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Mothers' Speech to Infants With and Without Down syndrome

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Mothers' Speech to Infants With and Without Down syndrome

by

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Louisiana State University
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Honors College
Louisiana State University
Baton Rouge, Louisiana

CERTIFICATE OF APPROVAL

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HONOR'S THESIS

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This is to certify that the Honor's thesis of

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has been approved by the Examining Committee for the thesis requirement for the Bachelor of Arts degree in Communication Disorders at the May 2010 graduation.

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confidence to attempt a thesis, much less complete one and present my work at a national convention.

ABSTSRACT

Much research has shown a universal preference across typically developing infants for infant-directed speech (IDS; Fernald & Simon, 1984; Grieser & Kuhl, 1988). It is a preference demonstrated shortly after birth (Cooper & Aslin, 1990) across all infants. Not only is there a universal preference for IDS, there also appears to be a natural inclination for talkers of all ages to employ IDS when communicating with very young children (Fernald, et al., 1989; Weppelman, Bostow, Schiffer, Elbert-Perez, & Newman, 2003). This strong preference for, and use of, IDS even prompted some researchers to suggest there is a language-learning utility of IDS (Fernald & Mazzie, 1991; Kemler Nelson, Hirsh-Pasek, Jusczyk, & Wright Cassidy, 1989; Thiessen, Hill, & Saffran, 2005). Despite the great amount of research examining the preference for and use of IDS, few people to date have examined the preference and use of IDS with atypical, infant populations—particularly populations known to have delays in cognitive and language development, such as infants with Down Syndrome. The goal of my study was to determine whether mothers of infants with Down Syndrome employ IDS and how their IDS compares to the IDS of mothers of infants who are typically developing. Two-minute speech samples were taken from a 30-minute, in-home recording of 10 mothers' interactions with their infants. The mothers' speech was acoustically analyzed and compared across three groups of infants (Down Syndrome: n = 4; chronologically matched: n = 2; mentally matched: n = 4): Down Syndrome, chronologically matched, and mentally matched infants with typical development. I found there was no significant difference between the IDS of mothers of infants with Down Syndrome and the IDS used by mothers of typically developing infants when compared by chronological age or mental age.

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CHAPTER I

INTRODUCTION

As an adult, a natural inclination exists to use an exaggerated form of speech while speaking to typically developing infants (Fernald & Kuhl, 1987). This form of speech is referred to as infant-directed speech (IDS) within the literature. Variable fundamental frequency, short utterances, and a slow speaking rate help to characterize a few aspects of IDS noted throughout the literature. While most research was conducted with typically developing infants, research with different populations of infants, specifically populations with special needs, exists but in far less abundance. For instance, Bergeson, Miller, and McCune (2006) examined the acoustic qualities of IDS towards infants with hearing loss and cochlear implants. Iverson, Longobardi, Spaminato, and Caselli (2006) analyzed the functional characteristics of infant-directed language and gestures towards infants with Down Syndrome as compared to infants who are typically developing. However, little research has been conducted to date examining the acoustic characteristics of IDS toward infants with Down Syndrome. Does a mother of an infant with Down Syndrome utilize a different form of IDS when speaking to her infant compared to a mother of a typically developing infant? And if she does, would this have an effect on the infant's language development during her preschool and elementary years? Knowing the answers to these questions could lead to clinical interventions for individuals with Down Syndrome and their speech, language, and listening skills. In this study, I described the characteristics of IDS used by mothers of infants with Down Syndrome as well as the IDS used by mothers of typically developing infants. Additionally, I compared the mothers' speech across the groups to determine if the acoustic cues of the mothers' IDS were significantly different.

Mothers' Speech to Typically Developing Infants

Numerous studies indicated that adults' speech to infants is characterized by simplifying different acoustic characteristics (Fernald & Kuhl, 1987; Fisher & Tokura, 1996). Fernald and Kuhl suggested that the differentiating acoustic aspects of IDS include: high mean fundamental frequency (F0), high maximum F0, low minimum F0, large F0 ranges, long pauses, short utterances, and repeated prosodic cues. It's been theorized that due to these acoustic characteristics, typically developing infants show a universal preference for IDS[1]. This universal preference lasts from birth into toddlerhood. Using a visual habituation paradigm, Cooper and Aslin (1990) found that both 1-month-old and 2-day-old infants attended longer to a visual stimulus paired with IDS than a visual stimulus paired with adult-directed speech (ADS), providing evidence that infants as young as 2-days-old prefer to listen to IDS compared to ADS. Thus, adults utilize the acoustic characteristics described by Fernald and Kuhl (1987) when speaking to their infants, regardless of the infants' ages, and infants consistently prefer to listen to this style of speaking. Additionally, IDS has been shown to contain a social benefit for infants in that infants interact with adults while being the center of attention. A talker's positive affect and the infant's interacting with an adult while being the center of attention both contribute to IDS grasping an infant's attention (Walker-Andrews, 1997). Interactions between infants and adults, particularly their parents, build the foundation for interpersonal communication that is necessary to develop language (Striano, 2004). Thus, it is not surprising that adults employ this form of speech when speaking to infants and that infants show a robust preference for IDS.

[1] It is important to note that while much research suggests the acoustic characteristics of IDS are the cause of this robust preference, recent research (Singh, Morgan, & Best, 2002) suggested that the preference stems from a talker's positive affect, unrelated to the degree of emotion expressed and whether the speaker is speaking to an infant or adult.

Not only does research show that infants' have a robust preference for IDS, evidence also exists showing that talkers of all ages have a natural inclination to employ IDS during communication with infants (Dunn & Kendrick, 1982; Fernald & Kuhl, 1987; Fernald, et al., 1989; Weppelman, et al., 2003). This natural inclination to employ IDS with infants can be seen in the speech of children as young as preschool-aged. Weppelman, et al. (2003) analyzed the speech of 24 4-year-old children (half had younger siblings and half did not) to infants and adults. They determined that the children spoke slower when addressing an infant as compared to addressing an adult. These data suggested that children as young as 4-years-old utilize a specific characteristic of IDS (i.e., slower speaking rate) when speaking to infants. In addition to occurring in talkers of all ages, the inclination to employ IDS with infants exists across multiple cultures and languages. When exploring the prosodic characteristics of both mothers' and fathers' speech of multiple cultures (including Italian, French, Japanese, British English, German, and American English) to their infants, researchers found evidence for a natural inclination to employ IDS independent of the parent's culture (Fernald, et al., 1989). Thus, irrespective of age or culture, all talkers have a natural inclination to adjust their speaking style when addressing an infant. Why is it that this inclination to use IDS seems so prevalent? Is it possible that this style of speech is crucial to an infant's development of language or listening skills?

If all talkers have a universal tendency to employ IDS when speaking to infants, IDS is likely to contain some utility to the infant's development. Research suggested that one such utility associated with IDS is language facilitation (Fernald & Mazzie, 1991; Kemler Nelson, et al., 1989; Thiessen, et al., 2005). Kemler Nelson and colleagues presented four sets of stimuli to a group of newborn infants: IDS interrupted between clauses, ADS interrupted between clauses,

IDS interrupted within clauses, and ADS interrupted within clauses. They found that infants attended longer in a visual habituation paradigm to IDS that was interrupted at the ends of clauses as opposed to within-clause interruptions. This preference was only found for the IDS stimuli and did not appear in either of the ADS stimuli provided to the infants. Additionally, IDS seems to facilitate word segmentation suggesting that infants are able to distinguish different syllables and phonemes, due to the prosodic characteristics of IDS (Thiessen, et al., 2005). The pauses present between words and phrases offer information for infants about syntax, an important aspect that an individual must learn when developing language. Thus, these studies indicate that the prosodic characteristics of IDS promote the development of language skills as early as infancy. Finally, Soderstrom, Blossom, Foygel, and Morgan (2008) found that mothers use prosodic information to provide cues to grammatical units at utterance boundaries as well as at boundaries found in internal clauses of utterances. They suggested that the prosodic cues in questions (e.g., rising intonation) may play a role in an infant's development and understanding of verb phrases in English. In providing intonations associated with questions and cues to the beginnings and ends of phrases, IDS supplies infants with cues to the syntax of language and gives a foundation for language development. Together, the research findings of Kemler Nelson et. al., Thiessen, et. al., and Soderstrom, et. al., suggest a language-learning utility of IDS. Thus, I propose that parents' utilization of IDS when communicating with their infants is central to the development of a child's linguistic skills. If an infant's auditory environment lacks IDS, I argue the infant is at a disadvantage. Because of the extensive research supporting the idea that IDS contains a language learning utility (e.g., Soderstrom, et al., 2008; Thiessen, et al., 2005), a child not receiving IDS regularly may lag behind peers when language begins to emerge.

Mothers' Speech to Down Syndrome Infants

Since adults utilize IDS consistently with infants and IDS may facilitate language development in typically developing children, it is important to delve into the question of whether adults utilize the same style of IDS with infants of special populations, especially those who might benefit most from IDS' language facilitation. Because there is a dearth of research on IDS with infants in special populations, there is no normative data regarding the use of IDS with atypically developing infants. Although an abundance of normative data exists for infants with typical development (i.e., talkers' natural inclination to use IDS and the language-learning utility associated with IDS), it is difficult to generalize this data to infants in special populations. Therefore, researchers and clinicians should question whether the foundation of language built through use of IDS in typically developing infants exists to the same extent in infants in special populations. Because infants in special populations are not typically developing, I predict there is a difference between the styles of IDS employed by mothers with typically developing infants and those with infants in special populations. If my prediction holds true and a difference exists between IDS with typically developing infants and infants in special populations, clinical implications include educating parents to use IDS and interact with their delayed infants in a way to better facilitate language. It is possible such intervention would then lead to better language outcomes for infants that typically experience extreme language delays later in life (Chapman, Seung, Schwartz, & Bird, 1998).

For my study, I was particularly interested in IDS used when speaking to individuals with Down Syndrome. Down Syndrome is the most common genetic chromosomal disorder, occurring in approximately 1 in 900 live births (Stoll, Alembik, Dott, & Roth, 1990). Down Syndrome is associated with a wide range of development from severe to mild mental

retardation, with a few rare cases of average intelligence. A developmental delay begins to appear around 4 to 6 months of age and the gap between developmental age and chronological ages increases as individuals with Down Syndrome grow older (Saxon & Witriol, 1976). The developmental delay in individuals with Down Syndrome is particularly evident in their language development. Individuals with Down Syndrome often experience a delay in expressive language but their receptive language is on par with their typically developing, age-matched peers (Fidler, 2005). Along with a developmental delay, many physical features are common among individuals with Down Syndrome, including a distinctive craniofacial structure and health-related issues such as immune and endocrine system abnormalities, otitis media, hearing loss, and congenital heart disease (Pueschel & Pueschel, 1992). These health-related issues may cause problems in the language development of individuals with Down Syndrome. For instance, a child with hearing loss receives less auditory input, which may result in a lag in language development (Bess, Tharpe, & Gibler, 1986). Additionally, a child who is continually hospitalized for heart disease or immune deficiencies receives far less language exposure compared to a typically developing child who spends most of his or her time in the house with a caregiver. This reduced exposure to adult language models may result in a decrease in language abilities in a child with Down Syndrome (Landry, Smith, & Swank, 2002). Because of these issues, I believe it is important to research the linguistic and acoustic input parents provide to their infants with Down Syndrome to determine if individuals with Down Syndrome could benefit from intervention techniques different from those that benefit their typically developing peers. However, little research exists on the linguistic input to infants with Down Syndrome, and no research to date exists on the acoustic characteristics of IDS employed with infants with Down Syndrome.

While little research was conducted with infants with Down Syndrome, research has been conducted with infants in other special populations. Bergeson, Miller and McCune (2006) compared IDS with infants of a different special population, those with cochlear implants. In their study, they compared infants with cochlear implants to infants with normal hearing that were matched by chronological age and hearing experience. The researchers found that both groups of mothers employed IDS with their children. However, mothers with infants with normal hearing and infants with cochlear implants matched by hearing experience increased their pitch, changed their minimum pitch, and elongated their pauses more similarly than mothers of infants with cochlear implants and normal hearing infants matched by chronological age. Therefore, mothers exaggerated their IDS when an infant had access to sound for a relatively shorter amount of time and little spoken language listening experience. The mothers' exaggeration of IDS implies that these mothers adjusted their communication style to reflect their infants' delayed ability to hear, comprehend, and process the information. This study prompts one to wonder whether mothers adjust their communication style to their infants' comprehension abilities with infants of other special populations. I believe this is an interesting question to research because the populations are so diverse in development and enormity of their delays. I predict that the results of Bergeson et. al. (2006)'s study—mothers use a different type of IDS with infants with special needs—would be echoed in infants with Down Syndrome.

Little research has been conducted on IDS and the infant population of individuals with Down Syndrome. However, recent research examined the speech of mothers towards their older children with Down Syndrome. Fidler (2003) examined child-directed speech of mothers towards their children ages 3- to 8-years-old with Down Syndrome compared to the speech of mothers of children with other mental disabilities (e.g., Williams syndrome, Prader-Willi

syndrome, autism, and cerebral palsy). They found mothers of children with Down Syndrome increased their F0 and used broader mean F0 variance when speaking to their children as compared to mothers of children with other mental disabilities. However, their study compared mothers' speech toward children with Down Syndrome to mothers' speech to children with other mental disabilities, not typically developing children. Does a difference exist between the speech of mothers toward children with Down Syndrome and typically developing children? Additionally, because Fidler's study examined the speech of mothers towards their *children* with Down Syndrome, the data cannot be generalized to the *infant* population due to the fact that mothers tend to speak differently to their infants than to their older children. There is a significant gap in the research of IDS with infants with Down Syndrome. Since infancy is a period of prime language exposure and development, I propose that examining IDS with infants with Down Syndrome might lead to understanding the early development of language in individuals with Down Syndrome. If more is known about the mothers' acoustic input to infants with Down Syndrome, then researchers can determine whether the language delay experienced by individuals with Down Syndrome is primarily due to the cognitive delays associated with this group of individuals or to the variations in the acoustic characteristics of the speech used with this population. Furthermore, if we gain knowledge of how individuals with Down Syndrome develop language, we can develop more appropriate clinical interventions for the treatment of language delays in this special population.

Although no research currently exists examining the *acoustic* characteristics of IDS for infants with Down Syndrome, the research that does exist on communication with infants with Down Syndrome examined the *language* characteristics of mother-child interactions. For example, Iverson, Longobardi, Spaminato, & Caselli (2006) examined 10 mothers' language

input to their infants. They tallied the number of utterances and the use of gestures, nouns and pronouns during the time the mothers communicated with their infants. Half of the mothers had infants with Down Syndrome and the other half of the mothers had typically developing infants. Iverson et al. found that mothers adjust their communication style to the developmental status of their children by using more gestures, less nouns and pronouns, and fewer utterances when communicating with their infants with Down Syndrome. This implies that mothers of infants with Down Syndrome use infant-appropriate language and gestures to accommodate the developmental stage of their child. However, this study only examined the functional characteristics of mothers' interactions with their infants, characteristics that are easily and consciously altered when one is aware of an individual's cognitive delay. It is still unknown whether mothers alter the acoustic parameters of their speech when interacting with their infants with Down Syndrome. Because the acoustic parameters of IDS towards typically developing infants are suggested to facilitate language learning (Soderstrom, et al., 2008; Thiessen, et al., 2005), it is important to examine the acoustic parameters of IDS towards infants with Down Syndrome, who often experience a significant language delay (Chapman, et al., 1998; Fowler, 1990; Yoder & Warren, 2004). The language delay experienced by individuals with Down Syndrome is most evident in the syntactic characteristics of speech (Fowler, 1990) and averages 50% below the language abilities of typically developing individuals. However, positive reinforcement of communicative intent to infants with Down Syndrome predicts later productive language (Yoder & Warren, 2004). This implies that parents providing their infants with multiple positive responses to communicative intent facilitate their children's language development. Clinically, this suggests that educating a mother about her child's delay is extremely important. If the parents of infants with Down Syndrome were to use an acoustically exaggerated form of

IDS along with positive reinforcement of communicative intent—both of which have been suggested to assist in language-learning—children with Down Syndrome might benefit greatly in their development of language later in life.

Aims

I had two goals for my study: 1) to fill in the aforementioned gaps in the pediatric Down Syndrome literature and to describe the acoustic characteristics of IDS employed by mothers of infants with Down Syndrome and 2) to determine how the acoustic characteristics of IDS towards infants with Down Syndrome compare with the acoustic characteristics of IDS used by mothers of typically developing infants. I hypothesized that all of the mothers who participated would use IDS. However, I predicted that a difference would exist between the IDS used by mothers of infants with Down Syndrome and the IDS used by mothers of typically developing infants, particularly I believed that mothers of infants with Down Syndrome would have greater fundamental frequency variation, shorter utterances, longer pauses, and a slower speaking rate as compared to mothers of typically developing infants.

In summary, research suggests that mothers use an exaggerated form of IDS (when examined both acoustically and functionally) while speaking to their infants with disabilities. However, no research to date explored the acoustic characteristics of IDS towards the infant population with Down Syndrome. I wondered whether or not a difference exists between mothers' IDS towards infants with Down Syndrome and typically developing infants. This is an important question to research because, as I stated before, children with Down Syndrome often experience a significant language delay (Fowler, 1990; Yoder & Warren, 2004) which can be remediated by optimal parental responses. If parents also exaggerated the acoustic characteristics

of IDS when communicating with their infants with Down Syndrome, the exaggerated acoustic input could provide these children with an advantageous linguistic environment, leading to enhanced language development later in life. In my study, I examined the acoustic characteristics of mothers' speech with their infants with Down Syndrome and compared this speech to mothers' speech with their typically developing infants in order to begin the process of ultimately determining how mothers' speech during infancy may aid in the language development of their delayed children.

CHAPTER II

METHODS

Experimental Design

This study employed a between-subjects design with *child type* as the independent variable. The following served as the levels of the independent variables: Down Syndrome infants, typically developing infants matched by chronological age (CA), and typically developing infants matched by mental age. The numbers of infants in each of the groups were not equal due to recruitment challenges and the lack of infant-mother dyads available to participate in the study. Therefore, the Down Syndrome group contained four infants, the CA group contained two infants, and the MA group contained four infants.

Participants

A total of 10 mothers and their infants between the ages of 5 to 21 months participated in this study (five boys). Four of the mothers had infants diagnosed with Down Syndrome; six of the mothers had infants who are typically developing. The infants with Down Syndrome were matched by chronological age and mental age to the typically developing infants. See Table 1 for a breakdown of the participant groups and the participants' ages. All participants had normal-hearing thresholds and came from native American English speaking homes. I recruited participants through letters sent to the Down Syndrome Awareness Group of Baton Rouge as well as by word of mouth. Mental age was determined in accordance with the "Mental Scale" of the *Bayley Scales of Infant Development-II* (Bayley, 1993). The *Bayley Scales of Infant Development-II* is an assessment tool used to measure an infant's developmental abilities. The

"Mental Scale" evaluates aspects of the infant's cognitive functioning including "items that assess memory, habituation, problem solving, early number concepts, generalization, classification, vocalizations, language, and social skills" (Bayley, 1993, p. 1).

Participant	**Chronological Age** (month; day)	**Mental Age** (months)
DS1	13;8	9
DS2	21;14	12
DS3	14;15	8
DS4	5;12	3
TD1	15;29	14-16
TD2	7;22	8
TD3	17;12	17-19
TD4	9;12	8
TD5	5;8	5
TD6	8;19	9

Table 1. The chronological age of each participant listed in month; day format with the mental age of each participant listed in months. The mental age was calculated using the "Mental Scale" of the Bayley Scales of Infant Development-II. *DS = infant with Down Syndrome; TD = infant with typical development.*

Down Syndrome Group	Chronological Group	Mental Group
DS1	TD2	TD1
DS2	TD4	TD3
DS3		TD5
DS4		TD6

Table 2. The list of participants in each of the groups. The Down Syndrome (DS) group contains all four DS participants, while the typically developing (TD) participants were dispersed among the chronological and mental groups.

Procedures

For this study, I used procedures similar to Bergeson, Miller, and McCune's (2006) study examining mothers' speech to infants with cochlear implants and infants with normal hearing. My procedures differed in that a researcher went to the infant's home to observe the 30-minute session to record the mother and infant in their natural environment as opposed to observing the mother and infant in a lab setting. After scheduling an appointment with the parent, the researcher arrived at the home of each participant at the scheduled time. Initially, the researcher and mother found a quiet area in the home (free of visual and auditory noise) to set up the audio and video equipment for recording. The researcher explained to the mother the procedures. The mother then signed a consent form and filled out a birth history questionnaire. The researcher then audio and video recorded the mother's interactions with her infant for 30-minutes. The researcher instructed the mother to play naturally and allowed the mother to use her own toys as a means to elicit language. There were no rules governing the mother's speech production. The researcher did not participate in the interactions between the mothers and her infant. The mother's speech was digitally recorded using a *Shure KSM9* microphone held by the researcher

and linked to a *Marantz* solid-state digital audio recorder. Each session was also videotaped using a *Panasonic HD Digital* video recorder. After the play session between the mother and infant, the *Marantz* was turned off and the researcher, experienced in conducting the test, administered the "Mental Subtest" of the *Bayley Scales of Infant Development-II*. The researcher then turned off the video camera and compensated the infant-mother dyad with either a t-shirt or a toy for their participation in the study.

Acoustic Analyses

Two-minute audio samples were extracted from each 30-minute recording. These samples were extracted from the audio recording approximately 15 minutes into each session (recordings' average time stamp: 14:56.042) and used for acoustic analysis. The exact time at which the two-minute sample was extracted from each recording varied depending on whether the mother was talking to the baby at the 15-minute mark and whether background noise was present. The 15-minute mark was chosen (as opposed to the beginning of the recording) in order to account for any adjustments the mothers may have needed to make in the presence of video and audio equipment. For participant DS4, the presence of a sibling talking in the background forced the researcher to extract the two-minute sample, closer to the final 15-minute mark of the 30-minute recording, without the sibling talking in the background (recording's time stamp: 7:15.000-9:15.000).

PRAAT (Boersma & Weenink, 2009) was used to analyze all two-minute samples. The following acoustic and linguistic properties that characterize IDS were analyzed as in Fernald and Kuhl's (1987) study: average fundamental frequency (F0), maximum F0 of each utterance, minimum F0 of each utterance, F0 range of each utterance, F0 standard deviation, utterance

duration, duration of pauses between utterances, number of utterances, number of words per utterance, and speaking rate. Utterances were operationally defined as a complete thought or a complete sentence and measured in seconds. A breath group was *not* considered an utterance. For example, "What about the train?" and "Oh…I'm comin' get you" were both judged as utterances. The researcher marked the beginning and end time of each utterance. The ending time of one utterance was subtracted from the beginning time of the next utterance to determine pause durations. The researcher calculated the minimum F0 of each utterance and the maximum F0 of each utterance and used the total average of the minimum F0 as well as the total average of the maximum F0 during comparisons of the data. Speaking rate was calculated by dividing the total number of words from 120 seconds (i.e., two minutes).

Interrater reliability was gathered on 20% of the two-minute samples. Two unbiased researchers used *PRAAT* and conducted the same acoustic analysis described above. The results of the primary researcher's acoustic analyses were correlated with the results of two separate secondary researchers' acoustic analyses (rater 1: $r = .957$; rater 2: $r = .985$).

CHAPTER III

RESULTS

Frequency Analysis

Average F0. Figure 1 shows average F0 for each group of the infants: those with Down Syndrome (M = 306.465 Hz), and the typically developing infants matched for chronological age (CA; M = 317.594 Hz) and mental age (MA; M = 321.610 Hz). An independent *t*-test comparing the Down Syndrome group and the CA group revealed no significant difference between the average F0 for the two groups [t (4) = 0.3776, $p > 0.05$]. A second *t*-test comparing the Down Syndrome group and the MA group showed no significant difference between the average F0 of these two groups [t (6) = 0.6958, $p > 0.05$].

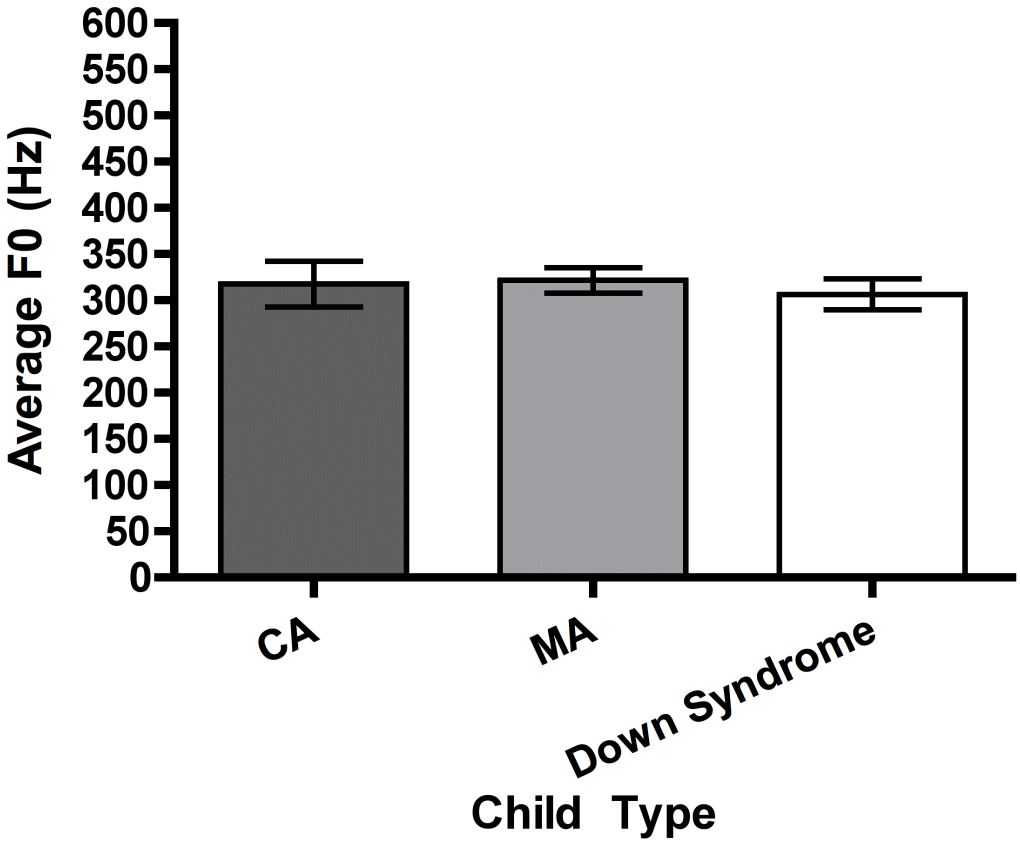

Figure 1. Average F0 (in Hz) and standard error of mothers' speech to their infants in the CA, MA, and Down Syndrome groups.

Maximum and minimum F0. The maximum F0 and minimum F0 were calculated for each utterance and then separately averaged across the total utterances from each mother. Figure 2 shows the group average maximum F0 results of the groups and Figure 3 shows the average minimum F0 [Down Syndrome group (max = 498.806 Hz; min = 193.484 Hz), CA group (max = 491.138 Hz; min = 205.542 Hz), and MA group (max = 452.462 Hz; min = 195.104 Hz)]. When the maximum F0 results of the Down Syndrome group was compared to the maximum F0 results of the MA group no significant difference existed between the two maximum F0 results [t (6) = 1.152, $p > 0.05$]. No significant difference was found when comparing the maximum F0 results of the Down Syndrome group to the maximum F0 results of the CA group [t (4) = 1.217, $p >$

0.05]. Separate *t*-tests conducted on minimum F0 results between the Down Syndrome group and each of the two typically developing groups revealed no significant difference in minimum F0 between the Down Syndrome group and each of the typically developing groups [Down Syndrome group and CA group: t (4) = 0.7187, $p > 0.05$; Down Syndrome group and MA group: t (6) = 0.9033, $p > 0.05$].

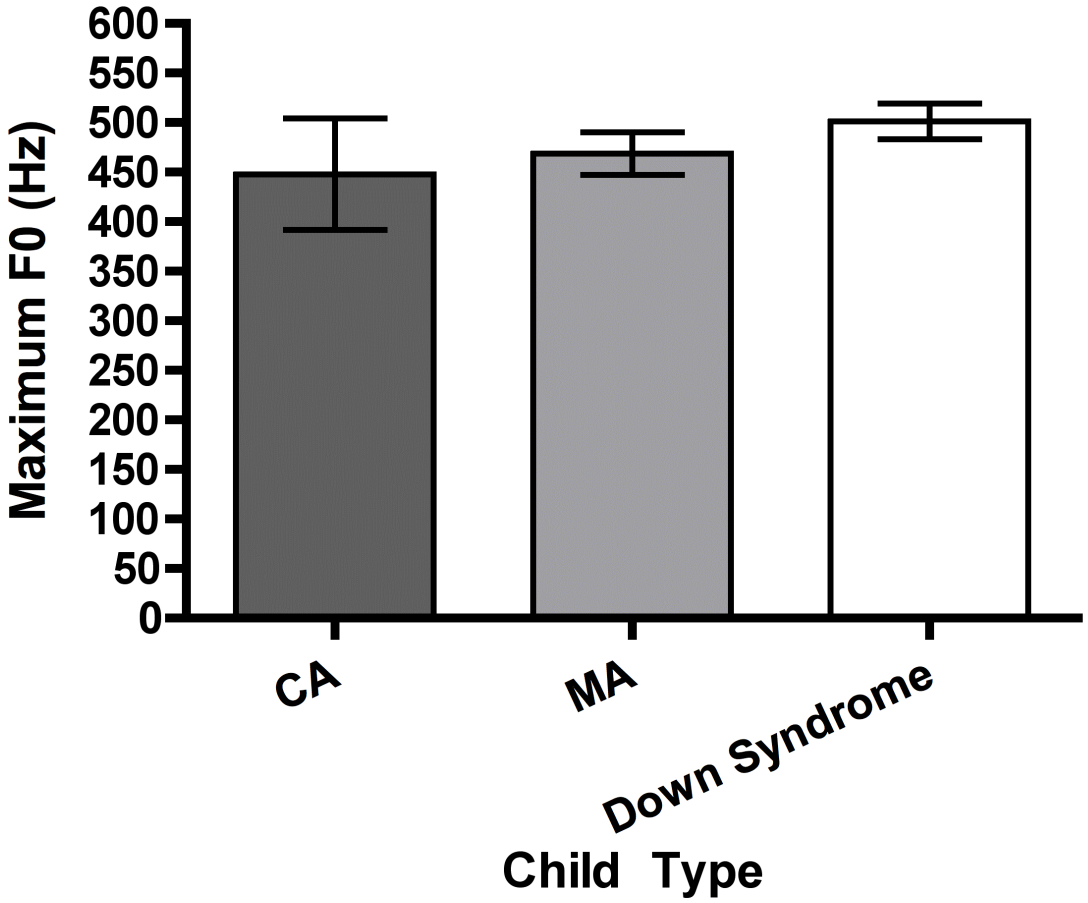

Figure 2. The average maximum F0 (in Hz) of each utterance and standard error of mothers' speech to infants in the CA, MA, and Down Syndrome groups.

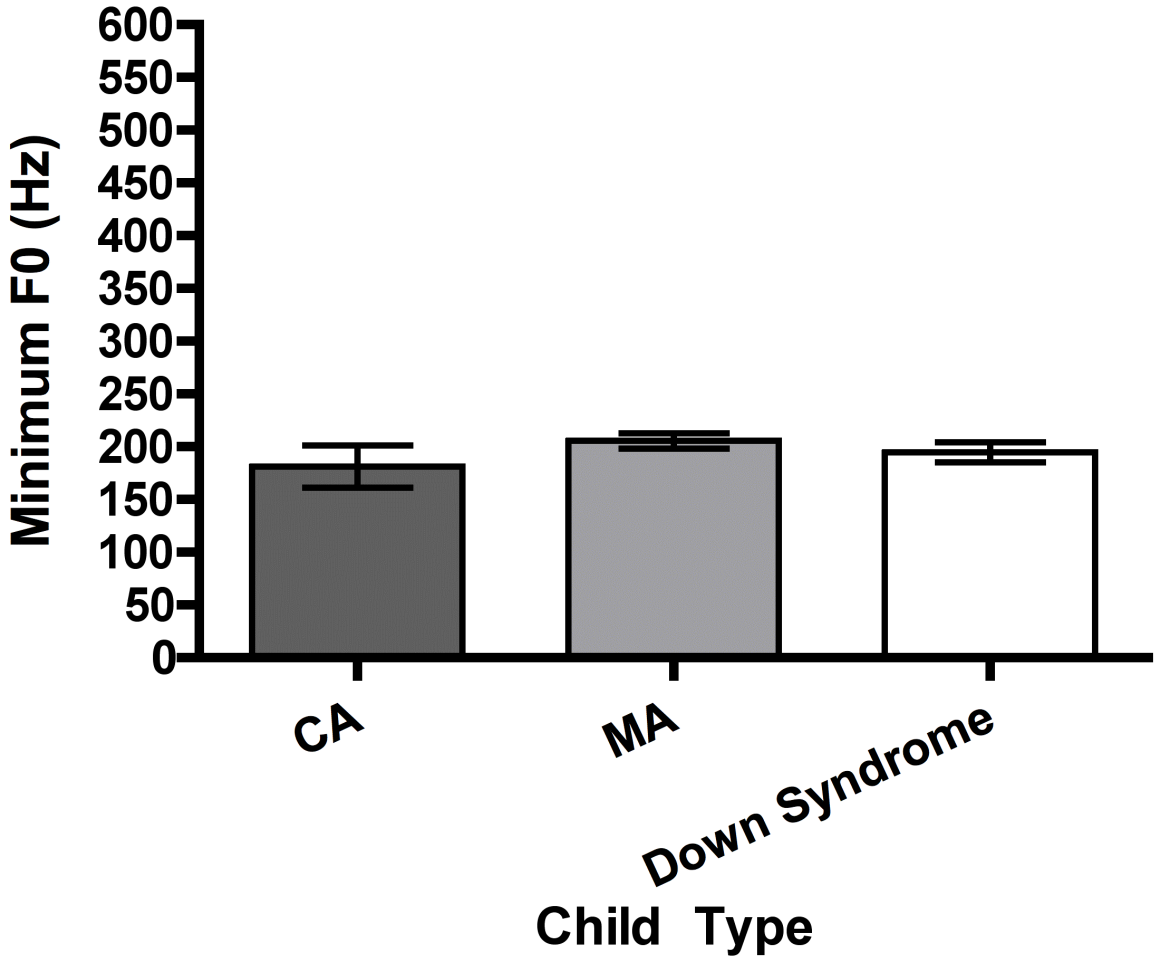

Figure 3. Minimum F0 (in Hz) and standard error of the mothers' speech to infants in the CA, MA, and Down Syndrome groups.

Pitch excursions. The two measures of F0 excursions in mothers' utterances were F0 range (maximum F0 for each utterance – minimum F0 for each utterance) and F0 standard deviation. Figure 4 shows the average F0 range of the Down Syndrome group (M range = 305.322 Hz; SD = 117.573 Hz), the CA group (M range = 285.596 Hz; SD = 107.845 Hz), and the MA group (M range = 257.357 Hz; SD = 107.579 Hz). A separate *t*-test compared F0 range of the Down Syndrome group to F0 range of the MA group and revealed that no significant difference exists [t (6) = 1.371, $p > 0.05$]. A *t*-test comparing the Down Syndrome group to the CA group showed no significant results between the F0 range of the two groups [t (4) = 0.9091, $p > 0.05$]. The F0 standard deviations for each of the three groups are shown in Figure 5. When independently comparing the F0 standard deviation of the Down Syndrome group to the CA and

MA groups, no significant difference was found between the Down Syndrome group with either typically developing group [Down Syndrome and CA group: t (4) = 1.160, $p > 0.05$; Down Syndrome and MA group: t (6) = 1.074, $p > 0.05$].

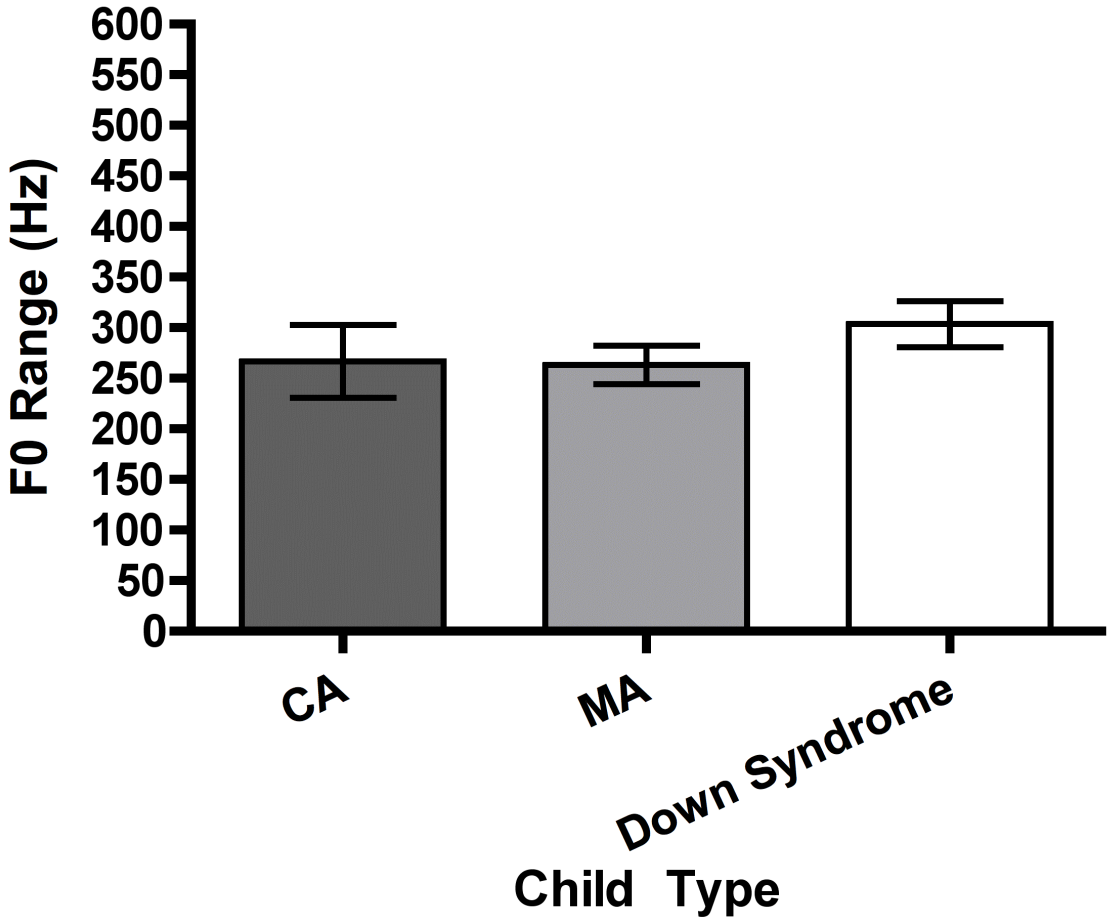

Figure 4. F0 range (in Hz) of the mothers' speech to infants in the CA, MA, and Down Syndrome groups.

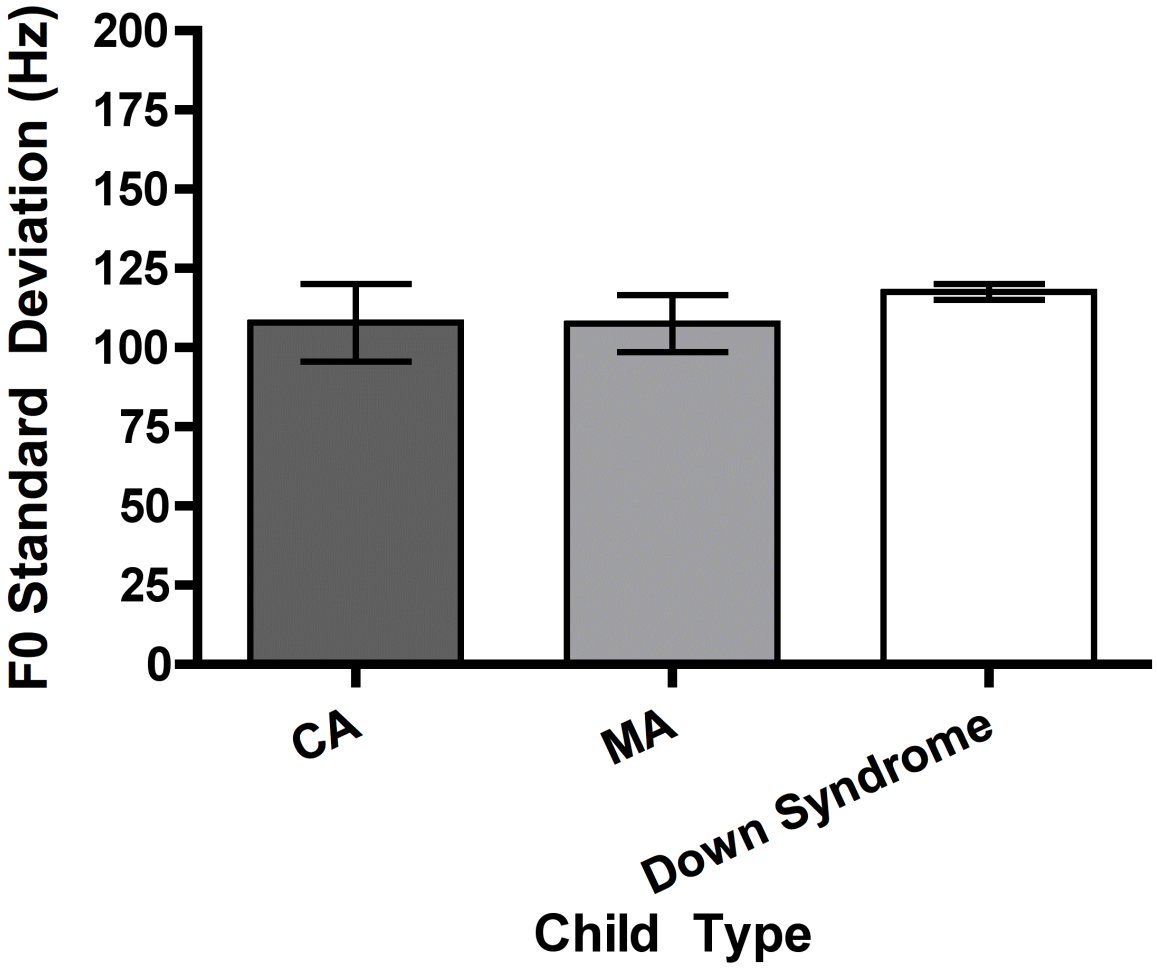

Figure 5. F0 standard deviation (in Hz) and standard error of the mothers' speech to infants in the CA, MA, and Down Syndrome groups.

Utterance Analysis

Durations. The duration of each utterance and the pause duration of each utterance, for each mother were calculated and then separately averaged across all utterances. Figure 6 shows the average utterance duration of the Down Syndrome group (M = 1.088 sec), the CA group (M = 1.033 sec), and the MA group (M = 1.249 sec). A *t*-test revealed no significant difference existed between the utterance duration of the Down Syndrome group and the utterance duration of the MA group [t (6) = 0.4728, $p > 0.05$]. No significant difference was found between the utterance

duration of the Down Syndrome group and the utterance duration of the CA group [t (4) = 0.2461, $p > 0.05$]. Figure 7 shows the average pause duration of the Down Syndrome group (M = 1.765 sec) and the CA (M = 1.807 sec) and MA (M = 1.861 sec) groups. When separately comparing pause durations of the Down Syndrome group to the pause durations of the CA group and the MA group, no significant difference was found between the pause duration of the Down Syndrome group and either of the two typically developing groups [Down Syndrome and CA: t (4) = 0.5132, $p > 0.05$; Down Syndrome and MA: t (6) = 0.2027, $p > 0.05$].

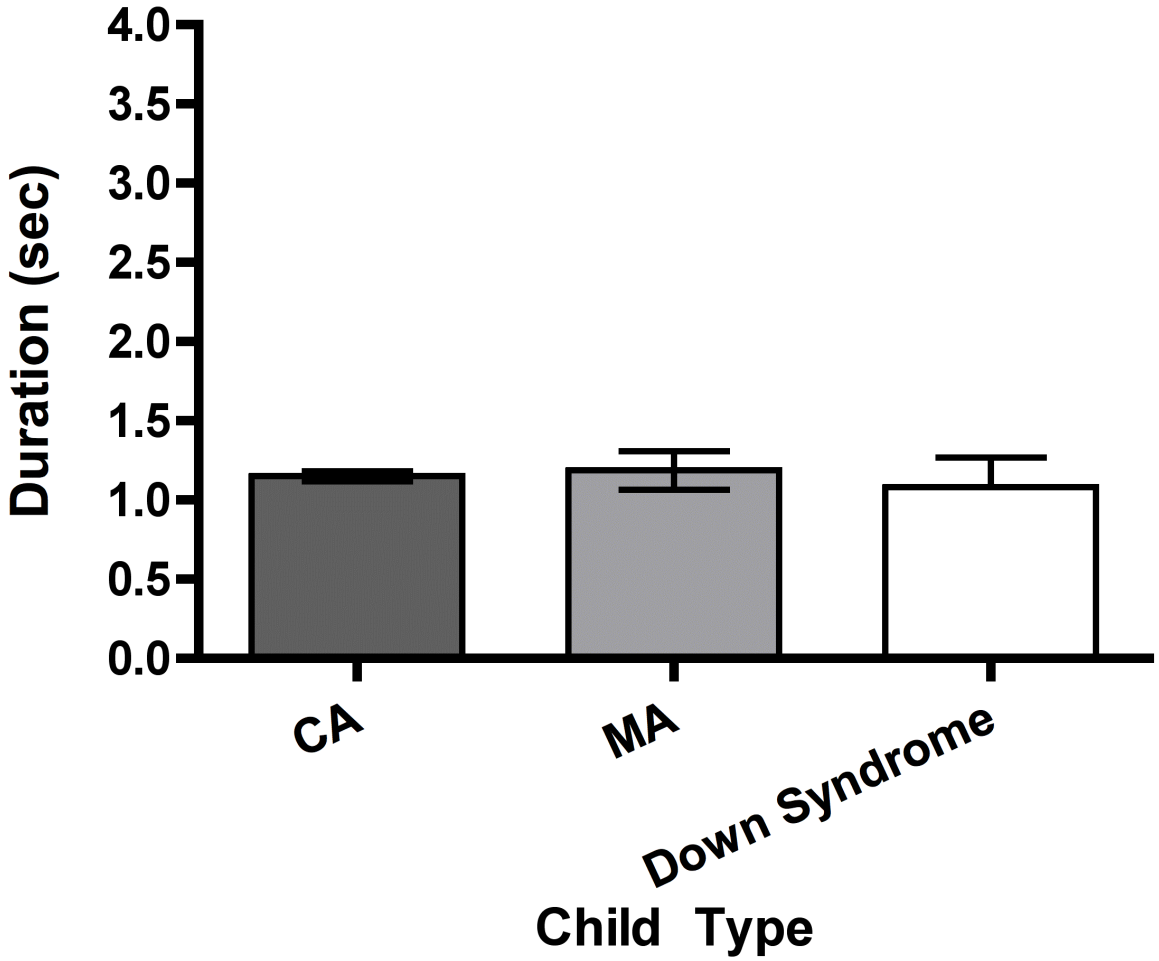

Figure 6. The average utterance duration (in sec) and standard error of mothers of infants in the CA, MA, and Down Syndrome groups.

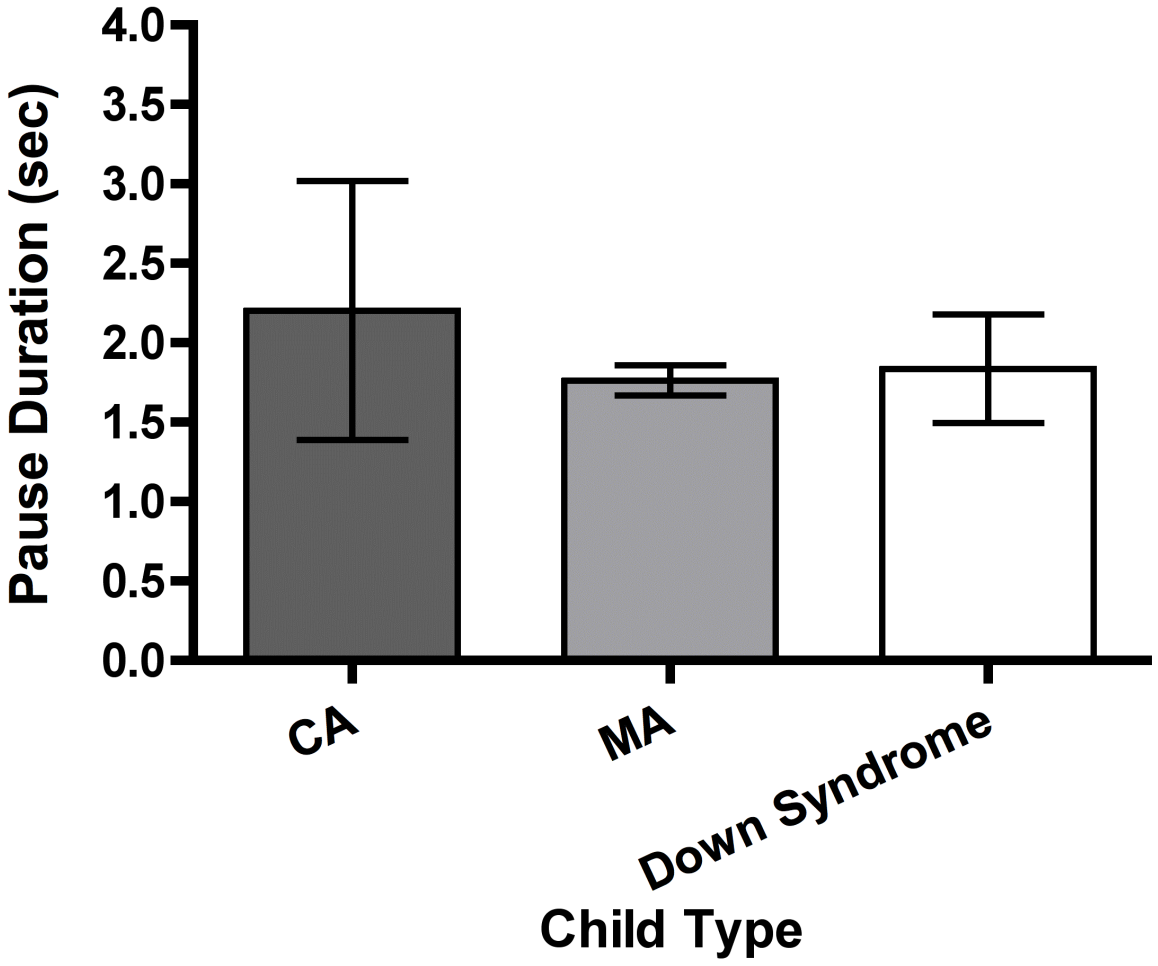

Figure 7. The average pause duration (in sec) and standard error of mothers speech to their infants in the CA, MA, and Down Syndrome groups.

Words per utterance. The average number of words per utterance is shown in Figure 8 for all three groups. An independent *t*-test between the Down Syndrome group (M = 3.030) and the MA group (M = 3.882) revealed no significant difference existed between the mean number of words per utterance used by mothers in the Down Syndrome group and by mothers in the MA group [t (6) = 1.282. $p > 0.05$]. When comparing the Down Syndrome group to the CA group (M = 3.229) using a *t*-test, no significant difference was found in the number of words per utterance [t (4) = 0.9474, $p > 0.05$].

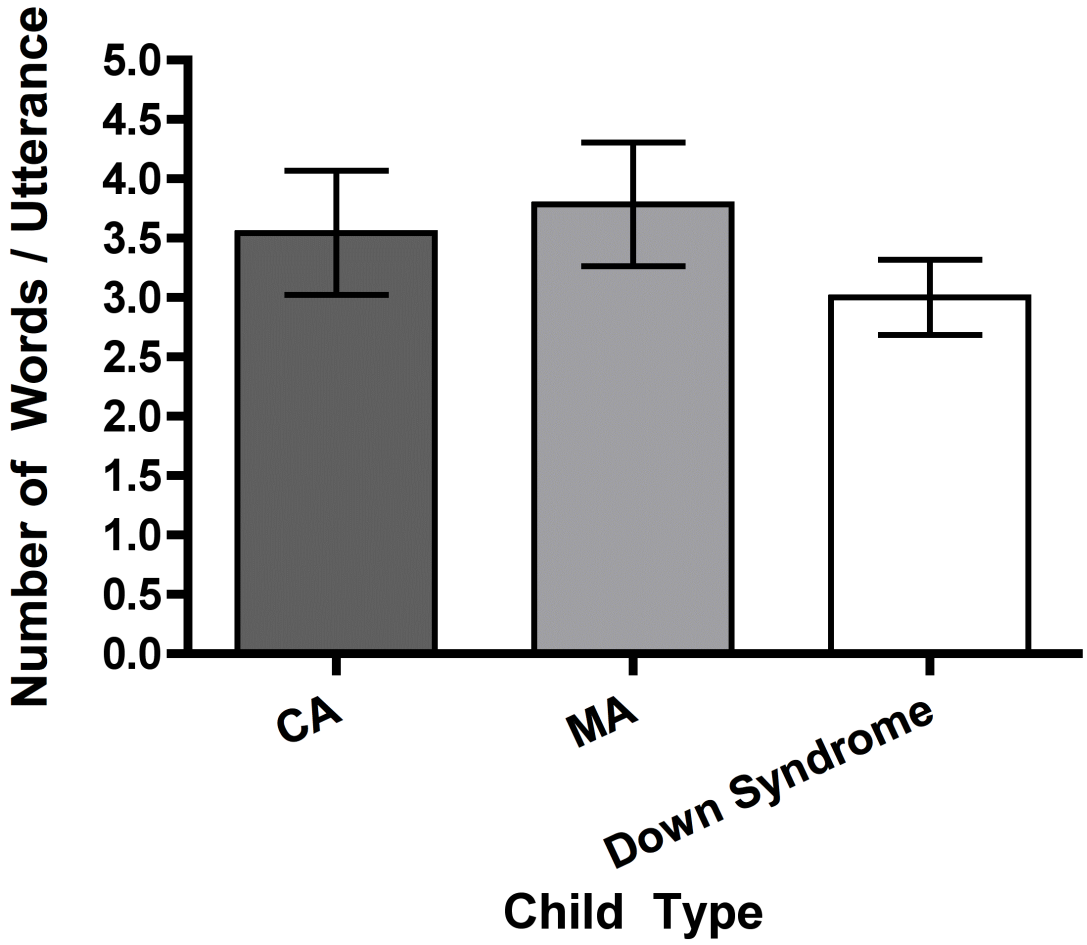

Figure 8. The average number of words per utterance of mothers in the CA, MA, and Down Syndrome groups.

Speaking Rate. Figure 9 shows the speaking rate of both the typically developing groups (CA (wps = 1.117) and MA (wps = 1.229)) and the Down Syndrome group (wps = 1.060). The speaking rate was calculated by determining the sum of the words per utterance produced throughout the 2-minute sample and dividing that number by the total length of the sample (120 seconds). It was calculated in words per second. *T*-tests showed no significant difference between speaking rate of the Down Syndrome group and the speaking rate of the CA group [*t* (4)

= 0.1711, $p > 0.05$]. Likewise, an independent *t*-test comparing the Down Syndrome group with the MA group revealed no significant difference of speaking rate [t (6) = 0.8394, $p > 0.05$].

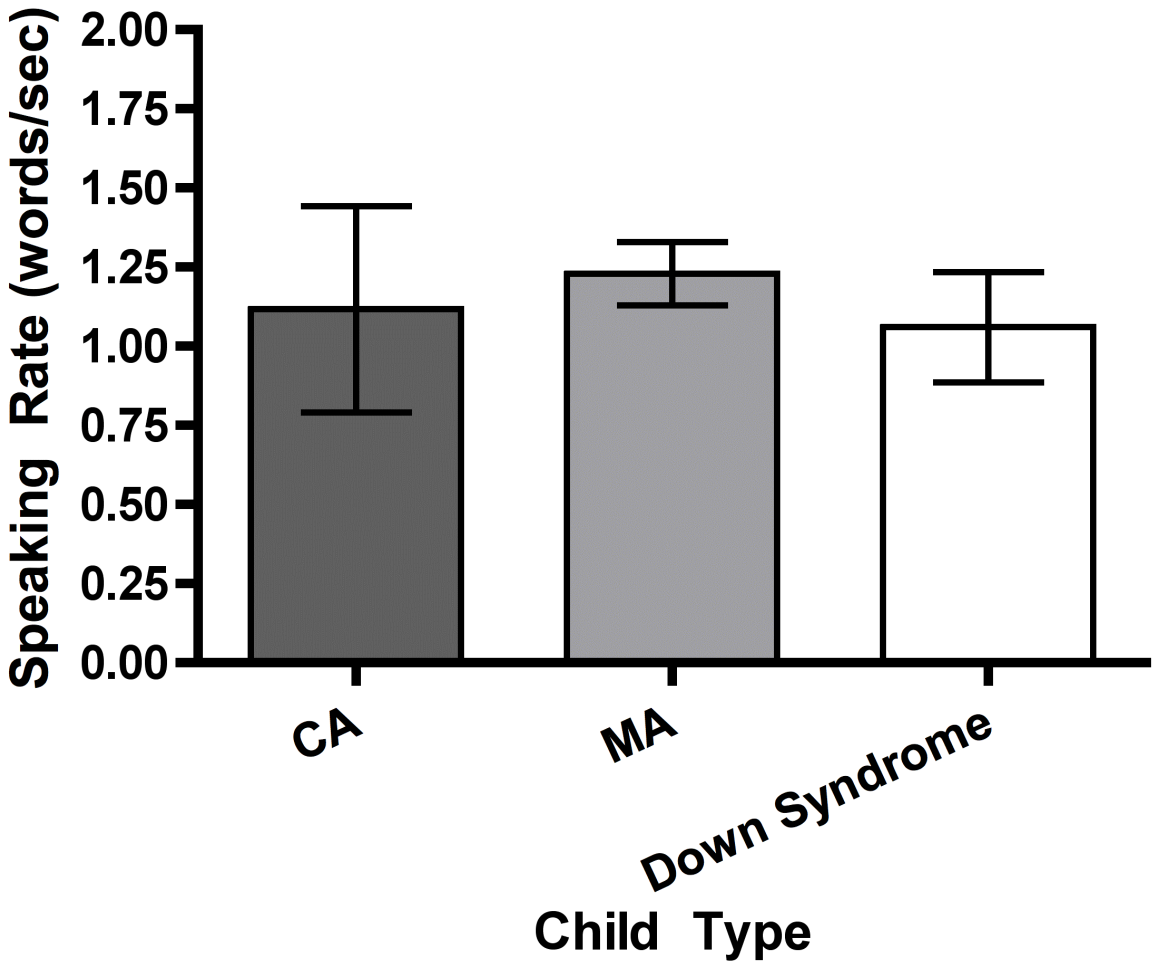

Figure 9. The speaking rate in words per seconds and standard error of mothers in the CA, MA, and Down Syndrome groups.

Number of Utterances. An utterance was defined as a complete thought or a complete sentence and calculated for each 2-minute sample. Figure 10 shows the average number of utterances for the Down Syndrome group (M = 42), the CA group (M = 41.5), and the MA group (M = 38). Through a comparison of the number of utterances of the Down Syndrome group and

the number of utterances of the CA group, no significant difference was found [t (4) = 0.0935, p . 0.05]. A separate t-test comparing the number of utterances in the Down Syndrome group to the MA group showed no significant difference between the two groups [t (6) = 0.7870, $p > 0.05$].

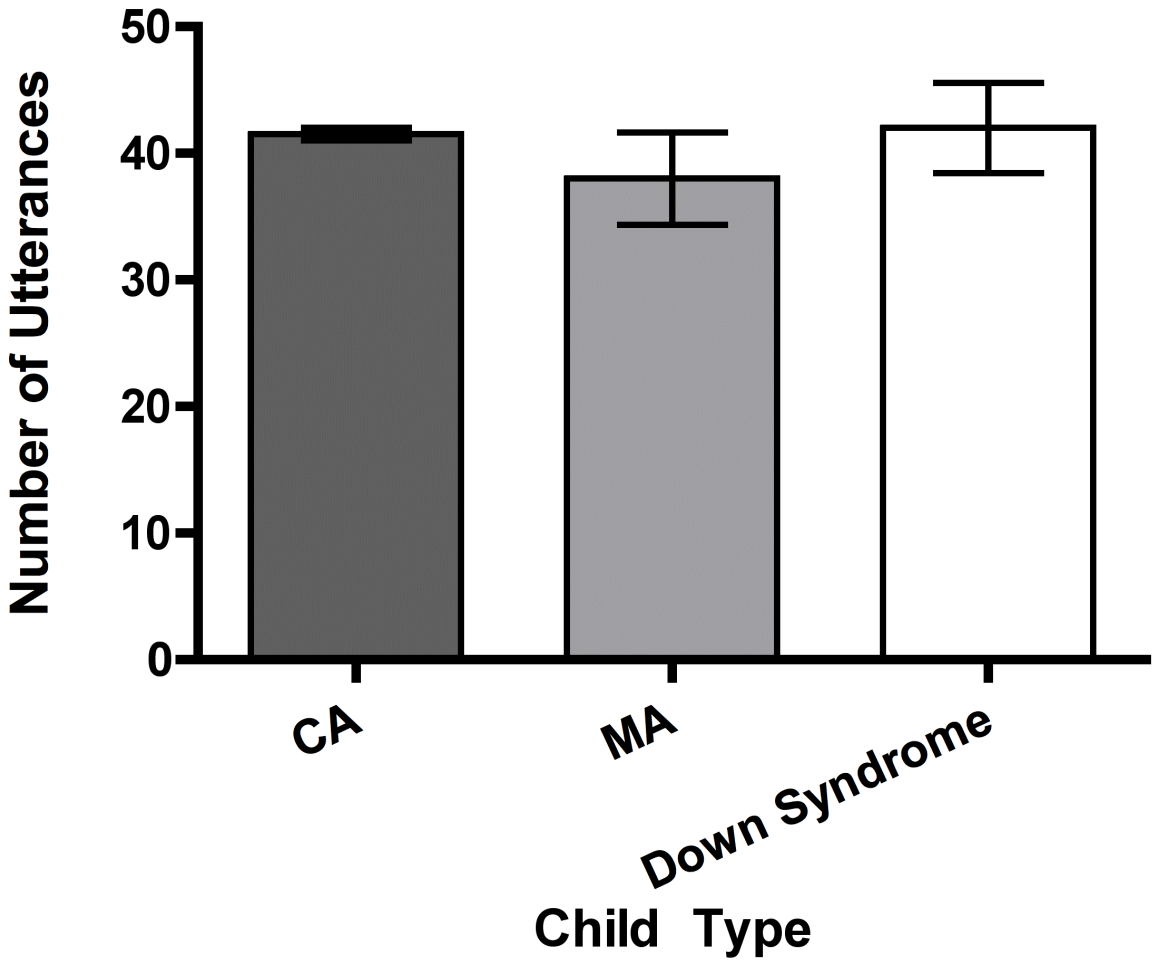

Figure 10. The average number of utterances and standard error of mothers' speech to infants in the CA, MA, and Down Syndrome groups.

CHAPTER IV

DISCUSSION

In this study, there was no significant difference between any of the acoustic characteristics of mothers' speech to infants with Down Syndrome compared to mothers' speech to typically developing infants (CA or MA matched). These data are in contrast to my hypothesis that mothers of infants with Down Syndrome would use an exaggerated form of IDS when communicating with their infants as compared to mothers of typically developing infants.

While there was no significant difference between any of the acoustic characteristics of the mothers' speech, I found that the IDS used by both mothers of infants with Down Syndrome and mothers of typically developing infants were characteristically reflective of the described IDS in many other studies (see Table 3). For instance, Bergeson, et al., (2006) found similar average F0 values for her mothers' IDS as I found in my study (~ 300 Hz) when they examined mothers' speech to infants with cochlear implants and infants with normal hearing. Likewise, Fernald and Mazzie's (1991) data from their study examining the prosody of speech to infants reflected similar maximum and minimum F0 values compared to those I found in my study (maximum F0 ~ 400 Hz; minimum F0 ~ 200 Hz). Fernald's (1989) cross-cultural study on IDS with infants even found similar utterance and pause durations to those noted in my present study (~ 1.1 sec and 1.6 sec, respectively). The similarities in acoustic characteristics found throughout multiple studies support the robust finding that IDS is employed by all mothers and contains similar acoustic characteristics. In regards to infants with Down Syndrome, the acoustic characteristics found in my study suggest that mothers of infants with Down Syndrome also use IDS when speaking to their infants.

Acoustic Properties	Current Study Findings	Previous Studies Findings
Average F0 (Hz)	315.2	315.9 (Cooper & Aslin, 1990)
Maximum F0 (Hz)	480	450 (Fernald, et. al., 1989)
Minimum F0 (Hz)	198	192 (Fernald & Mazzie, 1991)
Utterance Duration (sec)	1.1	1.1 (Fernald & Simon, 1984)
Pause Duration (sec)	1.8	1.5 (Fernald & Simon, 1984)

Table 3. Comparison of the findings of the current study with findings of previous studies.

However, my study yielded different results than those seen in previous literature with special populations. In previous literature, differences were found between IDS towards infants of special populations and IDS towards typically developing infants (Bergeson, et al., 2006; Fidler, 2003; Iverson, et al., 2006). Speicifially, Bergeson and colleagues (2006) found that mothers altered the characteristics of F0 in IDS when speaking to their infants in the special population of individuals with cochlear implants. Iverson and colleagues (2006) found that mothers used significantly shorter utterances when communicating with their infants with Down Syndrome. Furthermore, Fidler (2003) found that even mothers of *children* with Down Syndrome used a higher F0 in their child-directed speech as compared to the speech of mothers of children with other mental retardations. However, the findings of Iverson, et al., and Fidler differ from the findings of my study in which I found no significant differences between mothers' IDS towards infants with Down Syndrome and mothers' IDS towards typically developing infants.

I believe the difference in findings from previous literature and the current study stems from the small number of participants and low statistical power in my study. Because my study

is only a preliminary study, more participants are necessary to determine if the results would be supported across all inidivuals with Down Syndrome. The difference in findings from previous research and findings from my study may also be due to the wide range of ages of the infants in the Down Syndrome group. There was a 16-month age gap between the youngest and oldest infants with Down Syndrome, which is a significant difference in age, especially at such an important developmental period of one's life (i.e., infancy). It is also interesting to note that the IDS of mothers of individuals with Down Syndrome is marginally increased compared to the typically developing individuals when examining the graphs of my results. In particular, the IDS of mothers of infants with Down Syndrome showed a pattern of slightly higher maximum F0, slightly wider F0 range and standard deviation, fewer words per utterance, and a slightly slower speaking rate. This pattern of findings suggests that mothers of infants with Down Syndrome may exaggerate their speech as compared to mothers of typically developing infants. However, with such a small sample size from both the typically developing infant population and the population of infants with Down Syndrome represented in this study, it is difficult to determine if this pattern is a result of the small sample of participants in this study or if the results are relfective of *all* mothers of infants with Down Syndrome.

If mothers of infants with Down Syndrome did use an exaggerated form of speech when speaking to their infants, which has been seen to occur between the ages of 3- to 8-years-old (Fiddler, 2006), might these children benefit in their language development? Because the F0 characteristics of IDS are more extreme in exaggerated IDS, I feel that infants with Down Syndrome would benefit from this type of speech. The exaggeration of F0 characteristics might aide in capturing the attention of an infant with Down Syndrome for a longer period of time than IDS without F0 exaggeration. Infants with Down Syndrome often experience a

decrease in working memory and short term memory as compared to their typically developing peers (Bilovski & Share, 1965). If infants with Down Syndrome attend longer to high pitched speech, then they may receive more exposure to the syntactic characteristics of speech that promote language development and are present in IDS. Additionally, the positive affect associated with IDS may also lead to an increased attention span and more exposure to syntactic characteristics of speech. Therefore, I believe that using an exaggerated type of IDS with infants with Down Syndrome may increase their exposure to syntactic skills and benefit their language development.

Limitations and Future Directions

Since my study is only a starting point and there are limitations, I propose that a more in depth analysis of IDS towards infants with Down Syndrome be conducted. The replications should address the limitations that abound in my study. While I attempted to control for age variation and other variables, this study contains multiple limitations. With a larger sample of participants, I would have greater statistical power and the data I presented would more accurately represent the speech mothers use when speaking to their infants with Down Syndrome. With only 4 participants with Down Syndrome, it is evident that this population is under represented in the study. In my original study proposal, 10 infants with Down Syndrome were to be recruited and then chronologically matched and mentally matched to typically developing infants. Due to a lack of infant-mother dyads available to participate, this number was not attainable. In further studies, I suggest a minimum of 10 participants with Down Syndrome be recruited in order to represent the population more appropriately and give the study more statistical power. Another limitation of my study is that I failed to match the Down Syndrome infants one-to-one with an infant from each group of typically developing infants. In

failing to match the participants one-to-one, the large age gap in each of the groups made it difficult to make accurate assumptions based on the results of my study. Additionally, the CA group of typically developing infants only contained two infant-mother dyads as compared to four infants in both of the other groups. Statistically, with only two infant-mother dyads in the CA group and four infant-mother dyads in the Down Syndrome group, accurate analysis between the two groups could not be conducted. Additionally, the Down Syndrome group contained an outlier when compared to the two infants currently in the CA group (DS4 was 5-months-old, while the two typically developing infants were 15-months-old and 17-months-old). With an outlier in the Down Syndrome group and differing numbers of participants in the CA and Down Syndrome groups, the acoustic analysis performed in the current study does not lend itself to accurate comparisons between the two groups. With more typically developing infant participants, the ages would be matched to the ages of the four infants with Down Syndrome and thus eliminate the existence of the outlier. Additionally, because the outlier is 5-months-old, the developmental delay experienced in individuals with Down Syndrome may not yet have emerged (Saxon & Witriol, 1976), which makes the between groups comparisons difficult and possible inaccurate. Ultimately, I plan to recruit two more chronologically matched typically developing infant-mother dyads to participate in the study. Once I have completed data analysis on the 2-minute samples from these new recruits, I will be able to perform a multivariate analysis of variance (MANOVA) on all of the data collected. A MANOVA is the appropriate statistical analysis because there are 10 dependent variables in my study (average F0, minimum F0, maximum F0, F0 range, F0 standard deviation, utterance duration, pause duration, speaking rate, number of words per utterance, and number of utterances). Additionally, a MANOVA will give

information regarding whether changes in the independent variable's three levels (Down Syndrome, CA, and MA) significantly affect the dependent variables.

Another limitation in my study is the fact that the age range of the Down Syndrome infants varied greatly. Because there is a 16-month age gap between the oldest and youngest infant with Down Syndrome in this study, the analyses of mothers speech may not yield the ideal results when comparing them to the typically developing groups. Once the new recruits for the CA group are analyzed, the age range for the CA group will reflect the age range for the Down Syndrome group. Age matching these two groups will remove the factor of a large age gap in the Down Syndrome group and permit accurate analysis between CA group and the Down Syndrome group. In conclusion, more participants are necessary for a more precise analysis between the three independent variables, a larger sample size would contribute to greater statistical power, and one-to-one matching between the groups would resolve the conflict of age variations evident in each of the groups. Thus, multiple limitations to my study are evident and yet easily resolved with further replications of this study.

Along with accounting for the limitations of my study, when replicating this experiment, I propose that one should compare the IDS used with infants with Down Syndrome to the IDS used with infants with other mental disabilities, such as autism or Williams Syndrome. Fidler (2003) found that mothers of children with Down Syndrome use higher F0 when speaking to their children as compared to mothers of children with other mental disabilities. While Fidler found that mothers adjust their speech to *children* with Down Syndrome as compared to children of other mental disabilities, there is still no research to date on *infants* with Down Syndrome and the differences that occur in speech towards this special population as compared to speech towards other special populations with mental disabilities.

In order to increase the ecological validity of my experiment one could perform a longitudinal study that begins at birth and continues on until the infants reach adolescence. Because mothers' speech to typically developing *infants* differs from mothers speech to typically developing *children*, it would be interesting to determine if this was echoed for infants and children with Down Syndrome. Combining the findings of Fidler (2003) (mothers speak to their children with Down Syndrome differently than mothers of other populations) and the findings from my current study (there is no difference between the IDS towards infants with Down Syndrome as compared to IDS towards typically developing infants), I propose that mothers' speech towards children with Down Syndrome changes throughout the life span, depending on the mental abilities of the children. It is possible that mothers of infants with Down Syndrome do not employ a different form of IDS during infancy as compared to mothers of typically developing infants because the gap in cognitive development for individuals with Down Syndrome is not as apparent until late infancy and early toddlerhood (Saxon & Witriol, 1976). I believe that once a mother begins to realize the degree to which her child lags behind his peers, she begins to adjust her speech to the child to better facilitate language and communication. Once the longitudinal study was complete, I propose comparing the later linguistic development patterns of children with Down Syndrome whose mothers used an exaggerated form of IDS at an early age to those of children with Down Syndrome whose mothers did not employ an exaggerated form of IDS. This comparison may lead to determining the validity of the theory that IDS contains a language learning utility (e.g., Fernald & Mazzie, 1991; Kemler Nelson, et al., 1989). By analyzing how an exaggerated version of IDS impacts a child's later language development, researchers could clarify the extent to which IDS facilitates language skills.

Would a mother of a typically developing infant communicate with an infant with Down Syndrome in the same way that she communicates with her own baby or would she communicate with the infant with Down Syndrome in the same that the infant's mother communicates with her? I believe that mothers of typically developing infants would exaggerate their IDS when speaking to infants with Down Syndrome because of the physical features associated with Down Syndrome. Individuals with Down Syndrome often have physical characteristics such as upward-slanted and narrow-slit eyes, a flattened face, hyperflexibility of joints, weak reflexes, and poor muscle tone (Korenberg, et al., 1994). Because these features are easily noticed, it is likely that the mothers of typically developing infants would be constantly cognizant of the child's delay. With constant awareness of a cognitive delay, the mothers of typically developing infants would also have a constant external reminder that they should exaggerate their speech to meet the communication abilities of the child with Down Syndrome. Therefore, I believe that mothers of typically developing infants would exaggerate of IDS based on the mothers' expectations they have for the infants with Down Syndromes' communication abilities. This assumption is supported by a study performed by Kempe, Schaeffler, and Thoreson (2010). In a series of 5 studies, Kempe et. al. found that non-mothers have a tendency to disambiguate their speech towards toddlers, but mothers do not share this tendency and use ambiguous characteristics in their speech with their toddlers. The fact that non-mothers disambiguate their speech when speaking with unfamiliar toddlers implies that the non-mothers are aware of a difference in the communication abilities of another, younger, individual (i.e., the toddlers) and adjust their speech to the communication status of the listener. Because this study analyzed speech to toddlers, it is difficult to generalize the findings to IDS. Kempe et. al.'s study does, however, serve as

support for my suggestion that the speech characteristics of a talker stem from the talker's expectations of the listener's communication abilities. I propose performing a yoked study in which researchers analyze the speech of mothers of typically developing infants' to Down Syndrome infants and the speech of mothers of infants with Down Syndrome to typically developing infants. This would take into account the speakers' expectations of the infants and determine whether the mother exaggerates her speech based on her knowledge of the infant's cognitive abilities or whether mothers exaggerate their speech because of how they expect the infant to reciprocate and respond to her communication.

Clinical Interventions

Does the lack of exaggeration of IDS in mothers' speech strengthen or weaken the language development of individuals with Down Syndrome? With only the knowledge from current research, an accurate conclusion cannot yet be made. However, I propose that mothers' education on the topic of the acoustic characteristics of IDS may lead to better language outcomes for individuals with Down Syndrome. An added emphasis on the important acoustic aspects of language could possibly assist children with Down Syndrome in the development of phonology, morphology, and syntax, leading to better language outcomes later in life.

One way to educate mothers on the use of IDS is through direct instruction. For instance, mothers would first attend an information session highlighting the benefits of IDS for their infants (i.e., language facilitation). After completion of the information session, mothers would bring their infants into the clinic for individual training sessions. During the first few training sessions, the clinician would speak with the infant to model the correct type of IDS (exaggerated IDS or under-exaggerated IDS, depending on the findings of the research) for the

mothers. Once the mother was exposed to the correct type of IDS, the clinician would leave the mother and infant alone in the room with the mother wearing an earpiece. The clinician, speaking into a microphone attached to the ear piece, would then instruct the mother to begin practice and inform her of any corrections she should make to her speech. This method of intervention would increase the mother's awareness of the characteristics of IDS and the different ways that her infant can benefit from this style of speech. If a mother is cognizant of her infant's cognitive and linguistic abilities, she can alter the speech and language she uses with her infant to provide the infant with the most advantageous for the infant's developmental level. In this way, mothers can provide just enough speech and language to their infants so that the infants do not become frustrated and stop attending, but still continue to learn and be engaged.

Conclusion

In summary, I found that both mothers of infants with Down Syndrome and mothers of typically developing infants use IDS when speaking with their infants. However, I found no significant differences between the IDS used by mothers of infants with Down Syndrome as compared to the IDS used by mothers of typically developing infants when matched by chronological age or mental age. These results differ from previous research, which found that mothers adjust their communication style to meet the communication status and abilities of their child (Bergeson, et al., 2006; Fidler, 2003; Iverson, et al., 2006). I believe the difference in findings from previous literature and the current study stems from the small number of participants in my study. With a larger sample size, the population of infants with Down Syndrome would be appropriately represented. A larger sample size would allow me to accurately detect a difference, or lack thereof, in mothers' speech to infants with Down

Syndrome and mothers' speech to typically developing infants. While I found no significant difference between mothers' use of IDS to infants with Down Syndrome and mothers' use of IDS to typically developing infants, I found that both sets of mothers employ IDS in a similar manner as is seen in previous research. The similarity between IDS found in my study and IDS found in previous literature shows that the use of IDS is robust and employed with all infant populations, regardless of the individual's cognitive or developmental delays. Nonetheless, more research is necessary to determine the generalizability of the current results particularly due to my small, unbalanced sample sizes. In conclusion, I feel that although there were many limitations in my study, it is an excellent starting point to a series of significant research studies that could potentially alter the way that clinicians interact and intervene with individuals with Down Syndrome and their families during the beginning stages of therapy.

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