infant's ability to recognize words more efficiently? If yes, do differences in the ability to process language have a relationship with early language exposure and later vocabulary knowledge? The purpose behind asking these questions was that answers would help researchers understand the relationship between early language exposure, speech-processing efficiency, and vocabulary development (Weisleder & Fernald, 2013).

To answer these questions, the researchers studied 29 Spanish-learning infants (10 females and 19 males) between the ages of 19 and 24 months. At 19 months of age, audio recordings were captured an average of 7 hours over the period of 1 to 6 days. During a typical day at home, digital LENA recorders were placed in the chest pocket of specialized clothing. The recordings were then analyzed by LENA analysis software (Xu et al., 2009). Parents were asked

to complete a log of interaction locations, who was present, activities completed, and if anything abnormal happened throughout the recordings. To measure the child's expressive language, the parents reported the number of words their child was able to understand and say via the Spanish-language version of the *MacArthur-Bates Communicative Development Inventories* (Jackson-Maldonado et al., 2003) at 24 months. Lastly, the researchers measured language processing efficiency by infants being shown pairs of images (e.g., a shoe and a baby) while also verbally listening to a sentence naming one of the pictures shown. If the child looked toward the named picture, the child was thought to have correctly processed the lexical item. This assessment was used to measure words that are frequent and familiar to children during child-directed speech (Weisleder & Fernald, 2013).

Overall, the researchers found a significant statistical difference in the number of spoken words directed to the infant and per family. One family spoke more than 12,000 words to their infant, while another family only spoke 670 words. The researchers indicated that children who were exposed to more child-directed speech at 19 months had a larger vocabulary 6 months later than children who were exposed only to over-heard speech. For language processing efficiency, the results indicated that children who were exposed to more child-directed speech during home activity were more proficient in language processing at 24 months (e.g., these children correctly looked at the image of the spoken word; Weisleder & Fernald, 2013). In conclusion, the researchers discovered that more exposure to child-directed speech provides opportunities for learning new vocabulary and also aids in lexical processing (Weisleder & Fernald, 2013). Clinically, this study showed the importance of parent and infant interaction by measuring the outcomes of child-directed speech, which resulted in larger vocabulary development and better

lexical processing. Overall, research has demonstrated the benefit of rich language environments, quality interactions, and early language exposure.

Measurement of Quantity and Quality

Researchers have analyzed caregiver linguistic input directed to infants and children, in order to predict later language skills. The measurement of this variable is often an analysis of quantity and quality. In one study, quantity was the number of tokens, or words, introduced to the infant and quality was the variety of vocabulary introduced to the infant (Rowe, 2012). Number of different words, rare words (i.e., parents' vocabulary sophistication), and words associated with decontextualized language, were all included in the quality of language (Rowe, 2012). Other researchers also sought to explore the differences of children's experiences from caregiver linguistic input through measurement of quantity as the average number of utterances per hour and quality as the average number of different words per hour (Hart & Risley, 2003).

Both quality and quantity have been shown to be important for language development. However, it has been found that the quality of caregiver input is more valuable with regard to vocabulary growth (Rowe, 2012). Incorporating diverse and sophisticated vocabulary when speaking to children is more beneficial than simply talking a lot. Diverse and sophisticated vocabulary includes those words that are rare, decontextualized, and otherwise more advanced than simply saying a noun such as "ball". While quality has been proven to show a positive correlation with language development, quantity is still critical. Quantity provides children with more exposure to different language, and even to certain types of language, when incorporated with quality. All of these are key factors that contribute to the development of language.

Purpose

In line with prior work, the *long-term goal* of this research was to understand how various aspects related to the quantity and quality of caregiver linguistic input to infants (e.g., the

total number of words spoken, the number of different words spoken, etc.) influence later speech and language abilities. If we, as researchers and professionals are better informed on the intricacies of caregiver linguistic input, then we can better educate caregivers. If caregivers are aware of how their linguistic input is related to the later speech and/or language development of their children, caregivers may be more conscientious of the language they are using during interactions. With this knowledge, caregivers may also be better able to identify the need for early intervention (Leffel & Suskind, 2013). The objective of the present study was to analyze caregiver linguistic input directed to infants who are typically developing versus those at risk. We accomplished this objective by longitudinally exploring caregiver linguistic input directed to 14 infants from 7 to 18 months of age; seven infants who were typically developing and seven infants who were at risk for a speech/language delay/disorder. In line with prior work, ages were collapsed into three groups; the prelinguistic group from 7 to 10 months, during which time infants can be expected to produce largely prelinguistic vocalizations consisting of marginal babbling and quasivowels; the canonical group from 11 to 14 months, during which time infants can be expected to produce mostly well-formed consonant-vowel syllable sequences; and the early linguistic group from 15 to 18 months of infant age, during which time toddlers can be expected to be producing early protowords and true words (Ramsdell-Hudock, Stuart, & Peterson, 2018). Infants were considered at risk if they experienced one or more of the following conditions prior to 7 months of age: pre- and perinatal problems; ear, nose, and throat problems; swallowing/sucking problems; and/or an immediate family history of speech and/or language problems (Brady et al., 2004; Goldstein & Schwade, 2008; McDuffie & Yoder, 2010). Any of these conditions place infants at a greater risk for speech and/or language delay/disorder. The hypothesis was that there will be differences in caregiver linguistic input to infants (e.g., total

number of words spoken and total number of different words and word types spoken) dependent upon infant development status. The hypothesis was formulated on the basis of documentation that caregiver input to infants can differentiate between typically developing children and those who are at risk (Ambrose et al., 2015; Bontinck et al., 2018; Brady et al., 2004; Chericoni et al., 2016; Goldstein & Schwade, 2008; Iyer et al., 2016; McDuffie & Yoder, 2010; Weisleder & Fernald, 2013; Windsor et al., 2007).

The *rationale* for the study was that more detail related to the utility of caregiver linguistic input in differentiating between early developmental status may provide a means for educating caregivers about the importance of communication. If a difference existed between caregiver input directed to infants who are typically developing versus those who are at risk, the difference would provide unique detail to include in education for caregivers about the importance of linguistic input.

We tested the hypothesis by pursuing the following four Specific Aims. Across infant age groups and developmental classification (i.e., infants who were typically developing versus those who were at risk), we explored caregiver linguistic input directed to infants in 20-minute recordings, tallying *Aim 1*. The number of utterances, *Aim 2*. The number of words, *Aim 3*. The number of different words, and *Aim 4*. The number of words per word type (nouns, verbs, and adjectives).

Chapter 2: Methods

Participants

Data for this project was obtained from 14 caregiver/infant dyads video/audio recorded monthly for each infant between 7 and 18 months of age in two archived longitudinal studies conducted by Ramsdell-Hudock. One cohort of seven infants was considered typically developing, and the remaining cohort of seven infants was at risk for future speech and/or language delay/disorder. Caregivers were aware of their infants' developmental classification before the study was conducted, since they knew if their infant experienced any of the qualifying conditions prior to 7 months of age. The conditions included: pre- and perinatal problems; ear, nose, and throat problems; swallowing/sucking problems; and/or an immediate family history of speech and/or language problems (Brady et al., 2004; Goldstein & Schwade, 2008; McDuffie & Yoder, 2010). These participants were selected to determine differences in caregiver linguistic input to infants dependent upon infant developmental classification. Demographic information is presented in Table 1. There were four instances when recordings were not available to extract caregiver linguistic input (as shown in Table 1). Infants 12 and 13 did not have available recordings in the prelinguistic age group because they began participation in the original longitudinal study at 11 months of age. Infants 9 and 11 did not have available recordings in the early linguistic age group because they were not yet 15 months of age at the time when data was analyzed for this project. To account for missing data, caregiver linguistic input was averaged across infants for the prelinguistic age group and the average values were entered for infants 12 and 13, and for the early linguistic age group and entered for infants 9 and 11.

Table 1

Participant Information						
Infant	Gender	Risk Factor	Number of Older Siblings	Ethnicity	Languages Spoken in the Home	Missing Data (No Recordings)
Infant Developmental Status: Typically Developing						
1	F	NA	0	African American	English	
2	M		1	Asian American	English, Indian, and Vietnamese	
3	M		1	White	English	
4	F		3	White	English	
5	F		0	White	English	
6	M		0	White	English	
7	M		0	White	English	
Infant Developmental Status: At Risk						
8	M	Born prematurely	1	Pacific-Islander	English	Early linguistic age group
9	M	Older sibling with hearing loss	1	Hispanic	English	
10	F	Parent with fluency disorder	1	White	English	
11	M	Born prematurely	0	White	English	Early linguistic age group
12	F	Born prematurely	0	White	English	Prelinguistic age group
13	M	Born prematurely	5	White	English	Prelinguistic age group
14	M	Parent with fluency disorder	0	White	English	

All infants had normal hearing; they all passed an automated auditory brainstem response newborn screening (ALGO 3 or ALGO 5 Newborn Hearing Screener System) to click stimuli presented at 35 dB nHL. In addition, full hearing evaluations including tympanometry, transient evoked otoacoustic emissions, and visual reinforcement audiometry were conducted at 6 or 7 and 18 months of age, with follow-up testing as needed for instances where results were abnormal (i.e., middle ear dysfunction) or testing was incomplete. Four of the infants received bilateral myringotomy and pressure equalization tubes during their enrollment in the study.

Materials and Procedure

Study approval from the University and Medical Center Institutional Review Board at East Carolina University (group of infants who were typically developing) and Human Subjects Committee at Idaho State University (group of infants who were at risk) was obtained prior to data collection. Each caregiver provided voluntary informed consent for participation in the study. Exemption was also sought from the Human Subjects Committee at Idaho State University, as the study purpose was covered in the original consent. Parent/infant dyads were followed over a 12-month longitudinal period through weekly interviews, and monthly recordings were gathered.

Laboratory setting. Infants and caregivers came to the Infant Vocal Development Laboratory at East Carolina University (typically developing) or Idaho State University (at risk) once a month for hour-long recordings. During recordings, caregivers were instructed to play with their infants, and interact as they would typically do in a home setting. The lab was designed to simulate a natural environment, such as a nursery in a home; it included stuffed animals, toys, and various objects that would allow both parent and child to feel comfortable. This setting attempted to encourage natural interactions between caregivers and infants, to facilitate capture of a representative sample of the infant's vocal abilities.

The lab was equipped with both video and audio recording equipment. For video data, the recording room contained eight Sony EVI-D70/W wall-mounted cameras with pan and tilt capabilities. Further, three walls contained 4x4 foot mirrors to optimize camera angles in recordings. For audio data, an infant vest housed a high-fidelity wireless microphone to control mouth-to-microphone distance (Buder & Stoel-Gammon, 2002). Caregivers used a wireless lapel microphone. A signal-to-noise ratio of up to 96 dB was made possible with 16-bit quantization,

and with signals digitized at sampling rates of 44.1 or 48 kHz. All video and audio from the recording room was relayed to an adjacent control room. During recordings, laboratory staff would attempt to record two of the eight available camera angles, choosing those with the best view of the infant's face and the best view of the interaction between caregivers and infants.

Caregiver input. Through all coding for this project, a method of consensus was used such that laboratory staff learned and practice procedures together, coded primarily independently, and discussed all questionable codes until consensus over a label was reached. Caregiver utterances were located using a breath-group criterion (i.e., each vocalization occurred on a single egressive breath; Oller & Lynch, 1992). Caregiver utterances directed to the infant were transcribed orthographically for all recording sessions across infant and age. Due to time constraints, only a 20-minute portion of each recording session was used for transcription and analysis. The middle 20 minutes of each 60-minute session was used. Lab assistants coded, transcribed, and analyzed caregiver utterances independently. In order to decrease subjectivity a method of consensus coding was implemented. In the event that a lab assistant had a question regarding a specific utterance, they were able to ask another lab staff. Caregiver input was judged to be directed when utterances were directed to the infant (e.g., a response, request, or clarification) as indicated verbally (by semantic content), or nonverbally (through eye gaze). Conversely, caregiver input was not directed when their utterances were not directed to the infant, but rather to someone else in the room, or to someone on the phone, as indicated verbally, or nonverbally. Following the coding and transcription, each 20-minute session was analyzed to determine the exact quantitative and qualitative values of the caregiver utterances. Each transcription was entered into Microsoft Word where they were edited to determine the total number of words and utterances (quantity). Caregiver utterances such as animal noises, imitating

infant vocalizations, and other non-words were not included in the analysis because these utterances did not fall into a vocal type category (noun, verb, adjective). Information from the files were then entered into Microsoft Excel in order to determine the exact number of different words and total number of nouns, verbs, and adjectives (quality) spoken. To determine the different word types, lab assistants color coded each word on the transcriptions in Microsoft Excel. Once all word types were color coded, Ablebits was utilized to tally the sum of each word type (noun, verbs, and adjectives).

Design

A one-way multivariate analysis of covariance (MANCOVA) is used to compare two or more dependent variables by an independent variable, when controlling for a covariate. Accordingly, a MANCOVA was conducted to determine whether or not there was a difference between the dependent variables quantity (total number of words and utterances) and quality (total number of different words, nouns, verbs, and adjectives) of caregiver linguistic input directed to infants and the independent variable, infant developmental status (typically developing versus those at risk for speech and/or language delay/disorder) when controlling for the covariate infant age group (prelinguistic from 7 to 10 months, canonical from 11 to 14 months, and early linguistic from 15 to 18 months of infant age). We controlled for age group because our primary variable of interest was infant development status; we wanted to see how caregiver input varies solely dependent upon infant developmental status as typically developing or at-risk regardless of changes that occur naturally with maturation. A significance level (p) was set at 0.05 for the purpose of this study.

Chapter 3: Results

The 14 caregivers (seven infants who were typically developing and seven infants who were at-risk) produced a total of 9,539 utterances and 32,562 words directed to their infants across the three age groups. Further, the average number of variables in infant-directed caregiver utterances (the total number of utterances, words, different words, nouns, verbs, and adjectives) across infants per developmental status and age group are shown in Table 2.

Table 2

<i>Average Number of Variables Across Infants Per Developmental Status and Age Group</i>					
Infant Developmental Status	Infant-Directed Caregiver Utterances	Infant Age Group			Total
		Prelinguistic (7 to 10 Months)	Canonical (11 to 14 Months)	Early Linguistic (15 to 18 Months)	
Typically Developing	Utterances	206.75	176.12	183.51	566.38
	Words	627.32	617.69	661.11	1906.12
	Different Words	157.25	144.88	164.01	466.14
	Nouns	85.04	102.04	113.11	300.18
	Verbs	193.89	185.51	208.29	587.69
	Adjectives	31.32	27.95	34.38	93.65
At Risk	Utterances	260.85	267.56	267.95	796.35
	Words	882.69	909.71	953.16	2745.56
	Different Words	227.46	294.82	238.11	760.39
	Nouns	127.48	141.58	157.48	426.54
	Verbs	264.65	271.29	282.89	818.83
	Adjectives	70.64	69.74	77.55	217.92

The results of the MANCOVA (to determine if a difference was observed in caregiver input dependent upon developmental status with age as a covariate) showed a significant difference between the groups (typically developing and at risk), $F(6, 34) = 8.443, p = 0.000$, Wilks' $\Lambda = 0.402$, partial $\eta^2 = 0.598$. In reporting of MANCOVA results, F is the test statistic, and is followed by the degrees of freedom for the analysis in parentheses. The probability value, p , was set at 0.05 for the purpose of this study. A probability value is used to determine whether or not to reject or accept the null hypothesis. The null hypothesis states that there is no statistical significance between the variables. With our p value set to 0.05, the probability that the null hypothesis is true is less than 5 in 100. Accordingly, the null hypothesis was rejected since the

probability value was less than 0.05. Caregivers of infants who were at risk produced more words ($p < 0.006$), different words ($p < 0.001$), utterances ($p < 0.001$), nouns ($p < 0.020$), verbs ($p < 0.010$), and adjectives ($p < 0.000$) than caregivers of infants who were typically developing (see Table 3). This result indicated that there was a significant difference between caregivers of infants who were at risk and caregivers of infants who were typically developing where the caregivers of infants who were at risk produced more quantity and quality in linguistic input directed to their infants.

Table 3

Summary Statistics and Results from MANCOVA (Criterion Variable = Infant-Directed Caregiver Utterances)

Infant-Directed Caregiver Utterances	$F (df = 1, 39)$	p	Typically Developing		At Risk	
			Mean	Standard Deviation	Mean	Standard Deviation
Utterances	12.22	0.001**	188.79	68.75	265.45	71.71
Words	8.40	0.006**	635.37	327.02	915.19	290.32
Different Words	12.57	0.001**	155.38	64.97	253.46	112.59
Nouns	5.84	0.020*	100.06	58.79	142.18	55.36
Verbs	7.40	0.010*	195.90	94.42	272.94	87.25
Adjectives	38.89	0.000***	31.22	19.74	72.64	22.86

* $p < .05$, ** $p < .01$, *** $p < .001$

Chapter 4: Discussion

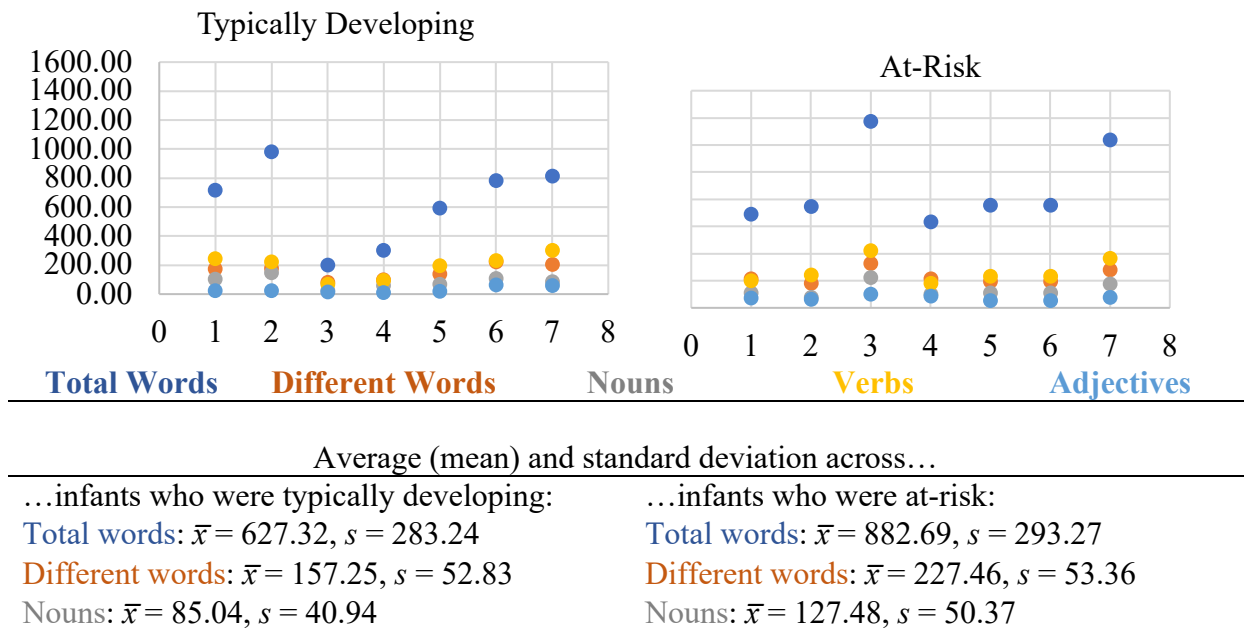
Through this study, we aimed to determine the relationship between caregiver linguistic input to infants, specifically quantity (total number of words and utterances) and quality (total number of different words, nouns, verbs, and adjectives) of infant-directed caregiver utterances to infants who were typically developing and at-risk between 7 and 18 months of age. The hypothesis was that there would be differences in caregiver linguistic input to infants (e.g., total number of words spoken, total number of different words, and word types spoken) dependent upon infant development status, despite caregiver's awareness of their infant's developmental classification. By determining factors that influence later speech and language abilities, SLPs are more prepared to educate families of children who are at risk, delayed, and/or disordered earlier in the importance of linguistic input. In the present study, we looked at the middle 20 minutes of 60-minute recordings of 14 caregiver-infant dyads, with each infant having a single recording per month of the study (12 in total from 7 to 18 months). A caveat to one recording per month may not show a true representation of the caregivers' communication, since there is so much variation in communicative interaction from day to day, and even hour to hour, or minute to minute. For example, caregivers could have been tired on the recording day, resulting in decreased communication interaction with their infant. Previous research has indicated that both quantity and quality of caregiver language input has a significant impact on vocabulary development, but quality is more influential (Rowe, 2012). Through the present study, statistical significance was discovered between the predictor and criterion variables.

Statistically significant MANCOVA results showed that caregivers of infants at risk for a speech/language delay/disorder produced more infant-directed linguistic input with respect to both the quantity (total number of words and utterances) and quality (total number of different

words, nouns, verbs, and adjectives) of utterances when compared to infant-directed caregiver linguistic input to infants who were typically developing, when age was controlled for. This information suggests that, in this sample of caregiver/infant dyads, there was a relationship between the quantity and quality of caregiver input dependent upon infant developmental status regardless of age group.

While reviewing the results, there was variability across infant-directed caregiver utterances. See data from each individual dyad presented in Figure 1. Some caregivers spoke a lot to their infant (e.g., in Figure 1, caregiver 2 in the group of infants who were typically developing infants, and caregivers 3 and 7 in the group of infants who were at-risk), while other caregivers did not speak a lot (e.g., in Figure 1, caregivers 3 and 4 in the group of infants who were typically developing). If those caregiver-infant dyads were removed from the present study, then the two groups of infants (typically developing versus at risk) became more similar. Removing caregiver-infant dyads with extreme scores (e.g., especially large or small numbers of utterances) eliminated the statistically significant results. While we found statistically significant results, our caregivers may have been more similar than not with respect to the amount of linguistic input they were providing the infants. Perhaps our results were a confound associated with more extreme scores from a few individual caregivers. There is no way of confirming this with the present sample, however. It would be necessary to conduct the study with a larger number of infants to confirm whether or not our results were biased by outliers in the sample.

Figure 1
Quantity and Quality of Caregiver Linguistic Input Directed to Infants



There are several factors that could have had an impact on the results. One thing to consider was that all caregivers knew how their infants were classified by project researchers, either as typically developing or at-risk. Since the caregivers were aware of their infant's developmental status, they may have explored ways to help their infant succeed. Caregivers also were aware of the original purpose of data collection, to track vocal development in their infants. During recordings, they were asked interview questions focusing on infant vocalizations and on caregiver-infant communicative interaction. This focus, and the requested task to 'play with their infant' could have resulted in skewed results, where caregivers of those at risk had a heightened awareness of the focus on communication, and therefore, spoke more to their infants. Research has shown that joint engagement emerges between a caregiver and a child in the first 3 years of a child's life (Adamson et al., 2004), but children with atypical development have delayed joint engagement (Adamson et al., 2012; Mundy et al., 1990; Prezbindowski et al., 1998; Tasker et

al., 2010). As logic would have it, with delayed joint engagement, infants are less engaging, therefore, caregivers are not as motivated to communicate with their infant. Because of study design, with caregivers knowing how their infants were classified (as typically developing or at risk) caregivers in the present study, may have been artificially influenced to communicate more with their infants despite their infant's engagement. These caregivers may also have been talking more to their infant in order to increase their infant's vocalizations.

Clinical Implications

Statistically significant results indicated a relationship between the quantity and quality of caregiver linguistic input to infants who participated in the study. Differences in quantity and quality linguistic input to infants who were at risk versus typically developing were predicated. For quantity in the current study, caregivers who had an infant with a developmental status as at risk, showed a greater total number of utterances and total numbers of words. Also, these caregivers showed higher quality of linguistic input with a greater amount of different words, nouns, verbs, and adjectives. These results were not in line with previous research, which has shown that caregivers with typically developing infants produced greater total of words, different words, and longer utterances (Ambrose et al., 2015; Weisleder & Fernald, 2013). Clinically, this notion is important as we know that environmental factors significantly impact infants' vocabulary development. It is imperative to consider which environmental factors most significantly impact language development so that we can focus on conveying that information to caregivers.

Caregiver education is a major component to the roles and responsibilities of an SLP, particularly during early intervention to children from birth to 3 years of age. Providing caregivers with information on the importance of quantity and quality in linguistic input is likely

to increase caregivers' awareness, and hopefully increase their use of quantitative and qualitative linguistic input. Both quality and quantity have been shown to be important for language development. Specifically, as the total amount of words produced by a caregiver to their children increases, it has been shown that later vocabulary skills will increase as well (Weisleder & Fernald, 2013). Researchers also discovered that children who are exposed to more quality exposure of greater number of different words, greater mean length of utterance, greater proportion of utterances that were high-level, and fewer proportions of utterances that were directing helped develop new vocabulary (Ambrose et al., 2015). However, it has been found that the quality of caregiver input is more valuable with regard to vocabulary growth (Rowe, 2012). Further, caregivers may be able to better identify a need for early intervention through accurate and precise caregiver education provided by clinicians on the importance of early exposure to linguistic input. If clinicians are able to provide early intervention services to children at younger ages, those with delays or disorders are likely to develop age-appropriate language skills more quickly.

Study Limitations

One study limitation to consider is caregivers' performance in the lab setting. For the purpose of this study, we analyzed the caregivers' linguistic input to their infants. The original use of the videos was to analyze infant vocalizations; therefore, caregivers were instructed to talk like they usually do in their natural environment, but to not talk over their infants' vocalizations. This lab setting environment can cause two problems: 1) caregivers may talk less so that they are not talking over their infants' vocalizations, or 2) caregivers may talk more since they know that they are being recorded. Future research could explore how caregivers interact in their natural environment to avoid confounding variables and increase internal validity.

Throughout this study, caregivers wore a microphone to record audio data. If there was a second caregiver, additional microphones were not distributed. This created challenges coding the second caregivers' utterances; while orthographically transcribing the second caregivers' utterances, it was sometimes difficult to clearly understand what was said. The unclear audio was uncommon, but did occur in some instances. This may have skewed the data recorded related to quantity and quality of linguistic input, due to transcribing the utterances as unintelligible.

Each recording file was coded, transcribed, and analyzed for different values on different occasions by different lab assistants. A study limitation is the potential occurrence of human error during the data analysis. While each lab assistant followed the same instructions and guidelines, there was still a possibility for individual human error. Additionally, while coding, transcribing, and analyzing the data, the lab assistants worked independently on each file, but brought any questions or concerns about particular files to other lab assistants in order to gain a second opinion, gaining consensus for questionable data. The potential for human error is present, however, many parameters were in place in order to lessen or prevent the occurrence of human error.

Throughout this study, data was obtained monthly for each infant between 7 and 18 months of age. However, there were a number of data points, or infant ages in months, that did not have actual data present resulting from two main issues: 1) lack of a recording session for the specific month during the collection of data in the longitudinal study, or 2) technical difficulties either from hardware or software malfunction. These data errors were not common, but did occur, and the missing data could have decreased the reliability of the results. Recall that in instances where data points were missing, values across infants at the particular age group were averaged, and the average value was used in the missing cell. For example, there were no

recordings for infants 12 and 13 in the early age group. Accordingly, the total number of utterances, total number of words, total number of different words, total number of nouns, total number of verbs, and total number of adjectives was averaged across all other infants (infants 1-11 and 14) and the average values were entered into the analysis for infants 12 and 13 in the early age group.

Future Directions

The present study has the potential for expansion and further investigation. There are three main lines of study that can come out of this project. First of all, directed linguistic input to infants has been shown to be related to later speech and language abilities in those same children, it would be interesting to follow the children in this study and assess their speech and language abilities at a later age. Given that the caregivers in this study provided more linguistic input to the infants who were classified as at risk, how will the later speech and language abilities of these infants who are at risk compare to the infants in the study who were typically developing? Full speech and language evaluations with the children in this study at 3 ½ years of age has been completed or is underway. We will follow-up to explore this question.

A second major direction for a future study would be to look at how infants are interacting with their caregivers. Specifically, are infants communicating with their caregivers or are they disengaged from the conversation. Farnsworth (2019) investigated infants from 7 to 18 months of age who were typically developing and those who were at risk for a delay/disorder to determine the relationship between caregiver report of early vocalizations and later vocabulary ability. She discovered that caregivers reported a greater quantity and more variability in sound types produced by infants who are typically developing compared to infants who are at risk for future speech/language delay/disorder. This information supports that infants who are typically

developing, produce more vocalizations compared to infants who are at risk. If infants classified as at-risk are not engaging in conversation, then perhaps caregivers have more opportunities for infant-directed utterances, to fill in the empty space left by the non-interactive communication partner. Future research could investigate the infant's total number of vocalizations during the recordings of caregiver/infant interaction to see if caregiver report is in line with infant vocalizations, such that infants who are reported to produce more vocalizations by caregivers, are also found to produce more vocalizations in recordings of interactions.

Finally, a third major direction for future work would be to explore the influence of varying amounts of caregiver education on the importance of directed linguistic input to infants to see what degree of instruction is needed to increase the quantity and quality of input. Is it true that limited instruction will result in increased caregiver linguistic input to infants, or is more focused education necessary?

Chapter 5: Conclusion

In conclusion, the results of this study demonstrated that quantity and quality caregiver linguistic input is dependent upon infant developmental status. Also, it may be noted, that with a little focus, even via the indirect focus of interview questions on the topic of vocal development and communicative interaction as was provided in the present study, caregivers may be able to increase the quantity and quality of the linguistic input they provide to their infants. This finding may be paramount for clinical practice in early intervention as SLPs can spend less time stressing the value of caregiver linguistic input to increase the richness of a child's language environment, and more time on other treatment areas. Doing so would allow the clinician to simultaneously focus on other goals to better facilitate speech and language growth, such as coaching caregivers on ways to improve play development, encourage infant vocalizations, and facilitate reciprocal responding on the part of caregivers and infants. While there were limitations to this study, clinical significance is still a major component. From this information, SLPs can use this to help strengthen caregiver education on the importance of linguistic input. Increasing caregiver awareness of the value of linguistic input for later speech and/or language development may directly influence the quality of caregiver-infant interaction.

References

- Adamson, L. B., Bakeman, R., & Deckner, D. F. (2004). The development of symbol-infused joint engagement. *Child Development*, 75(4), 1171-1187.
- Adamson, L. B., Bakeman, R., Deckner, D. F., & Nelson, P. B. (2012). Rating parent-child interactions: Joint engagement, communication dynamics, and shared topics in autism, down syndrome, and typical development. *Journal of Autism & Developmental Disorders*, 42, 2622-2635.
- Ambrose, S. E., Walker, E. A., Unflat-Berry, L. M., Oleson, J. J., & Moeller, M. P. (2015). Quantity and quality of caregivers' linguistic input to 18-month and 3-year-old children who are hard of hearing. *Ear Hear*, 36(1), 1-29.
- Bakeman, R., & Adamson, L. B. (1984). Coordinating attention to people and objects in mother-infant and peer-infant interaction. *Child Development*, 55, 1278-1289.
- Bergeson, T. R. (2011). Maternal speech to hearing-impaired infants in the first year of hearing aid or cochlear implant use: A preliminary report. *Cochlear Implants International*, 12, 101-104.
- Bontinck, C., Warreyn, P., Meirsschaut, M., & Roeyers, H. (2018). Parent-child interaction in children with autism spectrum disorder and their siblings: Choosing a coding strategy. *Journal of Child and Family Studies*, 27(1), 91-102.
- Brady, N., Marquis, J., Fleming, K., & McLean, L. (2004). Prelinguistic predictors of language growth in children with developmental disabilities. *Journal of Speech, Language, and Hearing Research*, 47, 663-677.

- Buder, E. H., & Stoel-Gammon, C. (2002). Young children's acquisition of vowel duration as influenced by language: Tense/lax and final stop consonant voicing effects. *Journal of the Acoustical Society of America*, 111, 1854-1864.
- Bzoch, K. R., & League, R. (1971). *Assessing language skills in infancy*. Baltimore, MD: University Park Press.
- Carrow-Woolfolk, E. (1999). *Comprehensive assessment of spoken language*. Circle Pines, MN: American Guidance Service.
- Cejas, I., Barker, D. H., Quittner, A. L., & Niparko, J. K. (2014). Development of joint engagement in young deaf and hearing children: Effects of chronological age and language skills. *Journal of Speech, Language, and Hearing Research*, 57(5), 1831-1841.
- Chericoni, N., de Brito Wanderley, D., Costanzo, V., Diniz-Gonçalves, A., Gille, M., Parlato, E., Cohen, D., Apicella, F., Calderoni, S. & Muratori, F. (2016). Pre-linguistic vocal trajectories at 6-18 months of age as early makers of autism. *Frontiers in Psychology*, 7, 1-11.
- Cruz, I., Quittner, A. L., DesJardin, J. & Marker, C. (2013). CDaCI investigative team. Identification of effective strategies to promote oral language in deaf children with cochlear implants. *Child Development*, 84, 543-559.
- Dunn, L. M. (1981). *Peabody picture vocabulary test-revised (PPVT-R)*. Circle Pines, MN: American Guidance Service.
- Durand, V. N., Loe, I. M., Yeatman, J. D., & Feldman, H. M., (2013). Effects of early language, speech, and cognition on later reading: A mediation analysis. *Frontiers in Psychology*, 4, 1-11.

- Duff, D. & Tomblin, B. (2018). Literacy as an outcome of language development and its impact on children's psychosocial and emotional development. *Language Development and Literacy*, 1-6.
- Farnsworth, A. (2019). *Examining caregiver report of infant vocalizations and later vocabulary ability*. (Unpublished master's thesis). Idaho State University, Pocatello, ID.
- Goldstein, M. H., & Schwade, J. A. (2008). Social feedback to infants' babbling facilitates rapid phonological learning. *Psychological Science*, 19, 515-523.
- Golinkoff, R. M., Can, D. D., Soderstrom, M., & Hirsh-Pasek, K. (2015). (Baby)Talk to me: The social context of infant-directed speech and its effects on early language acquisition. *Association for Psychological Science*, 24(5), 339-344.
- Greenwood, C. R., Thiemann-Bourque, K., Walker, D., Buzhardt, J., & Gilkerson, J. (2011). Assessing children's home language environments using automatic speech recognition technology. *Hammill Institute on Disabilities*, 32(2), 83-92.
- Hart, B. & Risley, T. R. (2003). The early catastrophe: The 30 million word gap by age 3. *American Educator*, 27, 4-9.
- Iyer, S. N., Denson, H., Lazar, N., & Oller, D. K. (2016). Volubility of the human infant: Effects of parental interaction (or lack of it). *Clinical Linguistics & Phonetics*, 30(6), 470-488.
- Jackson-Maldonado, D., Thal, D. J., Marchman, V. A., Newton, T., Fenson, L., & Conboy, B. T. (2003). *MacArthur inventarios del Desarrollo de habilidades comunicativas*. Baltimore, MD: Brookes Publishing Co.
- Klinnert, M. D., Campos, J. J., Sorce, J. F., Emde, R. N., & Svejda, M. (1983). Emotions as behavior regulators: Social referencing in infancy. In R. Plutchik & H. Kellerman (Eds.), *Emotions: Theory, research, and experience* (2, pp. 57-86). Academic Press.

- Leffel, K. & Suskind, D. (2013). Parent-directed approaches to enrich the early language environments of children living in poverty. *Seminars in Speech and Language, 34*(4), 267-278. doi:10.1055/s-0033-1353443
- Marschark, M. (1993). *Origins and interactions in the social, cognitive, and language development of deaf children*. Hillsdale, NJ: Lawrence Erlbaum Association Inc.
- McCarthy, D. (1972). *The McCarthy scales of children's abilities*. New York: The Psychological Corporation.
- McDuffie, A., & Yoder, P. (2010). Types of parent verbal responsiveness that predicts language in young children with autism spectrum disorder. *Journal of Speech, Language, and Hearing Research, 53*, 1026-1039.
- Mundy, P. & Neal, A. R. (2001). Neural plasticity, joint attention, and a transactional social-orienting model of autism. *International Review of Research in Mental Retardation, 23*, 140-168.
- Mundy, P., Sigman, M., & Kasari, C. (1990). A longitudinal study of joint attention and language development in autistic children. *Journal of Autism and Developmental Disorder, 20*, 115-128.
- Paul, D., & Roth, F., P. (2011). Guiding principles and clinical applications for speech-language pathology practice in early intervention. *Language, Speech, and Hearing Services in Schools, 42*, 320-330.
- Prelock, P. A., Hutchins, T., & Glascoe, F. P. (2008). Speech-language impairment: How to identify the most common and least diagnosed disability of childhood. *The Medscape Journal of Medicine, 10*(6), 136.

- Prezbindowski, A. K., Adamson, L. B., & Lederberg, A. R. (1998). Joint attention in deaf and hearing 22 month-old children and their mothers. *Journal of Applied Developmental Psychology, 19*, 377-387.
- Quittner, A. L., Cruz, I., Barker, D. H., Tobey, E., Eisenberg, L. & Niparkso, J. (2013). CDaCI investigative team. Effects of maternal sensitivity and cognitive and linguistic stimulation on cochlear implant users' language development over four years. *Journal of Pediatrics, 162*, 343-348.
- Ramsdell-Hudock, H.L., Stuart, A., & Peterson, T. (2018). What do caregivers tell us about infant babbling? *Studies in Linguistics and Literature. 2*(3). Retrieved from www.scholink.org/ojs/index.php/sll
- Rowe, M. L. (2012). A longitudinal investigation of the role of quantity and quality of child-directed speech in vocabulary development. *Child Development, 83*(5), 1762-1774.
- Tasker, S. L., Nowakowski, M. E., & Schmidt, L. A. (2010). Joint attention and social competence in profoundly deaf children with cochlear implants. *Journal of Developmental and Physical Disabilities, 22*, 509-532.
- Tomasello, M. (1995). Joint attention as a social cognition. In: C. Moore & P. Duham (Eds.), *Joint attention: Its origins and role in development* (pp. 103-130). Lawrence Erlbaum Associates, Inc.
- Toseeb, U., Pickles, A., Durkin, K., Botting, N., & Conti-Ramsden, G. (2017). Prosociality from early adolescence to young adulthood: A longitudinal study of individuals with a history of language. *Research in Development Disabilities, 62*, 148-159.

- Weisleder, A. & Fernald, A. (2013). Talking to children matters: Early language experience strengthens processing and builds vocabulary. *Association for Psychological Science*, 24(11), 2143-2152.
- Wetherby, A. M. & Prizant, B. M. (2002). *Communication and symbolic behavior scales-developmental profile*. Baltimore, MD: Paul H. Brookes.
- Windsor, J., Glaze, L. D., & Koga, S. F. (2007). Language acquisition with limited input: Romanian institution and foster care. *Journal of Speech, Language, and Hearing Research*, 50(5), 1365-1381.
- Woodcock, R. (1987). *Woodcock reading mastery test, rev.* Circle Pines, MN: American Guidance Service.
- Woods, J. J. & Wetherby, M., A. (2003). Early identification of and intervention for infants and toddlers who are at risk for autism spectrum disorder. *Language, Speech, and Hearing Services in Schools*, 34(3), 180-193.
- Xu, D., Yapanel, U., & Gray, S. (2009). Reliability of the LENA language environment analysis system in young children's natural home environment.
- <http://www.lenafoundation.org/TechReport.aspx/Reliability/LTR-05-2>