2015-01-01

The Effects of Sign on Speech Segmentation in Infants

Alma Rosa Acosta

University of Texas at El Paso, almaa914@gmail.com

Follow this and additional works at: https://digitalcommons.utep.edu/open_etd

Part of the Communication Commons, Other Languages, Societies, and Cultures Commons, Speech and Hearing Science Commons, and the Speech Pathology and Audiology Commons

Recommended Citation

https://digitalcommons.utep.edu/open_etd/985

This is brought to you for free and open access by DigitalCommons@UTEP. It has been accepted for inclusion in Open Access Theses & Dissertations by an authorized administrator of DigitalCommons@UTEP. For more information, please contact lweber@utep.edu.
THE EFFECTS OF SIGN ON SPEECH SEGMENTATION IN INFANTS

ALMA ROSA ACOSTA
Speech Language Pathology Program

APPROVED:

______________________________
Vannesa T. Mueller, Ph.D., CCC-SLP Chair

______________________________
Patricia Lara Ph.D. CCC-SLP

______________________________
Helen M. Hammond Ph.D.

______________________________
Charles Ambler, Ph.D.
Dean of the Graduate School
Copyright ©

by

Alma Rosa Acosta

2015
Acknowledgements

This project would not have been possible without the support of many people. I owe my deepest gratitude to my advisor, Dr. Vannesa Mueller, who has guided me throughout. Not only have you prepared me for the amazing yet professional developmental challenges that have accompanied this project, but you undoubtedly invested your time and trust into me with this major and exciting project. It has been a great honor to work with you in getting it published and has been a great privilege to develop a great working relationship, as you have been a constant source of knowledge and inspiration. Furthermore, it is with warmest appreciation to Amanda Sepulveda, Mar Bonilla, Gabriela Rodriquez, Callie Ortega, and to all that assisted with this project. It would not have been possible without you. And a special thank you to Amanda for constantly encouraging and supporting me but also for being my shoulder to lean on throughout my graduate academic journey.

I would also like to extend that gratitude to my committee members, Dr. Patricia Lara and Dr. Helen Hammond for agreeing to be on my committee. Your time, support and contribution are truly appreciated. I would also like to thank the entire graduate school faculty for providing me with a strong foundation to thrive and build my research upon. It has been a great honor and privilege to stand on the shoulders of giants. Special and tremendous warm thank you to my husband who has endured this long process with me. He has been a constant source of support and encouragement during the challenges of graduate school and life. I am truly thankful for having you in my life. And to my family but especially to my mother for instilling the importance of hard work and higher education, thank you for all of our understanding and support. Most of all thanks to God who continues to make the impossible possible. And finally, thanks to my entire 2015 cohort, we did it. I dedicate this paper to all of you.
THE EFFECTS OF SIGN ON SPEECH SEGMENTATION IN INFANTS

by

ALMA ROSA ACOSTA, BS.

THESIS

Presented to the Faculty of the Graduate School of
The University of Texas at El Paso
in Partial Fulfillment
of the Requirements
for the Degree of

MASTER OF SCIENCE

Program in Speech-Language Pathology

THE UNIVERSITY OF TEXAS AT EL PASO
May 2015
Abstract

Introduction: The ability to extract words from fluent speech (speech segmentation), perhaps one of the greatest obscure achievements for the purpose of learning language, is dependent upon imperceptible endeavors. Remarkably, infants are active participants from the moment they are born, using auditory and visual information to assist them segmenting speech. As motivated parents attempt to use baby sign to bridge communication gaps, visual information in the form of baby sign may benefit children in extracting words from speech. To examine the effects of baby sign on speech segmentation, a systematic replication of the Hollich et al. (2005) study, a within-subject study, with sign as a visual cue was conducted on six-month-old infants.

Purpose: The purpose of this study was to determine whether baby sign has an influence on the ability to segment speech in typical developing hearing infants. Methods: Seventeen typical developing six-month-old infants were familiarized with nonsense words using a sign + face, sign only and face only condition. A head-turn preference procedure was used to assess their ability to extract unfamiliar nonsense words from fluent speech. Results: The results suggest that infants as early as six-months of age can use faces to facilitate speech segmentation. However, to effectively extract words from fluent speech with the use of baby sign, prior exposure is essential.

Key words: speech segmentation, baby sign, language development
Table of Contents

Abstract ........................................................................................................................................... v
Table of Contents .............................................................................................................................. vi
List of Tables .................................................................................................................................... viii
List of Figures .................................................................................................................................... ix
Background and Significance ............................................................................................................ 1
   Introduction .................................................................................................................................... 1
   Headturn Preference Procedure .................................................................................................... 1
   Speech Segmentation ..................................................................................................................... 2
   Baby Sign ...................................................................................................................................... 4
   Purpose of Study ........................................................................................................................... 6
Methods .......................................................................................................................................... 8
   Participants ................................................................................................................................... 8
   Experimental Design .................................................................................................................... 8
   Stimuli ........................................................................................................................................ 9
   Dependent Measures .................................................................................................................... 11
   Independent Variable ................................................................................................................... 11
   Setting ......................................................................................................................................... 11
   Procedures .................................................................................................................................. 13
   Statistical Analysis ...................................................................................................................... 15
   Inter Rater Reliability ................................................................................................................... 15
Results ........................................................................................................................................ 17
Discussion .................................................................................................................................... 18
   Limitations ................................................................................................................................... 19
   Future Considerations .................................................................................................................. 20
Conclusion ................................................................................................................. 20
References ................................................................................................................. 22
Appendix ..................................................................................................................... 23
Curriculum Vita .......................................................................................................... 24
List of Tables

Table 1. Results of T-tests Comparing Orientation Times........................................17
Table 2. Results for The Three Infants with Baby Sign Exposure............................17
Table 3. Nonsense Word Pairs and Assigned ASL Sign................................. Appendix (23)
Table 4. Familiarized Passage and Assigned Condition ......................... Appendix (23)
List of Figures

Figure 1. Screen Shots of Familiarization Videos and Conditions ........................10
Background and Significance

Introduction

Infants are beautifully and uniquely equipped with a desire to understand the world around them. They have major developmental milestones to achieve and many hurdles to clear however these milestones and breakthroughs are dependent upon imperceptible achievements. A major one, perhaps one of the greatest obscure achievements includes the segmentation of speech into single words for the purpose of learning language. This ability is critical for development as it provides the preparatory stage for early communication, initially by comprehension and later by production (Jusczyk & Aslin, 1995). With absence of this ability, speech would appear rapidly and unclear, nothing more that a continuous string of nonsense noise. Remarkably, infants are active participants in their environment from the moment they are born, using auditory and visual information to assist them. In fact the ability to extract words from fluent speech has been present in infants as early as 7.5 months of age (Jusczyk & Aslin, 1995) and in a study by Hollich, Newman and Jusczyk (2005), infants demonstrated this ability using a speaker’s face as a visual cue.

Thus, if the use of a visual cue has proven to be effective then will the implementation of baby sign prove to be just as effective? The purpose of this study was to add to the research base addressing baby sign and infant speech segmentation by examining the impact that baby sign has on the ability to segment speech in typical developing hearing infants.

Head Turn Preference Procedure

The fact that infants are highly sensitive to the world around them has its advantages. In terms of sound sensitivity, an infants’ attention to an auditory stimuli is capable of being assessed by investigating the length of time that their head is turned towards a sound source
(Kemler-Nelson et al., 1995). In addition, in terms of audiovisual sensitivity, even 4-week-olds have demonstrated the ability to direct their attention (Bahrick, 2001). Thus, the Head-Turn Preference Procedure (HPP) has proven to be reliable for testing perception of sustained auditory materials, particularly those of speech in infants between 4.5 and 12 months old (Kemler Nelson et al., 1995). The ‘peep show audiometry’ designed by Dix and Hallpike (1947) and Suzuki and Ogiba (1960) gave rise to the HPP procedure, perhaps the most adaptable procedure available in helping us understand the speech perception capabilities in infants (Werker, Polka, & Pegg, 1997). Since its debut, this procedure has been used in infant speech perception research (Kemler Nelson et al., 1995) to measure the duration in which an infant’s head is turned towards an auditory stimulus.

This particular procedure takes advantage of the fact that infants tend to orient visually to an attended sound source as well as maintain a response, a head-turn, when the motivating stimulation is dependent on their behavior (Nelson et al., 1995). This procedure is also beneficial as it may be adapted to investigate the ability of infants to recognize words embedded in sentences (Nelson et al., 1995). Many researchers have investigated an infant’s ability to segment speech. Jusczyk and Aslin (1995) found that 7.5-month-old infants, but not 6-month-olds, were able to segment the speech stream with only auditory cues. Bortfeld et al., (2013) found that infants as young as six months demonstrated the ability to exploit highly familiar words (such as their own name) to segment and recognize adjoining, previously unfamiliar words from fluent speech.

**Speech Segmentation**

The human communication process is a marvelous yet complex system in which infants begin learning the speech-sound categories of their language during the first 12 months of life
In fact, infants come into the world eager to learn and start by relying on their senses to understand the unfamiliar world around them. For instance, according to Mandel, Jusczyk, and Pisoni, (1997) infants as early as 4.5 months of age begin to identify the sound patterns of their own names suggesting that by the age of six months infants may be capable of detecting their own names from running speech. It has also been noted that infants at six months begin demonstrating sensitivity to the sound organization of their native language while at the same time begin learning how sounds form patterns in words (Jusczyk, 1999). In other words, this developing sensitivity may very well be the foundation for attributing word boundaries, suggesting that segmentation abilities might be developing at this time (Bortfeld, Morgan, Golinkoff & Rathbun, 2013).

The youngest age in which an infant has demonstrated the ability to segment fluent speech was from a study by Bortfeld et al. (2013). In their study, infants as early as six months of age where presented with a short passage consisting of a novel word following the infants name (familiar-name target) and a second passage consisting of a different name followed by a second novel word (alternate-name target). The researchers found that infants listened longer to the familiar-name target than to the alternate-name target. Suggesting that these six-month-old infants succeeded at segmenting novel words from running speech when linked to their own name.

Thus, learning the speech-sound categories and the ability to extract regularities in the speech stream allow infants to recognize the auditory forms of many words (Swingley, 2008). In addition, this ability to segment words from fluent speech is a critical step for acquiring a native language vocabulary (Jusczyk, 1999). This is significant as it creates a foundation for early
vocabulary acquisition, support for the learning of the native language’s phonological system, and has also been known to contribute to latter grammar knowledge (Jusczyk, 1999).

Hollich, Newman, and Jusczyk (2005) suggested that, if infants are just as sensitive to audio information then they might experience a similar advantage from the presence of visual information. Given the notion that visual information may help infants facilitate segmentation of a speech stream, Hollich et al. (2005) used a modified head-turn preference procedure with the addition of video information. Their study focused on 7.5 month-olds as the Jusczyk and Aslin (1995) study found this age to be when infants first demonstrated the ability to segment fluent streams of speech. In addition, they implemented a video recording of a close-up of the face of a Caucasian female speaker of American English as she read four passages in infant directed speech. This was an important aspect as studies have shown that infants prefer the fundamental frequency modifications of infant-directed speech over those of adult-directed speech as well as it is also noted that they may also prefer female voices over male voices (Fernald & Kuhl, 1987).

Hollich et al., (2005) found the motion of the video stimulus when coordinated to the auditory signal to be highly effective as it enabled the infants to succeed in segmenting the speech stream. The researchers concluded that the infants benefited significantly by having the facial information and that movement operated as a cue, aiding the infants’ attention to certain aspects of the auditory signal (Hollich et al., 2005).

Baby Sign

As infants attempt to segment speech in order to make sense of the world around them, they also begin to exhibit the use of gestures. Gestures, according to Kirk, Howlett, Pine, and Fletcher (2013) are intricately linked to language development. They are inseparable, combined they form a rich basis for human communication (Quek, Mcneill, Bryll, Duncan, Ma, Kirbas,
McCullough, & Ansari, 2002). As infants thrive towards maturity, most will usually utter their first words or sentences during the second year of life (Johnston, Durieux-Smith & Bloom 2010). This breakthrough happens to be dependent on infant and parent or caregiver interaction. As the foundation of language, sound perception, communicative gestures, and non-linguistic cognition are laid in the pre-speech exchanges between young infants and their parents or caregivers (Bates, O’Connell & Shore, 1987). This early form of communication is usually via deictic gestures such as pointing, reaching and grasping (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979). Because studies have found that the early use of gestures can support a child’s linguistic and nonlinguistic abilities (Kirk et al., 2013) there has been a movement towards the use of baby sign among motivated parents attempting to overcome the communication barriers.

Baby sign is a popular new phenomenon among parents of typical developing hearing infants. According to Doherty-Sneddon (2008), baby sign is an augmentative communication approach that practices the use of key word signing in order to enhance communication and facilitate spoken language development. Because the use of baby sign enables communication before infants can utter their first word, and the claimed benefits and promotions of the use of its implementation, parents are enthusiastically embracing its use (Doherty-Sneddon, 2008). Many of the appealing claims include facilitation of language development, reduction of problem behaviors, and even claims to increase a child’s intelligence (Doherty-Sneddon, 2008). Furthermore, the implementation of baby sign can have a positive impact on receptive and expressive language vocabularies, improved parent-child relationships by increasing moments of joint visual attention during interaction between parent and child, enables infant to focus on the topic and context of conversation, increases discussion and clarification of concepts, as well as promotes added practice with symbolic function (Accredolo et al., 1999; Goodwyn et al., 2000).
Thus, the basis of its appeal makes it no surprise as to why the baby signing movement is on the rise.

Despite the claims, the efforts may be unnecessary. Kirk et al., (2013) found no evidence to support the use of baby sign in advancing language development. In fact they noted higher levels of stress in mothers who attended baby sign classes as opposed to mothers who attended other mother-baby classes (Kirk et al., 2013). Thus, the lack of evidence does create opposing views and increase skepticism of its use. However Doherty-Sneddon (2008) claims that baby sign has a lot to offer and thus should not shy away from its use. If baby sign becomes an extra support then it can often be a valuable tool for language. An infants exposure to baby sign may not increase or improve all aspects of language development however it may enhance communicative function and assist in bridging the communication gap.

**Purpose of Study**

Given that infants demonstrate sensitivity to audiovisual information as seen in the Hollich et al. (2005) study and with the use of baby sign on the rise as motivated parents attempt to bridge the communication gaps, infants might just experience a similar advantage when extracting words from speech from the presence of visual information in the form of baby sign. Thus this study seeks to add to the current but limited evidence base on speech segmentation and baby sign by extending the scientific data. The purpose of this study was to examine the impact that baby sign has on the ability to segment speech in typical developing hearing infants. This study examined seventeen infants, in which infant looking time using the head-turn preference procedure (Nelson, Jusczyk, Mandel, Myers, Turk & Gerken, 1995) was used to determine if six-month-old infants were capable of extracting unfamiliar nonsense words from fluent speech when those words occur with a sign. The research questions asked are: (1) Can six-month-old
infants segment speech when provided with additional visual cues (sign + face, sign only and face only)? (2) What is the effect of sign on an infants’ ability to segment speech?

This specific age group was chosen because according to Bortfeld et al., (2013) six months is the youngest age in which speech segmentation has been documented. We hypothesize that among the six-month-old infants, the implementation of the sign condition will positively influence their ability to segment speech by enhancing their ability to extract unfamiliar nonsense words from fluent speech. The research questions asked compliment the current research on infant speech segmentation and baby sign and will in fact add to the research base. However, the first research question will determine whether infants as early as six-months can segment speech with the synchronized use of an addition visual cue. If significant, this will be the earliest age in which infants demonstrate the benefits of a visual cue in speech segmentation. The second research question further explores the use of baby sign to determine if its implementation plays an active role in the segmentation of fluent speech.
Methods

The university’s institutional review board reviewed our research with human participants and approved this study.

Participants

Seventeen infants (8 males and 9 females) between the ages of six months and zero days to six months and 29 days with a mean age of 6 months and 8 days participated in the study. All infants were recruited through friends and family as well as through the use of flyers with information of the study, participant characteristics, and contact information. All infants were typically developing as verified through the Ages and Stages Questionnaires, Third Edition (ASQ-3) (Squires & Bricker, 2009) upon initial contact. The ASQ-3 provides information on the developmental status of infants from 5 months of age to 6 months 30 days across five developmental areas: communication, gross motor, fine motor, problem solving, and personal-social. In addition, according to parent reports all infants came from primary English-speaking homes. Furthermore, parents of participants received compensation (i.e. $100 store gift card) for their time and for the participation of their infant in the study.

Experimental Design

The current study was a systematic replication of the Hollich et al. (2005) study with the addition of the sign condition. This within-subject study compared the effects of three different conditions (i.e. face only, sign only, sign+face) on infants’ ability to segment speech. The conditions were as follows:
A. Sign + face: In this condition, infants were familiarized with two target words by watching a video consisting of the whole upper body of a researcher reading two familiarization passages. Key word signing was used for the target word in each passage.

B. Sign only: In this condition, infants were familiarized with two additional target words by watching a video consisting of only the torso of the same researcher reading two different familiarization passages. Again, key word signing was used for the target word in each passage; however, the researcher’s face was not visible on screen in this condition.

C. Face only: In this condition, infants were familiarized with two more target words by watching a video consisting of only the face of the same researcher reading two different familiarization passages. Key word signing was not used in this condition.

Stimuli

The stimuli presented in the study were modeled after the Jusczyk, Houston, and Newsome (1999) study. The passages used included the Kingdom passage, the Hamlet passage and the Doctor passage (see appendix Table 2 or refer to Jusczyk, Houston & Newsome (1999) for passages). The words selected for the study differed from those used in Jusczyk et al., (1999) in that the target words were replaced with one-syllable nonsense words. The use of nonsense words were implemented to control for word familiarity and included, /gɪp, sɑɪf, ɒm, ɪg, zap, væm, ʊʊp, ut, ʃɪ, ʃɪb, ɒ, ʃɪm/. The six passages used were video recorded (Figure 1) consisting of a female, monolingual English speaker to be used for the familiarized portion of the study. The passages were read in child-directed speech that included variation in intonation and pitch typical of mootherese. The familiarized passages ranged from 21 to 27 seconds with the average time being 25.67 seconds.
The same female, monolingual English speaker was used to record the individual, familiarized nonsense words and the control nonsense words in child directed speech used in the assessment portion of the study. Each nonsense word was repeated for a maximum of 30 seconds.

The additional uses of a sign as a visual cue were used only in the sign+face and sign only condition. ASL signs were chosen to represent the nonsense words used for each of the conditions. The signs chosen for the familiarized passages included MACHINE, MEDICINE, FRIEND, and AREA/REGION. These particular signs were chosen on the basis of their ease of production, not linked or similar to any natural gesture, and because they are signs that the infants would less likely be exposed to as they tend to be exposed to more functional signs (e.g., mom, dad, milk and more).

Immediately after each condition, the infants’ were tested on their ability to recognize the target-familiarized words using the head-turn preference procedure. Infant looking time served as an indicator of speech segmentation ability. The conditions in which they were viewed were randomized for each infant as well as the speech stimulus was also randomized for each infant.

Figure 1: Screen Shots of Familiarization Videos for each condition
Dependent Measures

The dependent variable was the measured looking time from each participant. Using the head-turn preference procedure outlined by Kemler Nelson, et al. (1995), the infants’ time spent looking towards the familiarized (i.e. target) words and control words during the assessment portion of the study were recorded for each infant and condition. Orientation (looking time) was obtained using a stop watch measured in milliseconds starting when the infant’s head turned more that 30º towards the sound source, continuing until the infant’s head turned away from the sound source for longer than two seconds or after 30 seconds, when the entire stimulus for that trial was played. If the infant looked away from the sound source for less than two seconds but looked back towards the sound source, that time spent turned away from the sound source was not included in the total orientation time.

Independent Variable

The independent variables of the current study were the six videos of the familiarized passages (face only, sign only and sign+face). (See figure 1 above under subheading, Experimental Design).

Setting

The current study took place in a lab space in the University of Texas at El Paso Speech-Language Hearing Clinic. Within the lab space, two different settings were utilized, one for the familiarization portion of the study and the other for the testing portion of the study. The familiarization portion of the study took place in a clinic room. There the infants were familiarized with 6 passages taken from the Jusczyk, Houston, and Newsome (1999) by watching familiarization videos on a 15-inch laptop. During familiarization, the parent was seated in a chair in the lab space facing a desk and a 15-inch laptop screen as the infant sat on
their lap. The 15-inch laptop on the desk was connected to two computer audio speakers placed on each side. Behind the laptop was a video recorder that was used to track the infants’ eye gaze during the familiarization process that may be further analyzed in a latter study. During the familiarization process, all other noise was controlled for by closing the door to the lab space making sure that the familiarized passages was the only audio heard by the infant.

Following the familiarization process the infant was then tested in the audiometric booth, in the same clinic and lab space just a few feet away, set up to resemble the traditional three-sided booth used in the head-turn preference procedure (Kemler Nelson et al., 1995). The audiometric booth in the clinic was a double-walled 10'x10' soundproof booth containing two speakers at about the level of the infants head, on opposite walls of the booth. Placed on each speaker was an animated visual reinforcement audiology toy (animated VRA) used to draw the infants’ attention to the side of the auditory stimulus. Inside the booth, facing the center of a white sheet was a chair in which the parent sat with the infant on their lap with the speakers to the right and left. The front side of the booth was a white sheet that hung from the ceiling to the floor of the booth used to block the infants view of the rest of the room and the research assistant and camera set up on the other side. The sheet was constructed to have about a 5-cm hole at its center to accommodate the lens of the video recorder and a smaller hole above it that allowed a research assistant to monitor the infant’s behavior. The infant’s gaze was monitored by the research assistant and recoded using the video recorder. The other side of the booth was a control center in which two research assistants controlled the speech stimuli and head turn visual cues via communicating with the assistant researcher behind the curtain through the two-way window.
Procedure

Upon arrival of scheduled appointment, infant and parents were taken into a lab space in the University of Texas at El Paso Speech-Language Hearing Clinic. There the study was explained in greater detail, all questions were answered and the consent form was explained and encouraged to read prior to signing. Following the signed consent form by the parent, the ASQ-3 was then administered by a master’s student/research assistant to ensure that the infant was typically developing and for possible use in a latter study that further analyze and interpret the results of this study. The study commenced after the results of the ASQ-3 were explained to the parent(s).

The study began with only the master’s student/research assistant and the parent and infant in the clinic room during the familiarization process to control for any distractions. The parent sat in a chair in the lab space facing a 3’x2’ desk and a 15-inch laptop screen as the infant sat on their lap. The 15-inch laptop on the 3’x2’ desk was connected to two computer audio speakers placed on each side. Behind the laptop was a video recorder that was used to track the infants’ eye gaze during the familiarization process that may be further analyzed and compared with the results of this study in a latter study. Prior to the familiarization process the parent was instructed to simply sit with their infant in their lap while the infant watched the familiarization videos and was instructed to avoid cueing of any kind. All other noise was controlled for by closing the door to ensure that the familiarized passages were the only audio heard by the infant. Once parent and infant were seated, the master’s student/research assistant started the video and played the first passage followed by the second passage for the first condition.

The familiarized passages were randomized for each infant. Six familiarized passages consisting of nonsense target words (refer to Appendix), two at a time (e.g. two face only passages each with a target word), were seen by the infant as the master’s student/research assistant hid behind the parent to avoid distracting the infant. Thus, a familiarized passage was
played while the research assistant stood out of sight. Once the passage was complete the research assistant played the second passage, then stood out of sight. Each familiarization passage consisted of six sentences with a mean duration of 25.67 seconds.

Immediately after the first two familiarization passages were viewed by the infant, the parent and infant were escorted to the audiometric booth for testing, in the University of Texas at El Paso Speech-Language Hearing Clinic. The booth which was set up to resemble the traditional three-sided booth used in the head-turn preference procedure (Kemler Nelson et al., 1995) consisted of a chair in which the parent sat with the infant on their lap with the speakers to the right and left. Prior to testing, to prevent the parent from influencing their infants’ performance, over the ear noise-cancellation headphones were placed on the parents. The parent listened to classical music during testing to mask the experimental stimuli.

The speech stimuli in the testing portion consisted of single word repetitions of the target and control words recorded by the same female speaker from the familiarized passages in child-directed speech. The order of the speech stimuli (words) was randomized for each infant as well as the side in which they were administered (i.e. right side and left side) was also randomized for each infant. Once the parent and infant were situated and the over the ear noise-cancellation-headphones and music were on, the testing procedure began.

The test trial began by drawing the infant’s attention to the center by waving their hand or a small colorful toy just above the white sheet directly in front of the infant. Trial onset began when the researcher drew the infant’s attention to the center, moving their hand/toy from the infant’s sight, and the flashing of a light at one side signaled the speech stimulus. The researcher behind the sheet used hand signals to communicate with the researchers in the control center, adjacent to the window, signaling them to begin controlling the animated VRA’s to draw the attention of the infant to the side in which the speech stimulus streamed from. Once the researcher judged that the infant had turned his/her head at least 30° toward the blinking light the researcher would signal the speech stimuli to begin playing.
As the speech stimuli began to play through the loudspeaker, the researcher would carefully monitor their orientation towards the single word repetitions. The speech stimulus was played at 60 dB HL through the loudspeakers on each corner of the hearing booth. The speech stimulus played for a maximum of 30 seconds however, the trial would end after 30 seconds or once the infant looked away for longer than two seconds. After two test words and two control words were presented, a total of four nonsense words, the infant and parent would exit the sound booth to be familiarized with another set of videos for the next condition. This continued until all three conditions were presented and completed. Again, the order of the familiarization conditions and the order of the presentation of the test and control words were randomized for each infant. In addition, the side of presentation during testing was also presented at random.

Following completion of the three trials, the master’s student/research assistant provided the parent(s) with copies of the consent form and ASQ-3 along with there compensation for their time and for their infants participation in the study. Total time spent at the clinic was approximately one hour, this included the time to fill out the consent form and ASQ-3 form, address any questions or concerns, and to explain and complete the study. The time spent familiarizing and testing was approximately 20-25 minutes.

Familiarization passages and nonsense word pairs and assigned ASL sign found in the Appendix

Statistical Analysis

To parallel the Hollich et al. (2005) study and other head-turn preference procedures, a T-test was used to assess whether the means of the looking times per condition were statistically different from one another. Additionally, t-tests were used to determine if there were any significant differences between the familiarized nonsense words and the control nonsense words.

Inter-rater Reliability

All infants were video recorded during the assessment portion of the study for all conditions. These recording were used to measure orientation time by two raters who were
unaware of which nonsense words were test words and which were the control words. The primary rater, a master’s student in speech-language pathology, calculated each infant’s orientation time in milliseconds, to the nearest hundredth of a second. A second rater, another master student in speech-language pathology, also calculated infant orientation time for approximately 30% of the recorded test videos. Times were considered an agreement if they were within 30 milliseconds of each other. Inter-rater reliability was 93%.
Results

A series of T-test were run to compare the orientation times for each of the conditions. An alpha level of .05 was used for all statistical tests. Mean and standard deviations were obtained for all the conditions. Of the three conditions presented, the face only condition was the only condition, which demonstrated a statistical significant difference between the orientation times of the control words versus the familiarized words. No significant differences were seen between the sign+face and the sign only condition (refer to Table 1 below).

We did not anticipate any of the infants having been exposed to baby sign. However, three of the seventeen infants who participated in the study were exposed to some baby sign prior the study. According to parent reports, each of the three infants was exposed to less than five signs. Data from these three participants were isolated from the other participants who were not exposed to baby sign and where included in a separate T-test. The T-test was run to determine whether exposure to the baby sign had any influence on the infants’ ability to extract words form fluent speech. According to the T-test, the significance level for the sign+face condition was above the .05 alpha level. However, the p values for the face only and sign only condition were the same p = .09 (refer to Table 2 below).

Table 1. Results of T-tests Comparing Orientation Times

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t</th>
<th>df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sign+face</td>
<td>.64698</td>
<td>6.20822</td>
<td>.590</td>
<td>31</td>
<td>.560</td>
</tr>
<tr>
<td>Face only</td>
<td>-3.06696</td>
<td>7.22531</td>
<td>-2.475</td>
<td>33</td>
<td>.019*</td>
</tr>
<tr>
<td>Sign only</td>
<td>-3.7500</td>
<td>7.41533</td>
<td>-.295</td>
<td>33</td>
<td>.770</td>
</tr>
</tbody>
</table>

*p<.05

Table 2. Results for The Three Infants with Baby Sign Exposure

<table>
<thead>
<tr>
<th></th>
<th>Face+Sign Control</th>
<th>Face+Sign Test</th>
<th>Face Control</th>
<th>Face Test</th>
<th>Sign Control</th>
<th>Sign Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>7.936111</td>
<td>5.840556</td>
<td>6.129444</td>
<td>10.66889</td>
<td>9.518889</td>
<td>15.48778</td>
</tr>
<tr>
<td>T-test</td>
<td>0.252744</td>
<td><strong>0.097702</strong></td>
<td><strong>0.097702</strong></td>
<td><strong>0.092217</strong></td>
<td><strong>0.092217</strong></td>
<td><strong>0.092217</strong></td>
</tr>
</tbody>
</table>
**Discussion**

The purpose of this study was to examine the impact that baby sign has on the ability to segment speech in typical developing hearing infants. More specifically to answer the research questions: (1) Can six-month-old infants segment speech when provided with additional visual cues (sign + face, sign only and face only)? (2) What is the effect of sign on an infants’ ability to segment speech?

The first research question asked was whether six-month-old infants could segment speech when provided with additional visual cues. The results indicated that six-month-old infants are capable of segmenting words from fluent speech when provided with a visual cue. However, the only visual cue we found to assist this was the face only condition. Nonetheless, these results compliment the studies by Jusczyk and Aslin (1995), Hollich et al. (2005), and Bortfeld et al. (2013) such that we can conclude that infants require a cue whether it be a face, a visual cue such as baby sign, or a familiar word or name as an auditory cue in order to successfully segment the speech stream at six months of age. This particular question is not only important but also significant as the results of this study are the first to demonstrate speech segmentation when synchronized with a visual cue in infants as early as six-months of age.

The second research question wished to explore the effects of sign on an infants’ ability to segment speech? From the results, baby sign had no significant affect overall on infants’ ability to segment speech. Infants demonstrated a preference for the face only condition when compared to the face+sign and sign only condition. Thus the results of this study did not support the hypothesis. The fact that baby sign had no significant affect was interesting and the fact that three of the seventeen participants had prior exposure to baby sign permitted further analysis. The infants with prior baby sign exposure demonstrated similar preference to both the face only and sign only conditions. For them it appeared as thought the sign only condition was as effective as the face only condition. The fact that the sign+face was not effective leads one to suggest that the sign+face may have been overwhelming for the infant. Such that the face+sign in addition to the auditory stimuli may perhaps have been too much of a stimulus for the infants
making the task of segmenting speech more complex. Another possibility is that the video of the female speaker in this condition was different in some way from the other conditions. A close up of the female, monolingual English speaker was not possible for the sign+face condition as to accommodate for the entire body whereas a close up of the speaker was capable for the sign and face only conditions. Thus, given these variations, this may have affected the infants’ ability to use the face+sign cue to effectively extract words from running speech. Whether it acted as a distraction or was too far for the stimulus to facilitate speech segmentation, this emphasizes the need for further research as well as provides insight into the areas in need of further investigation.

Future research is necessary to determine how much baby sign exposure is in fact necessary for it to be effectively used. However, based on these early findings it appears that not much exposure is really necessary for it to be effectively used, as these infants according to parent reports had very little and inconsistent exposure yet were able to use it to the same extent as the face only condition. Thus, it may very well be that a small amount of baby sign exposure is necessary for infants to realize that information could be found on the hands. This not only raises the importance of gesture use but also that the use of baby sign perhaps may very well be the vehicle for parental support of pre-speech development over and above oral communication providing parents with an opportunity to create more meaningful language learning interactions with their infants (Johnston et al. 2010).

Limitations

This study was limited by its small sample size. Sample size may have been expanded, however was limited to seventeen six-month-old infants due to the limited compensation for participants and time constraints. Even if compensation could have been reduced to include a larger sample size, the specific age range of six months zero days and six months thirty days makes it difficult to acquire participants. Another limitation may have included the use of a
modified head turn procedure. Unlike the head turn preference procedure by Kemler Nelson et al., (1995) which used computerized software, all calculations in the current study were completed manually. Furthermore, controlling for the state of the infant is rather impossible. Such that reactions to the stimuli may have changed throughout the study due to fatigue, hunger or other states in which we had no control over.

**Future Considerations**

This study was conducted to examine the impact that baby sign has on the ability to segment speech in typically developing, hearing infants. As a preliminary study, it sought to add to the limited evidence base on speech segmentation and baby sign by extending the scientific data. Research is most necessary if we wish to bridge the gap in understanding speech segmentation and the implications that baby sign has on infant development and language learning. Thus, future research could further explore the use of baby sign in determining how much exposure is necessary for infants to use as visual cues to extract words from a speech stream or perhaps even look at different groups of infants with different levels of exposure. In addition, because the HPP has been validated on infants as young as 4 months of age, it would be interesting to look at infants at a much younger age. These would make for an interesting focus in a latter study that aims to enhance the research base.

**Conclusion**

The results of this study concluded that six-month-old infants can segment fluent speech when provided with a visual cue, in this case a speaker’s face. In addition, the results also indicated that the use of baby sign as a visual cue can assist in extracting words from fluent speech when exposed early on in development. However, further research is necessary to determine the amount of baby sign exposure that is necessary for it to be effective for speech
segmentation. Furthermore, the results of this study complement the current focus of infant studies as it provides further insight into the wonders that drive research today. It should be no surprise that infants are capable of segmenting speech in the midst of their first year of life. Infants are much more adept than we may think and their abilities to date have proven to be nothing less than extraordinary. The current study may just be scratching the surface of what perhaps may be the driving force for cracking the speech code that enables language development in infants. However, this step leads to a whole new exciting world of infant research and questions still left to be discovered.
References


Appendix

Table 3. Nonsense word pairs and assigned ASL sign

<table>
<thead>
<tr>
<th>Nonsense word pairs and assigned ASL sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>pm/gip</td>
</tr>
<tr>
<td>smi/bab</td>
</tr>
<tr>
<td>zap/ut</td>
</tr>
<tr>
<td>ig/saif</td>
</tr>
<tr>
<td>fei/pêl</td>
</tr>
<tr>
<td>oap/væm</td>
</tr>
</tbody>
</table>

Table 4. Familiarization Passages and Assigned Condition

Passage #1 (pm/gip) – face and sign
Your (pm/gip) is in a faraway place. The prince used to sail to that (pm/gip) when he came home from school. One day he saw a ghost in this old (pm/gip). The (pm/gip) started to worry him. So he went to another (pm/gip). Now in the big (pm/gip) he is very happy.

Passage #2 (smi/bab) – sign only
The (smi/bab) saw you the other day. He’s much younger than the old (smi/bab). I think your (smi/bab) is very nice. He showed another (smi/bab) your pretty picture. That (smi/bab) thought you grew a lot. Maybe someday you’ll be a big (smi/bab).

Passage #3 (zap/ut) – face only
Your (zap/ut) lies just over the hill. Far away from here near the sea is an old (zap/ut). People from that (zap/ut) like to fish. Another (zap/ut) is in the country. People from that (zap/ut) really like to farm. They grow so much that theirs is a very big (zap/ut).

Passage #4 (ig/saif) – face and sign
Your (ig/saif) groans a lot. The nice, big (ig/saif) likes to laugh. The son of the old (ig/saif) will soon visit them. The prince will tell a joke to the (ig/saif). Then he will tell it to the new (ig/saif). That (ig/saif) will smile, too.

Passage #5 (fei/pêl) – sign only
The (fei/pêl) by the lake had sailboats. Motor boats stay at the old (fei/pêl). That (fei/pêl) gets very busy. Fishing from the (fei/pêl) looks like fun. People at your (fei/pêl) like to swim, too. A family brought their boat to the new (fei/pêl).

Passage #6 (oap/væm) – face only
The (oap/væm) with the apple sauce is on the shelf. Your (oap/ væm) holds alphabet soup. Beans from the new (oap/væm) will be good, too. We’ll dust off the old (oap/væm). It is by the big (oap/væm) hiding in the back. It will be hard to reach that (oap/væm).
Curriculum Vita

Alma Rosa Acosta graduated from the University of Texas at El Paso with a Bachelor of Science in Kinesiology, with a Minor in Biology. She is currently pursuing a Master’s of Science Degree in Speech-Language Pathology with a Bilingual certificate at The University of Texas at El Paso. Alma may be contacted at:

almaa914@gmail.com

Permanent address: 4526 Titanic Sp. 29

El Paso, Texas 79904

This thesis was typed by Alma Rosa Acosta.