2019

Parent Interaction Between an Infant with a Cochlear Implant and Additional Disabilities

Lillian Southern
Butler University

BUTLER UNIVERSITY HONORS PROGRAM

Honors Thesis Certification

Please type all information in this section:

Applicant: Lillian Jane Southern

Thesis Title: Parent Interaction Between an Infant with a Cochlear Implant and Additional Disabilities

Intended Date of Commencement: May 11, 2019

Read, approved, and signed by:

Thesis Adviser: [signature] 4-29-19

Reader: [signature] 4/26/19

Certified By: ______________________ ________

Parent Interaction Between an Infant with a Cochlear Implant and Additional Disabilities

Student Researcher: Lillian Southern

Faculty Mentor: Tonya Bergeson-Dana

Butler University

Communication Sciences and Disorders

2019

Abstract

Pediatric hearing loss has many spoken language learning issues that can impact parent-infant interaction. Moreover, additional disabilities are likely to increase stress, which could have cascading effects on communication. The purpose of the study was to examine interactions between mother- and father-child dyads with and without hearing loss and/or Autism Spectrum Disorder (ASD), Cytomegalovirus (CMV), and global delay. Recordings of the parents speaking with six infants in the study were analyzed: an infant with cochlear implants and ASD (low socioeconomic status, SES), two infants with cochlear implants and normal development (high SES and low SES), one infant with a cochlear implant and CMV (average SES), one infant with a cochlear implant and global delay (average SES), and one infant who was typically developing and had normal hearing (high SES). After analyzing the results for communication measures, such as vocalization attempts, turn-taking in utterances, mean-length of utterances, and type-token ratio, it was concluded that maternal and paternal interaction was negatively affected due not only to the difficulty of the hearing loss and/or additional disability, but rather due to a combination of factors, including the disability, SES, maternal and paternal education, and the home environment.

Parent Interaction Between an Infant with a Cochlear Implant and Additional Disabilities

Little if any research to date has been conducted on the impact of maternal and paternal interaction when an infant has both a hearing loss and additional disabilities (Beer et al., 2012; Wiley et al., 2011). Beer et al. (2012) studied the language development of children with cochlear implants and additional disabilities ranging from cognitive or learning delays, autism spectrum disorders (ASD), developmental delays, and other syndromic conditions. Understanding that typical testing would not be as effective for individuals in this population, the researchers created a battery of tests specific for testing children with disabilities. Beer et al. (2012) tested for functional auditory skills, which assesses the infant's ability to respond spontaneously to sounds in their environment, using the Infant-Toddler Meaningful Auditory Integration Scale (IT-MAIS; Zimmerman-Phillips, S. Robbins, A.M., & Osberger, M.J., 1997), receptive and expressive language, using the Preschool Language Scale (PLS-4; Zimmerman, Steiner, & Pond, 2002), adaptive behaviors, which measures communication abilities, daily living skills, socialization, and motor skills, using the Vineland Adaptive Behavior Scale (Sparrow, Cicchetti, Balla, 2005), and cognitive functioning, using the Bayley Scales of Infant and Toddler Development (Bayley, 2005). After assessing the 23 children in the study with a pre-test, before cochlear implantation, and post-test, Beer et al. (2012) found that overall the participants with hearing loss and additional disability made progress in functional auditory skills, receptive and expressive language, and adaptive skills after one year of implantation. The data were compared to children who also had cochlear implants with the same age at implantation who did not have additional disabilities. Beer et al. (2012) noted that the children with cochlear implants and additional disabilities did not see the same level of progress as their cochlear implant only peers, but they still made some progress in language development. This research is important for the current study because it suggests that there is development of language skills in children with hearing loss and additional disabilities.

Studies from the two different fields suggest that having a disability in addition to cochlear implantation would affect mother- and father-infant interactions in many forms. When parents interact with an infant with a hearing loss, previous studies have suggested different methods of communication to maximize speech and language outcomes, such as being direct with the infant during the interaction and reinforcing the infants' vocalization attempts (Choo and Dettman, 2015). Focusing more on the interaction to ensure the infant is both understanding their speech and trying to create a conversation of their own might also be beneficial. Being attentive to the conversation is very important, and something most parents of typical hearing infants would not naturally focus on as thoroughly. When additional disabilities are added in the mix, communication attempts could possibly be more difficult. As such, it is hypothesized that parent interaction will be negatively affected due to the added difficulty of the conversation.

Caregiver Interaction and Cochlear Implants

Previous research done by Fagan, Bergeson, and Morris (2014) examined how maternal interaction differed before and after an infant received a cochlear implant. They compared mother-infant vocal synchrony, maternal complexity and maternal directives and found that mothers adapted their speech to try to conform to the hearing loss, rather than using communication similar to mothers speaking to infants with typical hearing. For example, mothers' mean length of utterances (MLU) was less complex than that of speech to hearing infants the same age, and mother's utterances overlapped the infants' speech more than hearing infant, rather than typical turn-taking. Fagan et al. (2014) suggested that infants' ability to perceive sounds after cochlear implantation contributes to their mothers' increasing awareness of their infants' auditory abilities, which results in changes to mothers' reciprocal communication. Many mothers change their communication habits to better fit the infants' emerging vocabulary, for example, they may use simple utterances and less back-and-forth conversation. When dealing with infants with cochlear implants. Fagan et al. (2014) suggest that it is important to enhance interactions to help with infants' language learning.

It is important for parents of infants with hearing loss and cochlear implants to be educated on how to best promote language learning and communication. Choo and Dettman (2015) examined the effect maternal interaction has on the communication of an infant that has a cochlear implant, as well as strategies to best promote interactions. Most parents and infants who have a cochlear implant interact with an aural-oral approach, which focuses on visual interaction and spoken language. Choo and Dettman (2015) suggest that additional interaction might help advance the infant's communication and language learning. That is, interactions techniques can differ based on whether the focus is on the parent input or on encouraging reciprocal communication. Parent input is focused on using interesting voices, increasing frequency and consistency of the interactions. This can be done by sitting closer to the infant, or using more facial expressions and gestures. Reciprocal communication is finding ways to be more attentive and interactive in the communication attempts, such as creating a back and forth interaction with the infant. The goal of the approach with infants with cochlear implants would be to use a combination of techniques, encouraging parents to use these strategies to not only improve their own interaction, but also to help their infant interact and communicate more efficiently. The more focused the interaction, the better chance the infant has at acquiring language and learning to interact well with others and to carry out an interactive sequence.

Autism Spectrum Disorders

For over seventy-five years, research has been evolving to better understand Autism Spectrum Disorders (ASD). According to Faras et al. (2010), ASD is categorized by three main deficits, including impaired communication, impaired social interaction, and restricted and repetitive patterns of behavior and interest. Due to Autism being a spectrum disorder, the impairments range in severity and can change through acquiring additional developmental skills (Faras et al., 2010). With the characteristics of ASD in mind, the inability to communicate socially can impact the caregiver-infant interaction, creating more stressful communication attempts due to the deficits mentioned previously. As such, the ability to understand characteristics of ASD is important for any parent that has to partake in such interactions.

Before the official age of diagnosis, signs of autistic behavior have been observed in research during play or personal interaction. These cues can range from lack of eye contact to more specific aspects, such as limiting their focus. According to Bentenuto, De Falco, and Venuti (2016), infants who were later diagnosed with ASD showed signs of limited symbolic play, or shortening their play sequences and not creating pretend scenarios with their dolls or toys. They also noticed infants limiting their selection of toys, choosing to focus on a single object rather than switching their attention to more than one toy. Another infant behavior during play that has been shown to be a cue to ASD is the idea of "sticky attention," or what Sacrey, Bryson, and Zwaigenbaum (2013) describe in research as a child taking "longer to disengage their attention toward a second, peripheral target" (pg. 442). An infant having "sticky attention" or staring is a cue that is present in many infants, but is usually outgrown by the first year in life (Sacrey et al., 2013). When that behavior continues for infants past a year old, that could be a sign of autistic behaviors.

Global Delay

Mithyantha et al. (2017) describe global delay as a delay in two or more developmental domains. Domains can include gross or fine motor skills, speech and language, cognition, and social or personal skills, most commonly affecting children under the age of five years old (Mithyantha et al., 2017). Global delay can be classified as mild, moderate or severe. As global delay affects more than one area of developmental domains, the additional impact of hearing loss can cause major difficulty when communicating with the infant.

Cytomegalovirus

Cytomegalovirus (CMV) is the most common congenital infection that can cause disease in infants, according to Zuylen et al. (2014). Infants are infected by CMV during pregnancy, as the maternal infection crosses the placental barrier (Zuylen et al., 2014). Although a relatively mild infection for the mother, it can have devastating effects on the infant infected. Infants with CMV can have varying symptoms, including but not limited to unilateral or bilateral sensorineural hearing loss, vision loss, jaundice, seizures and mental disability (Zuylen et al., 2014). CMV is the leading cause of sensorineural hearing loss in developed countries, according to Zuylen et al. (2014). As such, the possibility of infants with CMV wearing cochlear implants is high. This can affect maternal and paternal interaction with infants as hearing loss is just one of many symptoms that would impact the conversation. Understanding how best to interact with the infant will be most beneficial to both parents as they try to navigate communication when cochlear implants and additional disabilities are involved.

Infant-Directed Speech and Later Language Learning

Caregivers changing their segmental and suprasegmental qualities of their speech when interacting with infants is known as infant-directed speech (IDS) (Ma, Houston, & Golinkoff, 2011). According to research done by Ma et al. (2011), using infant-directed speech during interaction has shown to support word learning and word segmentation for typically developing infants, but how it impacts language outcomes for infants with cochlear implants is still relatively unknown. Ma and colleagues (2011) investigated how IDS produced by 40 mothers affected the speech-language outcome for infants two years after their implantation. The results indicated that the quality and quantity of the speech had a positive effect on the predicted outcomes, indicating that the IDS promotes language growth and proficiency in infants with cochlear implants (Ma et al., 2011). This study is important in understanding how the dyads differed in interactions when using IDS.

Together, these studies suggest that hearing impairment or other disabilities affect various aspects of IDS, and IDS quantity and quality are related to later language outcomes. How does IDS compare across infants who have hearing loss and additional disabilities? It is hypothesized that parent interaction in the current study will be negatively affected due to the difficulty of the conversation.

Parental Stress Associated with Hearing Loss

Parental stress can be seen in any parent-child relationship due to the obstacles that appear when raising a child. These stressors, however, can be heightened when a child has a hearing loss. When parents discover that their child has a hearing loss, they often undergo a grieving process, which can be triggered as the child continues to grow and new hardships surface (Sarant and

Garrard, 2013). Sarant and Garrard (2013) state that parents will also face “ongoing practical challenges”, such as increased medical appointments, education on hearing loss and management of cochlear implants, and learning how to come to terms with their child having a disability and how to best advocate for their needs. Additional factors examined to cause stress include child age, age of diagnosis, social support, parental education and parental income (Sarant and Garrard, 2013).

Although parental stress was not specifically studied in this research, understanding the stressors that surface when a parent has an infant with a hearing loss is important when observing the parent-infant dyads in the study. It is understood when observing the dyads that the stressors mentioned above are present in the interactions, further affecting the communication beyond the hearing loss or other disabilities present.

Methodology

Participants

In the study, LENA audio recordings were analyzed for six infants who participated in an NIH-NIDCD funded research study with collaborators at The Ohio State University. The LENA is a recording device that the infant wears throughout the entire day. It records all interactions that take place and is used to pull out information on the infant's language abilities and communication skills. For this study, the LENA audio recordings were completed in each infant's home and included interactions with the infant's mother, and select interactions with both the mother and father. In the study, recordings of the parents speaking with six infants in the study were analyzed: an infant with cochlear implants and ASD (low SES), two infants with cochlear implants and normal development (high SES and low SES), one infant with a cochlear implant and CMV (average SES), one infant with a cochlear implant and global delay (average SES), and one infant who was typically developing (high SES). The LENA recordings were filtered, pulling out interactions during mealtime, playtime, story time or bedtime routine, a segment of the day that would yield high interaction and language content. These interactions were chosen due to the amount of time it takes to analyze the audio recordings, making sure specific and informative data were retrieved. This time period was chosen due to the consistency in daily interaction, as well as consistency across participants.

Procedure

The first phase of the study focused on transcribing the maternal and paternal interactions. For the infant with cochlear implants and normal development (low SES) and the infants with cochlear implants and an additional disability (ASD, CMV, global delay), the LENA recordings were transcribed at 3-, 6-, and 9-month intervals post-activation of the infant's cochlear implant (or after the first recording session). For the infant with cochlear implants and normal development (high SES) and the infant with normal development and normal hearing, the LENA recordings were analyzed for 3-months post-activation of the infant’s cochlear implant and 3-months of age, respectively. Most of the audio recordings had two to three days of recordings per month interval, meaning at each month interval, there were two to three days of LENA recordings that had been recorded in the infant’s home, allowing about 16-hours of audio recording per day. The audio recordings were first timed out to determine what type of interaction would provide the best depiction of the communication occurring between the infant and their parents. After listening to (and timing out) the audio file, the transcription took place, which entailed typing out the conversation between the infant and the parent. During the transcription, codes were also included that would allow for an easier understanding of the interaction that took place. For example, if the parent used any type of repetition or imitation of the infant's speech, a code was recorded, which can be used to understand what type of interaction the infant prefers, as well as how the parents are using different strategies to elicit vocalization from the infant (see Table 1). This process was repeated for each infant.

Once the transcripts were complete for each infant, at each month interval mentioned above, the transcript was processed through software called Systematic Analysis of Language Transcripts (SALT) (Miller et al., 2015) which provided detailed analyses based on the language used during the conversation. During the 3-month interval, the analyses focused on vocalization attempts (initiating a conversation with the infant or responding to their initiated conversation), turn-taking, in utterances ("switching between comprehending their partner's utterance and producing an appropriate and timely response") (Corps et al., 2018), mean-length of utterances (MLU) (calculated by the amount of morphemes, or smallest element of language, in each utterance, i.e. 'I like dogs' is a MLU of 4 due to the added –s to dog) (Williamson, 2014) and type-token ratio (total number of different words divided by the total number of words) (Templin, 1957) for the parents and the infant. When comparing the infants with cochlear implants and additional disabilities and cochlear implants and normal development, SALT analysis was further used to determine the target word repetition (how many times the parent would specifically repeat a word to try to provide a language learning opportunity, i.e. repeating the word 'milk' so the infant would comprehend the word with the object being discussed), repetition (the amount of times the parent would repeat what the infant said during the conversation), infant-directed speech (IDS), electronic use (amount of media used daily in the home) and use of American Sign Language (ASL) for the parent and infant across the 6- and 9-month intervals (see Tables 2, 3, and 4).

Results

The Role of Additional Disabilities

When considering the role of additional disabilities in the study, no differences across groups were discovered (see Table 2, 3 and 4). Although there are no differences, noting that the additional disabilities did not affect the parent-infant interaction is an important result.

The Role of Socioeconomic Status

Using SALT, specific details about the communication attempts of both the parents and infant were analyzed. When comparing the averages acquired across the six dyads (see Table 2), the families with high socioeconomic status had a higher amount of vocalization attempts, higher turn-taking, and used more utterances in their interaction than those with low socioeconomic status. For example, two dyads have infants with cochlear implants and normal development, however one dyad has a high SES and the other dyad has a low SES. When comparing vocalization averages, the dyad with high SES has an average of 98 attempts, while the low has an average of approximately 22 attempts. Since the infant diagnosis is the same, the family's SES is a key contributor in how the communication is affected between the parents and the infant. It was assumed that the dyads that have a cochlear implant and an additional disability would have similar results, but that is not the case. The dyads with CMV and cochlear implants and global delay and cochlear implants both have an average SES, while the dyad with ASD and cochlear implants has a low SES. The average SES dyads have vocalization and turn-taking attempts more than double that of the low SES dyad and a higher MLU, with averages that are more similar to the high SES dyads. Since the ASD and CI dyad was so much lower than the others, it is assumed that SES plays a significant role.

The Role of the Environment

For 6- and 9-months, averages were documented in terms of vocalization attempts, turn-taking in utterances, mean-length of utterances, and type-token ratio, target word repetition, repetition, infant-directed speech (IDS), electronic use and use of American Sign Language (ASL) (see Table 3 and 4). For both time intervals, each dyad had similar averages for vocalization attempts, unlike the 3-month results. This similarity could be due to the parents becoming more familiar with their infant's hearing loss and disability, learning how to better communicate with the infant, or simply due to the therapy that both the parents and infant are receiving, causing interactions to come with more ease. The ASD and CI dyad, however, was still lower in aspects of the interaction, such as, lower MLU and IDS at 6-months post activation, and lower in turn-taking and target word repetition at 9-months post activation. The infant was also exposed to three times the amount of media and electronics use than other dyads, which can drastically affect language and communication. These factors combined showed that the environment can have a significant impact on the interaction, demonstrating that the interaction is affected by more than the infant having a hearing loss and additional disability, as originally hypothesized.

Discussion

It was hypothesized that parent interaction would be negatively affected due to the added difficulty of the conversation when an infant has a hearing loss and an additional disability. However, the findings suggest that the interactions were not affected due to the additional disability alone, but rather due to other factors influencing the interaction.

Socioeconomic Status Impact

As described previously, maternal interaction with an infant with a cochlear implant and an additional disability can cause stressful communication attempts, however, results indicate that the disability is not the sole cause of the stress. One major component of the stress was the SES of the family observed. When evaluating maternal interaction with an infant with a cochlear implant and ASD, it is important to understand the environment that the infant has grown up in, as well as what resources and treatments they have had access to before or after diagnosis. To acquire the most accurate information, the parent's socioeconomic status (SES) can be taken into consideration.

When researching SES and rate of ASD in infants, there are varying views and opinions as how the two relate. According to Rai (2012) and colleagues, epidemiological studies in the United States often find a relationship between higher SES and a diagnosis of ASD, whereas studies from other countries with universal health care, such as Sweden, reveal a correlation between lower SES and a diagnosis of ASD. Rai et al. (2012) discovered that infants with ASD were more than likely to come from families with lower income, as well as from families with parents that work in manual occupations, or unskilled manual labor. The study was administered in Sweden, so the population that was studied is an important factor in the results. Swedish parents and infants have access to free universal health care, which includes routine screenings and easier access to diagnosis and treatment of disorders, such as ASD. Similarly, Fujiwara (2013) found a correlation between lower SES and ASD in Japan, another country with access to free universal health care. Since seeing the results from the Japan study compared to those in the United States, Fujiwara (2013) associates the findings of the United States based studies (higher SES and ASD) with the healthcare system. Families with higher SES often have higher education levels, higher income and better access to diagnosis and treatments of ASD at earlier ages, than those of a lower SES. With those comparisons in mind, it is understandable that the United States would see a relationship between higher SES and ASD, as many infants with lower SES could have never been given a diagnosis, which would exclude them from any studies or research that is compiled in the United States.

SES can also be indicative of the infant's ability to process skills for language development, access to therapy or strategies to combat issues pertaining to ASD, as well as those issues with hearing loss and cochlear implants. According to Fernald et al. (2012), there are significant differences in vocabulary and language development between low and high SES families by 18 months of age, and by 24 months there is a gap of 6 months, between the two groups, as far as language development. When adding in the difficulty of hearing loss and ASD, this discrepancy can become even more apparent in the infant's ability to communicate effectively with their parents, lowering the ability to have a successful maternal or paternal interaction.

Environmental Factors

Extended television and media use in the home negatively affected the communication attempts made by parents during the study. Previous research suggests that media usage can be varied based on SES of the family, as well as the age of which the infant is exposed. Mendelsohn et al. (2008) completed a study on the impact of infant television use and interactions in low SES households. The goal of the study was to determine the percentage of infants that watched television in low SES households compared to high SES, as well as how the interactions between the infant and parent were affected due to the early exposure to television. Although television use is not recommended until 2 years of age and older, according to the American Academy of

Pediatrics, many parents allow their infants to watch television due to the entertainment and perceived educational programming shown on child-centered television stations (Mendelsohn et al., 2008). Mendelsohn et al. (2008) found that 96.8% of the low SES mothers reported daily media exposure in their household, with the average exposure being at least 60 minutes per day, with exposure of television was seen most in parents with lower levels of education and familial income. The results also indicated that interactions were reported the most during educational child-oriented programs (42.8%), and about half of the infant's exposure was toward programs not aimed for children (Mendelsohn et al. 2008). However, even with a higher interaction based in educational child-oriented programming, the study determined that infant-directed educational programming was not a good substitute for co-viewing and verbal interaction, claiming that increased television use (even when it seems educational) is not beneficial to the infant's overall development (Mendelsohn et al., 2008). Even when infants watch educational based programming, there is still the need for increased interaction and discussion during the program. For example, rather than just allowing the infant to view the program alone, it would be more beneficial for the infants' development if the parent watched the program too, allowing a conversation and educational opportunities to emerge around the program. Increased television use without measures to counteract the potential developmental issues (i.e. decreased verbal interaction, loss of focus to other objects or people due to focus on television, limited exposure to reading and play) can have a negative effect on an infant's language and social development. Low SES is only one factor related to increased television use, however, and is not always indicative of delayed development or acquisition of disorders.

All disabilities observed in the study (ASD, CMV, and global delay) can adversely affect communication and an infant's ability to interact with others. Therefore, early exposure to media usage can cause a delay in development and acquisition of language. Heffler and Oestreicher (2016), demonstrate how media affected infants with ASD. Since the increased television access starting around the 1980's, and even higher in the 1990's and 2000's, there has been a rise in ASD diagnosis in infants, potentially demonstrating the correlations between ASD and increased television use (Heffler and Oestreicher, 2016). Infants are naturally attracted to media, without having an understanding of social interaction. For example, Heffler and Oestreicher (2016) state that increased television exposure creates a lack of understanding of real life social interaction, which means that when the infant watches the actor on the television screen and tries to smile, coo, provide joint-attention (sharing focus), or interact with a conversation (turn-taking, eye contact, etc.), there is no interaction back to the infant. This lack of back and forth interaction can both confuse and discourage the infant, resulting in the infant to stop attempting social interaction and lack the motivation to communicate with the television actors, or real life people, such as their parents. Heffler and Oestreicher (2016) state that the "socially disengaged infant" would continue to lose shared attention opportunities and lack the ability to learn from their environment and develop language. Interest in interactive speech would be diminished and eventually the infant would stop attending toward their parents or other individuals in social interactions, resulting in a bigger developmental delay in language (Heffler and Oestreicher, 2016). Heffler and Oestreicher (2016) continue to explain that an infant that did not orient during a social interaction would be unlikely to partake in imitation and turn taking, which are key cues when evaluating ASD.

Parental Interaction and Cochlear Implants

When evaluating paternal interaction, research from Broesch and Bryant (2017) suggests that it is important to understand the differences and variation in paternal interaction, as it can affect later language outcomes, similar to maternal interaction. When mothers speak to infants, they often change their speech compared to how they talk with adults, however when comparing father's speech, the differences arise due to societal factors rather than age of the communication partner. The study determined that when communicating with infants, fathers would often modify their acoustic features of speech (i.e. pitch) based on their socio-economic status (low, average or high SES) (Broesch and Bryant, 2017). Broesch and Bryant (2017) suggest that fathers in small scale societies "emphasize relationships and emotional attunement", while fathers in urban societies "focus on language learning and formal education". These findings indicate that the fathers use infant directed speech differently based on their own upbringing or the cultural group that they are currently associated. Although Broesch and Bryant's study does not involve infants with hearing loss, it is still important to understanding the basis of parental interaction and how the father may differ their interaction based on their societal situation, which can affect how the infant receives and acquires language. Whether the mother or father is communicating with the infant, when hearing loss is involved it is imperative that the parents learn effective ways to communicate to provide optimal language learning.

Conclusion

Parent interaction was not negatively affected due only to the difficulty of the additional disability, but rather due to a combination of factors, including the disability, SES, maternal and paternal education, and the home environment. The prominent example in the study was the ASD and cochlear implant dyad. The family had a low SES, lower maternal and paternal education (the mother completing only 9th grade and the father with a high school diploma or GED equivalent), extensive media and television use in the home, and a disability that has proven to impact language and communication. The parental interaction also played a role, as the father was more involved in the daily interaction than the mother because he stayed home with the infant. The combination of factors caused the parent interaction to be less engaging than their similar cochlear implant and additional disability counterparts. The factors have been shown in research to have a negative effect on language and vocabulary growth, further stunting an efficient interaction between the parent and infant.

Since the study is based on a selective and limited amount of participants, further research would need to be done to determine if the results stem from the factors included or if the small sample size and limited disabilities play a role. In the future, it would be beneficial to compare the ASD and cochlear implant dyad to one of high SES and caregiver education to see if those factors did indeed cause the decreased communication. As of now there is no dyad in the NIH-NIDCD funded research study at The Ohio State University that meets that criterion, however that would be the ideal next step.

References

Antonopoulou, K., Hadjukakou, K., Stampoltzis, A., Nicolaou, N. (2012). Parenting styles of mothers with deaf or hard-of-hearing children and hearing siblings. *Journal of Deaf Studies and Deaf Education, 17*(3), 306-318. https://doi.org/10.1093/deafed/ens013

Bayley, N. (2005). *Bayley Scales of Infant and Toddler Behaviors.* San Antonio, TX: Pearson Early Childhood.

Beer, J., Harris, M., Kronenberger, W., Holt, R., & Pisoni, D. (2012). Auditory skills, language development, and adaptive behavior of children with cochlear implants and additional disabilities. *International Journal of Audiology,* 51, 491-498. DOI: 10.3109/14992027.2012.664291

Bentenuto, A., De Falco, S., & Venuti, P. (2016). Mother-child play: A comparison of autism spectrum disorders, down syndrome, and typical development. *Frontiers in Psychology, 7*(1829), 1-9. http://doi.org/10.3389/fpsyg.2016.01829

Broesch, T., & Bryant, G. (2017). Fathers' infant-directed speech in small-scale society. *Child Development, 89*(2), 29-41. doi: 10.1111/cdev.12768

Choo, D., Dettman, S. (2016). Video analysis of mother-child interactions: Does the role of experience affect the accuracy and reliability of clinical observations? *Deaf &*

Education International 18(1), 13-24. https://doi.org/10.1179/1557069X15Y.0000000009

Corps, R. (2017). Coordinating utterances during turn-taking: the role of prediction, response preparation and articulation. *Discourse Process 55*(2), 230-240. https://doi.org/10.1080/0163853X.2017.1330031

Droucker, D., Curtin, S., & Vouloumanos, A. (2013). Linking infant-directed speech and face preferences to language outcomes in infants at risk for autism spectrum disorder. *Journal of Speech, Language, and Hearing Research, 56,* 567-576. DOI: 10.1044/1092-4388(2012/11-0266)

Fagan, M., Bergeson, T., & Morris, K. (2014). Synchrony, complexity, and directiveness in mothers' interactions with infants pre- and post-cochlear implantation. *Infant Behavior and Development, 37*(3), 249-257. https://doi.org/10.1016/j.infbeh.2014.04.001

Faras, H., Ateeqi, N., & Tidmarsh, L. (2010). Autism spectrum disorders. *Annals of Saudi Medicine, 30*(4), 295-300. doi: 10.4103/0256-4947.65261

Fernald, A., Marchman, V., Weisleder, A. (2012). SES differences in language processing skill and vocabulary are evident at 18 months. *Developmental Science, 16*(2), 234-248. https://doi.org/10.1111/desc.12019

Fujiwara, T. (2013). Socioeconomic status and the risk of suspected autism spectrum disorders among 18-month old toddlers in japan: A population-based study. *Journal of Autism Developmental Disorders, 44*(6), 1323-1331. doi: 10.1007/s10803-013-1988-3.

Heffler, K., & Oestreicher, L. (2016). Causation model of autism: Audiovisual brain specialization in infancy competes with social brain networks. *Medical Hypotheses, 91*, 114-122. doi: 10.1016/j.mehy.2015.06.019.

Ma, W., Golinkoff, R., Houston, D., Pasek, K. (2011. Word learning in infant-and adult-directed speech. *Lang Learn Dev, 7*(3), 185-201. doi: 10.1080/15475441.2011.579839

Mendelsohn, A., Berkule, S., Tomopoulos, S., Tamis-LeMonda, C.S., Huberman, H., Alvir, J., Dreyer, B. (2008). Infant television and video exposure associated with limited parent-child verbal interactions in low socioeconomic status households. *Archives of Pediatrics and Adolescent Medicine, 162*(5), 411-417. doi: 10.1001/archpedi.162.5.411

Miller, J., Andriacchi, K., Nockerts, A. (2015). Systematic Analysis of Language Transcripts [Computer software]. Middleton, WI: SALT Software LLC.

Mithyantha, R., Kneen, R., McCann, E., Gladstone, M. (2017). Current evidence-based recommendations on investigating children with global developmental delay.

Archives of Disease in Childhood, 102(11), 1071-1076. Doi: 10.1136/archdischild-2016-311271

Rai, D., Lewis, G., Lundberg, M., Araya, R., Svensson, A., Dalman, C., Carpenter, P., Magnusson, C. (2012). Parental socioeconomic status and risk of offspring autism spectrum disorders in swedish population-based study. *Journal of the Academic Academy of Child and Adolescent Psychiatry, 51*(5), 467-476. doi: 10.1016/j.jaac.2012.02.012.

Sacrey, L. A., Bryson, S., & Zwaigenbaum, L. (2013). Prospective examination of visual attention during play in infants at high-risk for autism spectrum disorders: A longitudinal study from 6 to 36 months of age. *Behavioural Brain Research, 256*, 441-450. https://doi.org/10.1016/j.bbr.2013.08.028

Sarant, J. & Garrard, P. (2013). Parenting stress in parents with cochlear implants: Relationships among parent stress, child language, and unilateral versus bilateral implants. *Journal of Deaf Studies and Deaf Education, 19*(1), 85-106. https://doi.org/10.1093/deafed/ent032

Sparrow, S., Cicchetti, D., & Balla, D. (2005). *Vineland Adaptive Behavior Scales--2nd Edition.* San Antonio, TX: Pearson Clinical Psychology.

Templin. M. (1957). *Certain language skills in children; their development and interrelationships.* Minneapolis, MN: University of Minnesota Press.

Willey, S., Meinzen-Derr, J., Grether, S., Choo, D. (2011). Children with cochlear implants and developmental disabilities: A language skills study with developmentally matched hearing peers. *Research in Developmental Disabilities, 32*(2), 757-767. https://doi.org/10.1016/j.ridd.2010.11.004

Williamson, G. (2014, January 29). *Mean length of utterances.* Retrieved from https://www.sltinfo.com/mean-length-of-utterance/

Zimmerman, I. L., Steiner, V., & Pond, R. E. (2002). *Preschool Language Scale--4th Edition. Preschool Language Scale--4th Edition (PLS-4)*. Minneapolis, MN: Pearson Assessments.

Zimmerman-Phillips, S. Robbins, A.M., & Osberger, M.J. (1997). *Meaningful Auditory Integration Scale (MAIS)/Infant Toddler: Meaningful Auditory Integration Scale (IT-MAIS).* Sylmar, CA: Advanced Bionics

Zuylen, W., Hamilton, S., Naing, Z., Hall, B., Shand, A., Rawlinson, W. (2014). Congenital cytomegalovirus infection: clinical presentation, epidemiology, diagnosis and prevention. *Obstetric Medicine, 7*(4), 140-146. https://doi.org/10.1177/1753495X14552719

Appendix

Table 1

Codes used during transcription

[IMITATE]	Parent imitated child's vocalization
[LAF]	Laughing
[SENM]	Sound effect, no meaning
[SEM]	Sound effect, meaning (i.e. woof for dog barking)
[REP:n]	Repetition of a sound
[UREP]	Repetition of an utterance
[PUREP]	Partial repetition of an utterance
[EUREP]	Expanded utterance repeated
[IV]	Infant vocalization
[IC]	Infant crying
[NRC]	No response from child
[NRP]	No response from parent
[TARn:n]	Target word, how many times used
[IDS]	Infant directed speech
[SU]	Unintelligible speech understood by parent

Table 2

Comparison of average infant and parent communication at 3-months post-activation of the cochlear implant

	SES		**Vocalization**		**TT (Utterances)**		**MLU (Words)**		**TTR**	
	M	**I**	**M**	**I**	**M**	**I**	**M**	**I**	**M**	**I**
ND/NH	High		43.5	16	4.39	1.58	7.65	1.00	0.42	0.16
	M	**I**	**M**	**I**	**M**	**I**	**M**	**I**	**M**	**I**
ND/CI	High		98	106	1.94	1.87	4.87	1.04	0.41	0.16
	M&F	**I**	**M&F**	**I**	**M&F**	**I**	**M&F**	**I**	**M&F**	**I**
ND/CI	Low		21.67	36	2.16	2.24	2.79	1.12	0.51	0.40
	M&F	**I**	**M&F**	**I**	**M&F**	**I**	**M&F**	**I**	**M&F**	**I**
ASD/CI	Low		16.5	29.3	1.63	2.59	3.13	1.00	0.55	0.06
	M	**I**	**M**	**I**	**M**	**I**	**M**	**I**	**M**	**I**
GB/CI	Average		47.5	15.5	3.00	1.29	4.46	1.00	0.57	0.14
	M	**I**	**M**	**I**	**M**	**I**	**M**	**I**	**M**	**I**
CMV/CI	Average		83	24	4.31	1.18	4.19	1.00	0.31	0.11

Note. ND=Normal Development, CI=Cochlear Implant, ASD=Autism Spectrum Disorder, GB= Global Delay, CMV=Cytomegalovirus, SES=Socio-Economic Status, TT=Turn-Taking in Utterances, MLU=Mean Length of Utterances in Words, TTR=Type-Token Ratio, M=Mother, M&F=Mother & Father, I=Infant

Table 3

Comparison of average infant and parent communication at 6-months post-activation of the cochlear implant

	SES		Vocalization		TT		MLU		TTR	
	M&F	**I**	**M&F**	**I**	**M&F**	**I**	**M&F**	**I**	**M&F**	**I**
ND/CI	Low		44.2	33.6	2.12	1.66	4.26	1.10	0.47	0.38
	M&F	**I**	**M&F**	**I**	**M&F**	**I**	**M&F**	**I**	**M&F**	**I**
ASD/CI	Low		32.3	47.3	1.61	1.72	4.10	1.00	0.53	0.05
	M	**I**	**M**	**I**	**M**	**I**	**M**	**I**	**M**	**I**
GB/CI	Average		44.00	22.00	2.27	1.47	4.71	1.00	0.48	0.12
	M	**I**	**M**	**I**	**M**	**I**	**M**	**I**	**M**	**I**
CMV/CI	Average		23.00	14.00	2.06	1.47	5.23	1.00	0.51	0.14

	TWR	Repetition	IDS	Education Level	ASL Use
	M&F	**M&F**	**M&F**	**M&F**	**M&F**
ND/CI	3.8	5.6	5.0	HS/GED	0
	M&F	**M&F**	**M&F**	**M&F**	**M&F**
ASD/CI	0.7	7.67	1.5	9th grade and HS/GED	0
	M	**M**	**M**	**M**	**M**
GB/CI	7.5	4.0	8.0	HS/GED	0.5
	M	**M**	**M**	**M**	**M**
CMV/CI	1.0	1.5	4.5	Associates Degree	2.5

	Age	Electronic Use
	I	**I**
ND/CI	25 months	5%
	I	**I**
ASD/CI	21 months	22%
	I	**I**
GB/CI	23 months	4%
	I	**I**
CMV/CI	19 months	8%

Note. ND=Normal Development, CI=Cochlear Implant, ASD=Autism Spectrum Disorder, GB= Global Delay, CMV=Cytomegalovirus, SES=Socio-Economic Status, TT=Turn-Taking in Utterances, MLU=Mean Length of Utterances in Words, TTR=Type-Token Ratio, TWR=Target Word Repetition, IDS=Infant Directed Speech, ASL=American Sign Language, M=Mother, M&F=Mother & Father, I=Infant, HS/GED=High School Diploma

Table 4

Comparison of average infant and parent communication at 9-months post-activation of the cochlear implant

	SES		Vocalization		TT		MLU		TTR	
	M&F	**I**	**M&F**	**I**	**M&F**	**I**	**M&F**	**I**	**M&F**	**I**
ND/CI	Low		46.00	30.67	2.09	1.66	4.51	1.49	0.50	0.46
	M&F	**I**	**M&F**	**I**	**M&F**	**I**	**M&F**	**I**	**M&F**	**I**
ASD/CI	Low		57.30	54.30	1.25	1.04	5.41	1.05	1.02	0.46
	M	**I**	**M**	**I**	**M**	**I**	**M**	**I**	**M**	**I**
GB/CI	Average		48.5	13.00	3.8	1.04	4.88	1.00	0.29	0.16
	M	**I**	**M**	**I**	**M**	**I**	**M**	**I**	**M**	**I**
CMV/CI	Average		78.00	20.50	6.40	1.05	4.65	1.00	0.34	0.09

	TWR	Repetition	IDS	Education Level	ASL Use
	M&F	**M&F**	**M&F**	**M&F**	**M&F**
ND/CI	4.33	6.67	3.33	HS/GED	2.67
	M&F	**M&F**	**M&F**	**M&F**	**M&F**
ASD/CI	0.25	14	7.5	9th grade and HS/GED	0
	M	**M**	**M**	**M**	**M**
GB/CI	2.5	1.5	5	HS/GED	4
	M	**M**	**M**	**M**	**M**
CMV/CI	3	5.5	14	Associates Degree	1

	Age	Electronic Use
	I	**I**
ND/CI	28 months	7%
	I	**I**
ASD/CI	24 months	29%
	I	**I**
GB/CI	26 months	N/A
	I	**I**
CMV/CI	22 months	N/A

Note. ND=Normal Development, CI=Cochlear Implant, ASD=Autism Spectrum Disorder, GB= Global Delay, CMV=Cytomegalovirus, SES=Socio-Economic Status, TT=Turn-Taking in Utterances, MLU=Mean Length of Utterances in Words, TTR=Type-Token Ratio, TWR=Target Word Repetition, IDS=Infant Directed Speech, ASL=American Sign Language, M=Mother, M&F=Mother & Father, I=Infant, HS/GED=High School Diploma