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Is Maternal Touch Used Referentially?

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IS MATERNAL TOUCH USED REFERENTIALLY?

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06/25/2014

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IS MATERNAL TOUCH USED REFERENTIALLY?

A Thesis
Submitted to the Faculty
of
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by
Rana Abu-Zhaya

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of
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West Lafayette, Indiana

To my mom and dad, the best parents anyone could ask for.

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ABSTRACT

Abu-Zhaya, Rana. M.S., Purdue University, August 2014, Is Maternal Touch Used Referentially? Major Professor: Amanda Seidl.

Early social interactions are highly multimodal and include a wealth of cues (e.g., speech, facial expressions, motion, gestures and touch). Infant-directed speech by itself may aid in language development. Touch by itself has been also shown to play an important role in dyadic interactions affecting both the infant and the caregiver. However, little is known about the impact of the combination of these two modes of communication on infant language development. In this thesis, I hypothesize that caregiver touch is provided in synchrony with speech, providing the language-learning infant with cues that may not only help her to find words in the continuous stream of speech, but also to map between words and their referents. I examined the naturalistic use of touch by having mother read books to their 5-month-olds. Results suggest that mothers temporally align touches with the production of target words. Thus, the infant is provided with yet another cue to segment the speech stream and pull out the words produced by the caregiver. In addition, results suggest that caregivers tend to touch in locations congruent with their speech (e.g., touch the belly while saying the word belly). This might highlight the meaning of target words to infants through the use of touch. Thus, results suggest that caregiver touch may be useful to the language learning infant for both segmentation and word learning.

INTRODUCTION

Infants are exposed to many forms of social interaction from their first days of life (Stern, 1985) and provided with a rich communicative environment (Thompson, 2001). Further, research shows that the amount of dyadic interaction that infants are involved in is important in predicting later language development (Falk, 2004; Topping, Dekhinet & Zeedyk, 2013). These early social interactions are rich with multimodal communication in the form of spoken language, facial expressions, motion, gestures and touch. Touch, plays a key role in dyadic interactions and it is a prominent component of the multimodal communication in mother-infant interactions (Anisfeld, Casper, Nozyce, & Cunningham, 1990; Feldman, Singer & Zagoory, 2010; Ferber, 2004; Ferber, Feldman & Makhoul, 2008; Franco, Fogel, Messinger & Frazier, 1996; Herrera, Reissland & Shepherd, 2004; Hertenstein, 2002; Jean & Stack, 2009; Jean, Stack & Fogel, 2009; Moszkowski & Stack, 2007; Muir, 2002; Stack, & Arnold, 1998). For example, touch plays a role in directing the infant's attention, regulating arousal levels, behavioral states, negative emotions, and reducing distress (Hertenstein, 2002; Jean & Stack, 2009; Jean & Stack, 2012; Stack & Muir, 1990). It also reflects the mother's sense of well-being (Ferber et al., 2008; Herrera et al., 2004) and sensitivity to her infant (Jean & Stack, 2009). All of these could indirectly contribute to infant language outcomes; however, we do not know whether touch has any *direct* role in language development. In this paper, we examine ways in

which caregiver touch may be used referentially, that is, to highlight wordform-referent associations.

Using the skin, the largest sensory organ in the human body and the first sensory system to develop in the uterus, as its sensory organ (Ferber, 2004; Muir, 2002), touch has profound importance in dyadic interactions (Ferber, 2004). Recently it has been suggested that touch might also be important in infant speech perception, specifically word segmentation (Seidl, Tincoff, Baker & Cristia, 2014). Seidl and colleagues (2014) familiarized 4-month-olds with a continuous stream of speech under two conditions. In one, infants received a timed tactile stimulation of their elbow or knee that was always synchronous with a specific trisyllabic pseudoword (e.g., *lepoga* was timed with a touch to the knee). In another condition, infants received similarly reliable visual input. Infants were also touched on or observed touch on another location (e.g., elbow), but this time the touch/visual cue was not consistently synchronous with a particular syllable sequence (e.g., *dobita*). After this familiarization, infants were tested for their ability to recognize the pseudowords from the speech stream using the Head turn Preference Procedure (HPP). The results showed that when infants received consistent tactile cues coupled with the auditory stimuli, they were able to segment words from the speech stream. Infants did not show this effect for the visual-auditory pairing. Further, they had a difficulty segmenting words from the speech stream when touch/visual cues were not synchronized with a specific sequence. Thus, it appears that providing reliable experimenter touches to 4-month-olds can help their word segmentation (Seidl et al., 2014). However, while this may be true in highly controlled experimental situations we do not know whether

caregivers in the real world use touch in synchrony with the speech they direct towards their infants.

Studies have shown that Infant-Directed Speech (IDS) plays an important role in supporting language acquisition (Falk, 2004; Hoff, 2008); it has been found to greatly influence early word recognition helping infants to process speech (Singh, Nestor, Parikh & Yull, 2009). However, IDS is never detached from other forms of infant-directed communication; it is part of an intricate multimodal communication system that characterizes human interactions. For example, studies examining multimodal communication in mother-infant interactions show that when demonstrating actions to their infants, mothers' speech is well aligned with their actions (Gogate, Bahrick & Watson, 2000; Meyer, Hard, Brand, McGarvey & Baldwin, 2011). Utterances that describe specific actions are more temporally aligned with the occurrence of these actions as opposed to other utterances that are not related to the ongoing action (Meyer et al., 2011). When teaching target words to their infants, mothers temporally synchronize bimodal communication combining word production with object motion more often with the younger than the older infants (Gogate et al., 2000). Furthermore, mothers use auditory-visual-tactile communication in synchrony more often to communicate target words than non-target words (Gogate et al., 2000). Thus, it seems that mothers use multimodal infant-directed communication to highlight novel target words and word-referent relations to their infants. It is possible that this multimodal temporally synchronized communication provides the language-learning infant with reliable cues to the relationship between the spoken word and the referent to which it refers (Gogate et

al., 2000). In other words, mothers use visual cues referentially, making their movements congruent with the meaning of the speech and aligning speech and gesture. Despite the importance of tactile information, no previous research has assessed whether caregivers similarly use tactile cues in referential ways.

Motivated by the findings of Seidl and colleagues (2014) and studies of infant-directed motions discussed above, we examined whether touch during naturalistic dyadic interactions may contain cues that may aid the language-learning infant. We specifically focused on maternal touch, and our main questions were the following:

1) Is touch in mother-infant dyads used in a way that could help infants to pull out target words from the running speech stream? This question addresses the temporal alignment between tactile and spoken streams.

2) Is touch in mother-infant dyads used in a way that could help infants to learn the mapping between sounds and meaning in their language after infants have segmented the speech stream? This question addresses the congruency between tactile and spoken cues.

In order to address our main questions, we used a book-reading interaction, since book reading is a common practice among parents in western societies and is an important part of early caregiver-infant interactions in these societies (Sénéchal, LeFevre, Thomas & Daley, 1998). Further, recurring book-reading interactions provide support for early language development (Dwyer & Neuman, 2008; National Association for the Education of Young Children, 1998) and enable children to experience the use of symbols at a very young age (National Association for the Education of Young Children, 1998). Books include pictures, written language and oral text, providing children with an exceptionally

rich context to explore symbolism (Sulzby, 1985). Reading a book is almost always accompanied by a social interaction between the adult reader and the child (Mol, Bus, de Jong, Smeets, 2008) and it is one of multiple episodes of physical closeness (Makin, 2006) that characterize early communication. Thus, we predicted that mothers participating in our study would naturally use touch during the interactions with their infants even without being told to do so. Based on previous findings showing differences in the amount of touch employed by mothers during early interactions (Weiss, Wilson, Hertenstein & Campos, 2000), we predicted that mothers in our study will also use touch in different degrees and would use different types of touch. Given previous findings showing that touch can serve the function of regulating arousal levels (Hertenstein, 2002; Jean & Stack, 2009; Jean & Stack, 2012; Stack & Muir, 1990) we also wanted to explore whether caregivers differ in their use of arousal cues.

In addition, using a book-reading interaction allows us to control for the linguistic input that infants receive and to focus on items that may be relevant to tactile-speech interactions. We created new books to be used in this study; half of the books were about animals and the other half were about body parts. Examining children's books revealed that animals and body parts were popular linguistic categories that appeared in many storybooks for infants (e.g. Adler, 2009; Hill, 1980; Katz, 2000; Williams, 1989). Furthermore, previous studies have shown that 6- to 7-month-old infants show some understanding of the meaning of at least some body part words (Bergelson & Swingley 2012; Tincoff & Jusczyk, 2012), and that these items are part of the early vocabulary. For example, 21.4% of parents report that by the age of 8 months, their children can

understand the word nose. 18.6% of parents report that their 8 month-olds can understand the word foot. By the age of 16 months, around 85% of parents report that their children can either understand or say these same words (Dale & Fenson, 1996: data retrieved from <http://www.sci.sdsu.edu/lexical/>, on 06/02/2014). As for animal names, they are considered part of the first words that children understand and say (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick & Reilly, 1993). For example 38.6% of parents report that by the age of 8 months, their children can understand the word dog, and 25.7% report that their 8-month-olds can understand the word cat. By the age of 16 months, nearly 82% of parents report that their children can either understand or say these same words (Dale & Fenson, 1996: data retrieved from <http://www.sci.sdsu.edu/lexical/>, on 06/02/2014). Naturally, tactile cues are useful for learning body part words, but not for animal words, since highlighting the word's referent leads to touching in the former but not latter case.

Using these two sets of word categories enables us to examine whether the use of touch cues during book-reading interactions is related to a specific set of words – body parts vs. animals. Touch characteristics associated with body part words might in some part explain their special place in the infant's early lexicon. We were interested in exploring whether touch is used to teach body part words in particular, or whether these words are specifically emphasized to young infants in a way that might account for their early acquisition. Furthermore, we were interested in examining the temporal alignment of touch and word production. Given that infants can benefit from touch as a cue for segmenting speech (Seidl et al., 2014) and since word segmentation is related to later

word learning (Newman, Ratner, Jusczyk, Jusczyk & Dow, 2006), we wanted to know whether caregivers use tactile-auditory synchrony during dyadic interactions with their infants in a way that could aid word segmentation and later word learning. Given previous findings showing that touch can serve the function of regulating arousal levels (Hertenstein, 2002; Jean & Stack, 2009; Jean & Stack, 2012; Stack & Muir, 1990) much the way Infant-Directed Singing and Speech can (Nakata & Trehub, 2004) we also wanted to explore whether caregivers differ in their use of arousal cues. Exploring these different functions of touch and its contribution to linguistic development might provide some insight into the content of infants' early vocabularies (e.g., why body parts are acquired so early) and might also shed light on the signals that caregivers use unconsciously while interacting with their language learning infant.

METHODS

Participants

Participants were recruited from flyers posted in the Greater Lafayette region as well as through birth announcements in the local newspaper. Parents were contacted via mail, telephone, email and facebook©. Forty-six caregivers agreed to participate in our study with their infants. Twenty dyads were excluded from the final sample due to fussiness (n = 9), experimenter errors (n = 3), prematurity/low birth weight (n = 2) and non-compliance with instructions (n = 6), e.g. reading the books once or more than twice. Two dyads were also excluded due to the participation of the father and dialect of the mother (British English). The final sample included 24 dyads; infants were full-term, had normal birth weight and were from American English speaking families. Infants' age ranged from 4.34 to 5.82 months, (M = 5.33 months; 12 Female). Mothers' education ranged from 12 to 22 years (M = 15.7 years). All mothers gave informed consent before participation and all infants received a book or a toy for their participation in the study.

Materials

Eight books were created especially for this study, 4 on animals and 4 on body parts. In order to create these books (animal books: A1, A2, A3, A4 and body part books: B1, B2, B3, B4), we used seven commercial children's books (see Table: A.1, Appendix A): three on body parts (Adler, 2009; Katz, 2000; Tymms, 2005) and four on animals (Campbell, 1982; Cimarusti, 1998; Hill, 1980; Williams, 1989). The reference books served merely as a source from which we extracted the words that were used as target words in our new books. To this list of words, we added some other body part words that did not appear in any children's books; these new words (eyebrow, finger, chin, and heel) enabled us to avoid any overlap between the target words in the newly created books.

Each new book included four target words; one of these was a bisyllabic word with a strong-weak stress pattern, while the other three were monosyllabic strong words (see Table A.2, Appendix A). Reviewing children's books revealed that most of books include mainly monosyllabic and bisyllabic words; there were also some words with unusual stress patterns and/or length that we decided to exclude due to previous findings showing that infants have a difficulty segmenting (i.e., pulling out from running speech) these words (Johnson & Tyler, 2010). All body parts were presented in their singular form, apart from the word "feet" which has an irregular plural form. Each word in the new books was accompanied by a picture that was carefully chosen from picture databases in the web (see Table A.3, Appendix A). All eight books included the same text in which each target word was repeated four times in sentence-final position (for an

example see Appendix B). All of the eight new books included the same number of pages (for sample pages from two out of the eight books see Appendix C).

Procedure

To avoid preference effects for specific body part and animal words, and to avoid the effect of previous knowledge for these words, each dyad was randomly assigned a combination of two books from the total of eight books, one on body parts and one on animals. Prior to the book-reading session, mothers were provided with a brief explanation about the study and they were told that our main interest in conducting this study is exploring how parents read books to their infants. The book-reading interactions took place in a quiet room where the infant was seated in a high chair facing his/her mother. We used two cameras to videotape the book-reading interactions. The main camera provided a side view of both the mother and the infant allowing a good view on the mothers' hands, and the other camera was located behind the infant's high chair and provided a different view on the mother's face and hands, showing part of the infant's body too. Video recordings from this last camera were used in cases where the mother's hands were not visible enough in the video from the main camera. Mothers wore a clip-on microphone that was wirelessly connected to the main camera, allowing us to separate the audio stream from the video stream to allow for separate analyses and coding. Mothers were asked to read each book twice, the way they would do at home, and they were asked to try to feel as comfortable as possible in spite of the new setting and the cameras.

Data Analyses

Audio Coding An audio file was extracted from the videos recorded through the main camera. Using Praat software (Boersma & Weenink, 2013) we coded all the target words (eight target words that appeared in sentence-final position in each book) that the moms produced during the reading. The edges of the target words were marked in Praat based on acoustic features of the phonemes as they appeared in the waveform and the spectrogram. Tags were placed at upward zero crossings to ease extraction of acoustic values for each target word. We tagged words as mothers produced them even if their productions did not correspond with the target words as they appeared in the books (e.g. kitty for cat, horsey for horse...). Words that were whispered or surrounded by noise (turning a page, mother laughing, baby vocalizing) were marked with an “x” (e.g. mouse_x, belly_x...) and excluded from acoustic analyses, but used in temporal alignment analyses. Audio coding was performed by two separate coders who shared their notes on the coding process and resolved issues and questions through discussion.

Video Coding Using ELAN software (Brugman & Russel, 2004) we coded all the intentional maternal touches during the book-reading interactions. For this coding we used the video files from the main camera, allowing us later to examine the alignment between the use of touch cues and the production of target words, since they were time-aligned. This coding was performed by watching the videos without the sound to control for any interference that might occur from hearing the mothers’ speech. Intentional touch was defined as any type of touch that the mother intentionally provided to her infant on any part of his/her body; once the infant grabbed or touched his/her mother in any way,

coding was ceased (e.g. the mom grabs the baby's hand, but when she is about to release her grip, the baby grabs the mom's finger). Touch that occurred unintentionally was not coded. A template was created in ELAN allowing unified coding for all the videos. We coded the beginning and end times of each touch unit and its location. Possible locations were: head, hair, nose, cheek, eyebrow, eye, ear, chin, mouth, arm, hand, torso (upper body), belly, waist, leg, foot, feet, toe, toes, finger, fingers, knee and heel. The beginning and end of each touch were clearly defined using an algorithm that differentiated touch types (see Table D.1, Appendix D). On a separate tier we also marked the type of session (which book the mother was reading) "animals", "body parts" or transition between sessions. Further coding was conducted but it is not included in the analyses provided in this paper (we coded the different types of touch and the number of beats for each touch unit; however, this coding has not been analyzed yet). Video coding was performed by two teams, each including two coders. Each touch unit was agreed upon by the two coders before it was annotated in ELAN. Disagreements were settled through discussions and in some cases through consulting members of the other team. In cases in which a touch unit was not visible from the main camera and in cases of doubt about the specific features of the touch, coders consulted the video from the other camera. Upon completion of coding, a Praat text-grid file was extracted from ELAN.

Extracting the data

A Praat script was written specifically for this study allowing us to align and integrate information from the video and audio coding (other information was extracted but will not be discussed here). The script logged three types of items:

1. Word only: a target word is produced but there is no active, concurrent touch. In this case, the script extracted the start and end times of the word, and all video variables in the same row were declared as NA (not applicable).
2. Touch only: a touch unit is identified but there is no target word overlapping at least partially with the touch (in these cases, mothers touch their infants without saying any of the target words, but they might be saying some other words that were not coded; for this study, we only coded target words in the audio files). In this case, the script logged the touch location as well as beginning and end times of touch; all the word fields were declared as NA.
3. Word-touch co-occurrence: there is a touch that overlaps at least partially with the target word. To identify this type, we interrogated the touch tier at specific points in time, which depended on the word tier. We first looked at whether any touches were ongoing at the word midpoint (the point in time which was halfway between the word onset and offset). If there was no active touch at that point, then we interrogated the touch tier at the word onset. If no active touch was present at that point, we looked at the time of and the word offset. Finally, if no active touches had been identified at any of those three points, we looked for touches that occurred between the onset and the offset of the word (even if they did not overlap with these 3 points). Once an active touch had been found, we logged both audio and video information noted in 1 and 2 above.

A custom-written R script performed all statistical analyses. To answer our research questions, this script tabulated frequencies of occurrence (e.g., how many touches were

found), as well as information regarding the congruence and temporal alignment of word-touch units. In terms of congruence, word-touch units were classified as:

1. Congruent – the meaning of the target word is congruent with the location of the touch (e.g. the mother says “belly” while touching the baby’s belly).
2. Incongruent – the meaning of the target word is not the same as the location of the touch (e.g. the mother says “horse” while touching the baby’s hand)

As for temporal alignment, we calculated the word-to-touch onset latency as the time elapsing between the word onset and the touch onset; and the offset latency as the same in terms of offset. Naturally, this latency is deeply affected by whether the touch we considered was extracted at the first phase (midpoint of the word) versus later phases (onset, offset, other) of the Praat script. Therefore, our latency analyses focus only on word-touch units where the touch was active at the word midpoint (congruence analyses include all touches).

Figure 1 shows an example from the audio and video coding; the images depict the occurrence of a touch unit that was congruent with the word produced, i.e. the mother touched the baby’s belly while producing the word belly. Further, the images show the temporal alignment in the production of the two cues.

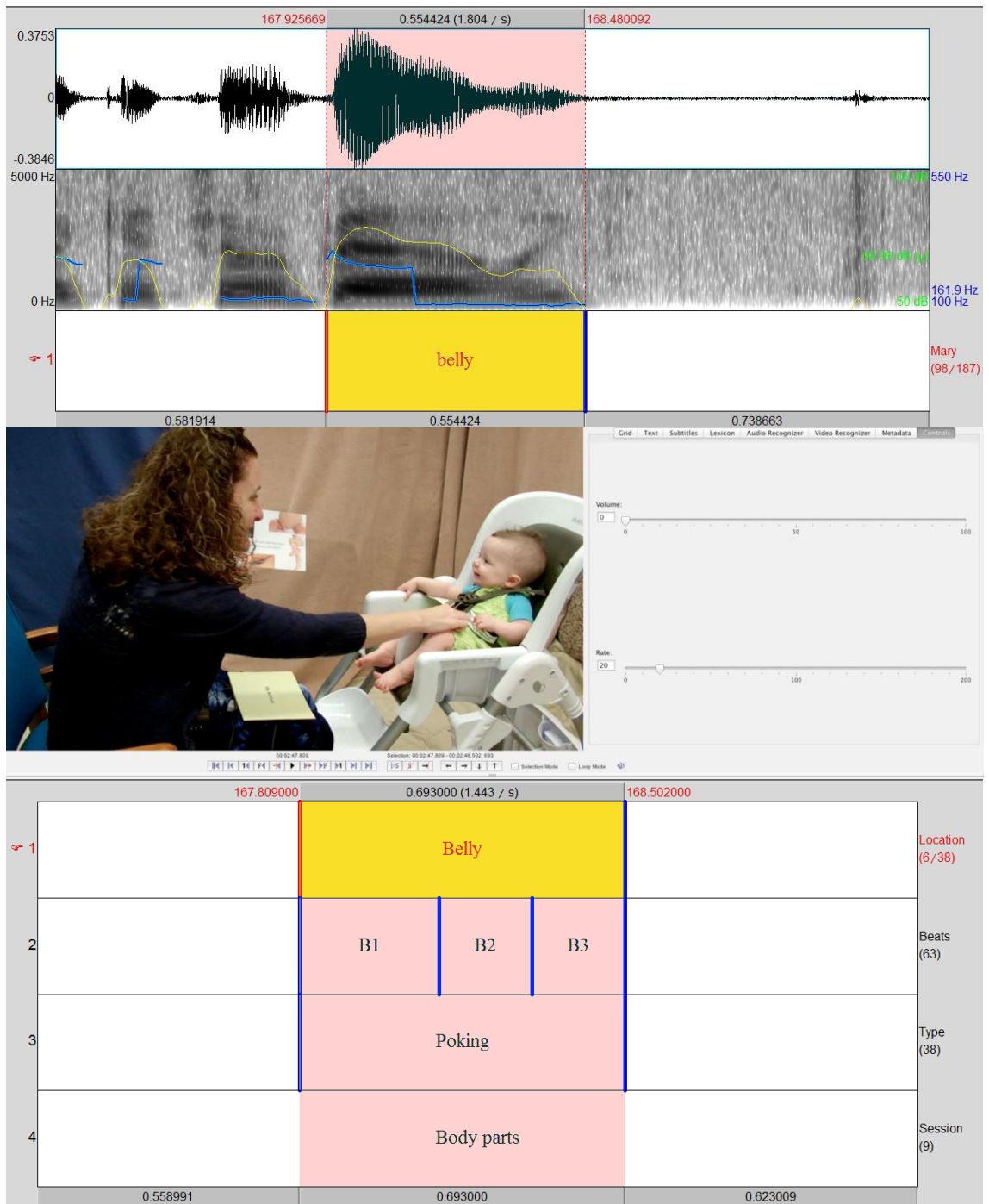


Figure 1: A time slice from the coding showing the alignment of both the video and audio tiers.

RESULTS

Before addressing any of our target questions specifically, we examined the frequency of use of touch during book-reading interactions, to explore whether it was a necessary component of these interactions. Results revealed that 3 out of 24 mothers never touched their infants at all and 2 other mothers did not touch their infants during the reading sessions, and did so only when transitioning between the books (primarily readjusting their infants' position). Hence, in total, 19 mothers (79%) touched their infants during the book-reading sessions. The number of touches that occurred in each dyad ranged from 0 to 68 ($M = 20.29$ touches). Of the mothers who touched their infants, 17 used more touches during body part sessions than during animal sessions. These findings show that touch was not a *necessary* means of communication during book-reading interactions, and that it is employed by most, but not all mothers. Thus, the remainder of our analyses explore touch within those mothers who exploited this cue and ask whether this cue, while it might not be necessary (or may not be employed in all interactions) may still be a reliable word learning and word segmentation cue for the infant who *is* provided with it.

First we asked, is touch in mother-infant dyads used in a way that could help infants to segment words from the speech stream? Previous studies have shown that when presenting target words to their infants, mothers use multi-modal communication in

which cues are temporally aligned (Gogate et al., 2000; Meyer et al., 2011). As mentioned, we predicted that mothers might also use multimodal IDS and accompany the production of words with touch, aligning these cues temporally. Further, if touch is a possible cue that may aid in infants' segmentation of the speech stream, it would only be helpful in this task if words were aligned with touches. To address the above question we examined whether touch was provided to infants in synchrony with our target words.

Similar to proportions reported by Gogate and colleagues (2000) showing that 17% of all target words were synchronous with touching the infant with the object and visual object motion, our analyses revealed that 10% of all target words co-occurred with touch. While this percentage might seem very small, it is important to note that some other words in the stream of speech, not coded from the audio files, might have co-occurred with touch. Thus, for the purpose of addressing the question above it is important to examine these 10% and explore how well aligned touches and target words are.

Since we only coded the target words in the audio files, and given the possibility that some of the touches might have occurred with other words that we did not code and might have even been perfectly aligned with these words, it seems more reasonable to focus on the temporal alignment of words and touches that were congruent (e.g., saying "foot" while touching the foot). Analyses looking at the alignment of touch with body part target words (those with the most touches associated with them) revealed that 43% of all touches occur temporally aligned with the target words as defined by the script mentioned earlier. Figure 2 illustrates this alignment and shows that congruent touches

are most often aligned with both the onset and the offset of the target word. These findings show that when mothers used touch while producing the target words, they unconsciously aligned the cues in such a way that touch encompassed the word produced.

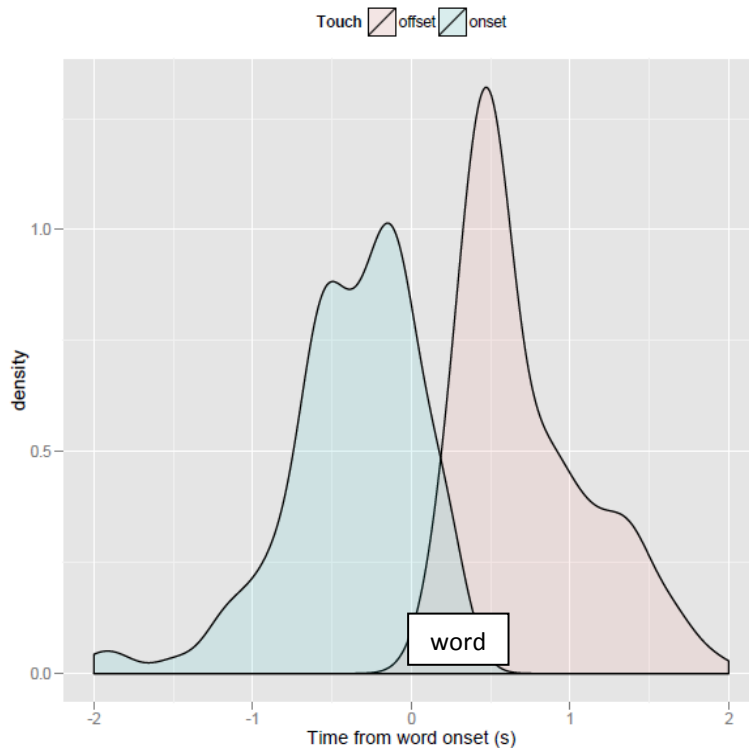


Figure 2: This is a density plot of touches in which the lilac box represents a spoken word. The box is aligned to the spoken word onset and it ends at the average duration of words. Most of the words have touch onsets (in blue) that are at -0.75 to 0.25 with the word onset at zero and touch offsets (in pink) that are at -0.25 to 0.5 with the word offset at zero.

Second, we asked, whether touch in mother-infant dyads was used referentially in a way that could conceivably help infants to learn the mapping between sounds and meaning in their language after they have segmented the speech stream. To address this question we examined touches that occurred during the book-reading interactions and

their occurrences with target words. We hypothesized that mothers would touch their infants in a referential way. Specifically, mothers might use touch as a cue to unconsciously communicate the sound-meaning relationship to their language-learning infant. Thus, analyses explored whether touch location and word referent were congruent (touch location matched the target word).

The results revealed that there were more body part words than animal words accompanied by touches for 89% of the mothers (17 out of 19), significantly more often than would be expected by chance (binomial tests showed that p (two-tailed) = .007). Further, of all the touches co-occurring with a target word (211 touches), 74% (157 touches) were congruent with the referent (a body part word; see Figure 3). 16 mothers out of the 17 who used touch more frequently with body part words, i.e. 94%, produced more congruent than incongruent body part word touches, significantly more often than would be expected by chance (binomial tests showed that p (two-tailed) = .0003).

Analyzing the patterns of use of touch across mothers revealed that congruent touches were more frequent than incongruent touches (see Figure 4). Moreover, when including the occurrences of the animal words with touch in the total number of incongruent touches, we found that most mothers followed this pattern such that, out of the 19 mothers who used touch during the book-reading interactions, 14 mothers used more congruent than incongruent touches (see Figure 4). Further, when we examined the proportion of words that were congruent with touch over the total number of words that occurred with touch, we found that for 9 mothers more than 80% of touches used were congruent (5 mothers between 0.8-0.9 and 4 mothers between 0.9-1.0; see Figure 5); this

means that the locations of most of the touches that occurred with target words were congruent with the meaning of the words.

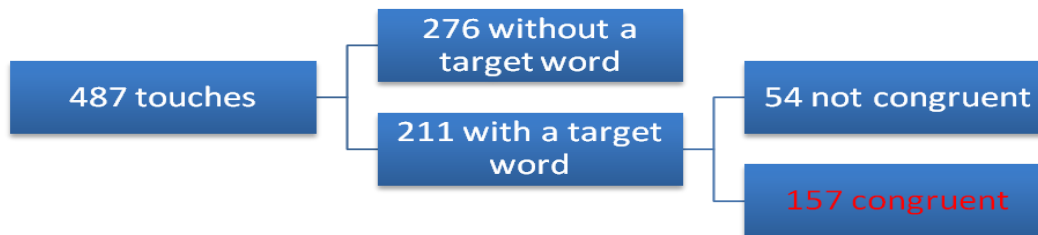


Figure 3: Distribution of the different occurrences of touch

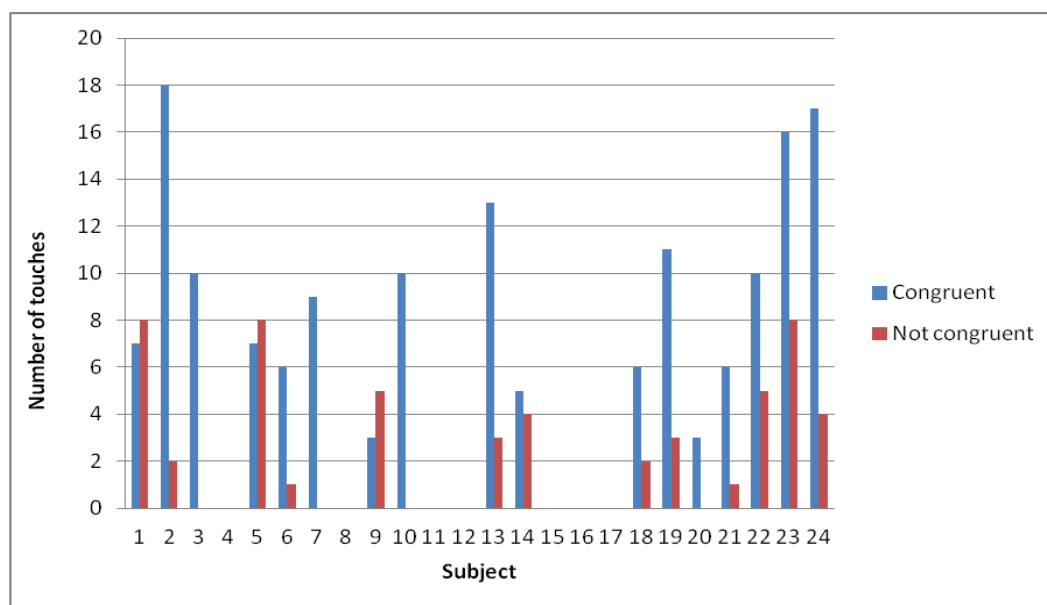


Figure 4: The proportion of congruent and incongruent touches for each of the 24 mothers.

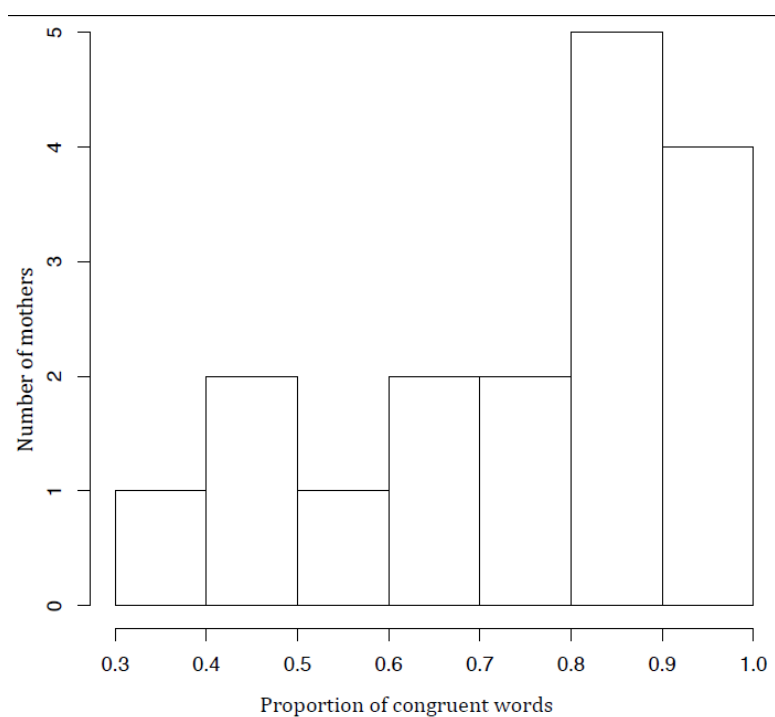


Figure 5: The proportion of congruent words out of the total number of words that occurred with touches

These findings suggest that when mothers touch their infants while producing target words their touches are most often referential/congruent. Simply put, the high rates for congruent touches as opposed to incongruent ones show that touch cues could potentially teach the infant about the word that he/she hears after segmenting it from the speech stream.

DISCUSSION

The results of our study emphasized, yet again, the importance of examining touch in early mother-infant interactions. As in previous studies (Gogate et al., 2000; Meyer et al., 2011), our results also suggest that infant-directed communication is multimodal and that caregiver actions are tied to the vocal productions. Indeed, mothers were likely to use touch in synchrony with the production of target body part words. More specifically, we found that when a word was accompanied with touch, the touch usually encompassed the word and the two were well aligned. In most cases, if the infant received a referential touch (a touch that was congruent with the word produced) then it was likely that the touch began shortly before the onset of the word and ended shortly after. One previous study showed that maternal touch is accompanied by other verbal and non-verbal modes of communication (such as noises produced by the mother, utterances like “you are crying, that was hard for you” or the baby’s name) aiming at either getting the infant’s attention or nurturing him/her (Jean & Stack, 2012). However, the researchers did not examine the exact *alignment* of touch with the other modes of communication and the coding procedure they employed was less precise than the one we used. Thus, the current study is the first to explore temporal alignment of touch with verbal communication showing that these two communication modes can be temporally aligned in infant-directed communication.

This alignment could act as a cue for the language-learning infant to identify the boundaries of words in the input speech stream. This seems likely given recent experimental data in Seidl et al. (2014). Specifically, controlling for all other cues, Seidl and colleagues (2014) showed that experimenter touch can aid word segmentation and allowed infants to find words in the speech stream when they were only 4 months of age. Since our results show that, during mother-infant book-reading interactions, 43% of touches which occurred congruently with body part words were well-aligned with the word edges, it is likely that maternal touch can provide infants with yet another cue to word boundaries to aid them in segmentation. Beyond its importance in parsing fluent speech into words (Jusczyk, 1999; Jusczyk & Aslin, 1995), speech segmentation can be viewed as an important early benchmark that infants need to reach in the process of learning words and building a lexicon (Graf Estes, Evans, Alibali, & Saffran, 2007; Junge, Kooijman, Hagoort & Cutler, 2012; Jusczyk, 1999; Kooijman, Junge, Johnson, Hagoort & Cutler, 2013). Further, it appears that word segmentation is related to early expressive language skills (Junge et al., 2012; Kooijman et al., 2013; Newman et al., 2006; Singh, Reznick & Xuehua, 2012), comprehension skills (Kooijman et al., 2013) and later syntactic and semantic language profiles (Newman et al., 2006). Due to the importance of speech segmentation for language learning, we cannot underestimate any cue aligning with speech directed to infants. It is reasonable to assume that infants rely upon this multimodal communication and the alignment of cues in order to be able to identify separate words in the speech stream. However, further research is still needed on

the multimodality of infant-directed speech so we can identify the specific contributions of the different multimodal cues to word segmentation.

Not only could these caregiver touches act as segmentation cues, but our findings go beyond this to suggest that touches could also aid in word learning by helping the infant learn the mapping between wordforms and meaning. Specifically, our results suggest that maternal touches that co-occur with a target word are more likely to be congruent (e.g., the mother says “belly” while touching her baby’s belly) than incongruent (the mother says “horse” while touching her baby’s foot). It is however, worthy of mention that while our results suggest that touch may be a useful cue in word learning, our results also suggest that touch may not be a *necessary* cue since in this specific task only 19% of body part words were accompanied with touch (i.e., mothers often say words without touches, though when they do touch the touches are highly informative). Nonetheless, given that maternal touch was more likely to accompany a word that is congruent with the location of touch than one that is incongruent with the location of touch (14 out of 19 mothers followed this pattern), we can assume that touch can be *informative*. Specifically, touches can be informative because the mother touches the baby’s belly while saying “belly” most of the time, allowing the baby to map the relationship between wordforms and their referents.¹

¹ Because we were also interested in why (beyond touch) body part words might be amongst the first acquired (Bergelson & Swingley 2012; Tincoff & Jusczyk, 2012), we also examined whether body part words were specifically emphasized in IDS in a way that might account for their early acquisition. We compared the acoustic features (duration, pitch measures and amplitude) of body part words and animal words in general, and we also specifically compared the minimal pair “mouse” and “mouth” (which appeared in books A3 and B3 respectively, with which we familiarized 6 infants out of the 24). Results did not reveal any statistically significant differences between these two groups of words, even when the analysis was conducted only on the minimal pair. Thus, it is unlikely that acoustic differences account for differences in acquisition between these two types of words, suggesting that touch cues occurring in congruence

Given that our findings suggest that mothers touch their infants in synchrony with their speech and their touch is more likely to be referential than not, the next question we need to ask though is why mothers do this. One possibility is that mothers' use of tactile cues is related to their regulation of their infants' arousal. Previous studies have found that touch regulates arousal levels and reduces distress (Hertenstein, 2002; Jean & Stack, 2009; Jean & Stack, 2012; Stack & Muir, 1990). Thus, touch (referential or not) might heighten the infant's arousal and caregivers might exploit it for this reason. If this were the case, temporal alignment and congruence might simply be a secondary cue or side-effect of the caregiver's main goal of arousal regulation. Nonetheless, this cue could help the infant to pay more attention to whatever occurs in synchrony with the touch. Specifically, the use of touch might allow infants to be more attentive to the speech stream and to the accompanying cues simply because he or she might be more aroused.

with the production of body part words could potentially aid infants in learning these words, perhaps explaining their early acquisition.

Our data may partially allow us to address this arousal hypothesis. If touch is used primarily by caregivers in this language-rich setting to regulate arousal then we might predict that caregivers would trade-off touch with IDS cues (such as pitch) since IDS has also been reported to heighten arousal (Nakata & Trehub, 2004) so that the infant is not overly aroused due to excessive use of multiple cues. To address this possibility, we examined whether words that co-occurred with referential touches were acoustically distinct from words that were not accompanied with touch. Our results revealed that there were no significant differences in any of the acoustic measures (duration, pitch and amplitude) between these two groups of words.² This might lead to the conclusion that touch is used as an accompanying cue to speech rather than a main arousal cue which might trade-off with speech cues.

Another possibility that might explain the occurrence of speech with touch cues in a referential and temporally synchronized manner might be related to the nature of human communication patterns. It is possible that our spoken language system evolved from a gestural or tactile system, thus these two systems still operate in a dependent manner (McNeill, 2012). Thus, it is not surprising that mothers use this feature when communicating with their infants, and it is possible if this shared origin is possible then infants use this multimodal communicative behavior in order to learn language. Once

² Spearman correlations were fit for the individual median of word duration, as well as minimum, maximum, average, and range of f0. None was significant even at $p = .05$, which is a liberal alpha given the number of correlations fitted to these data. Thus, there is little support to the idea that touch is used to modulate infant arousal at least in the present context.

again, only future work further exploring the dependence of these two communication systems (touch and spoken language) will contribute to support this hypothesis.

In sum, the explanation for why caregivers behave the way they do cannot be determined in confidence from our current findings. Nonetheless, it is possible that while not a necessary cue to speech segmentation and word learning, touch aligned with and congruent with spoken language is clearly a cue that caregivers unconsciously produce. Thus, touch cues appear to have another function in early interactions that is distinct from the previously reported functions of touch, i.e., touch served a referential and aligning function highlighting words in the speech stream that could aid the infant in the task of speech segmentation and later word learning.

Challenges for future work

The coding system we used in this study allowed us to code different features of maternal touch during early book-reading interactions, however, touch is a multi-dimensional means of communication which has different qualities (action, intensity, velocity, abruptness and temperature) and parameters (location, frequency, duration and extent of surface area touched) ((Hertenstein, 2002) that cannot be coded by watching a videotaped interaction. For example when coding videos of mother-infant interactions, we cannot really identify and measure the intensity of touch on the infant's skin or how the infant is experiencing the touches (Hertenstein, 2002). Future work is needed to develop better coding systems and techniques that will allow researchers to code all the

different qualities and parameters of touch, which will help in measuring the use of touch during early interactions in a more accurate way.

Future research can also focus on examining the significance of touch in linguistic interactions in contexts other than book-reading interactions. Most of the mothers (80%) who participated in our study touched their infants during the book-reading interactions. The number of touches however differed greatly between mothers and it was less than the frequency of touches previously reported in other studies (41-714 touches during feeding sessions: Weiss et al., 2000). However, this difference might be due to the differences in physical closeness that is observed during feeding vs. book-reading sessions. While feeding is highly tactile and usually allows the mother to use *both* of her hands, book-reading interactions are not tactile by definition and they allow mothers to use one hand only (the other hand is holding the book). However, mothers in our study naturally employed the use of touch even though they only, at most, had one free hand. Having two free hands, as in play interactions, might allow mothers to use touch more frequently. Further, researchers suggest that mothers and infants communicate in different ways depending on the context in which they are interacting (Tamis-LeMonda, Song, Leavell, Kahana-Kalman & Yoshikawa, 2012). Touch occurs in a context, and the types and functions of touch used by mothers can differ based on the context of the dyadic interaction (feeding, floor play, face-to-face interactions...; Jean et al., 2009). Thus, it is possible that our results reflect the use of touch during book-reading interactions only, and that we can expect to see other patterns during other interactions. Future research can

explore other interactions and examine the synchrony of touch cues with infant-directed speech.

Further, previous research has shown that the frequency of maternal touch decreases during the first year of life (Ferber et al., 2008; Jean et al., 2009) and can also differ between cultural groups (Franco et al., 1996). Thus, given these differences in the frequency of touch based on context, infants' age, developmental trajectories and cultural and ethnic backgrounds, our results can be viewed as representing the use of touch by white American mothers of a certain SES during book-reading interactions with their 5-month-old infants. Exploring the contribution of touch to the development of language in different contexts amongst different cultural groups and different ages is essential for better understanding the multimodal communication in early dyadic interactions and how it contributes to language learning. Such knowledge on the multimodality of infant directed communication can be essential for improving the quality of early interactions, and thus improving the developmental trajectories of infants and children (Field, 2002).

BIBLIOGRAPHY

BIBLIOGRAPHY

- Anisfeld, E., Casper, V., Nozyce, M., & Cunningham, N. (1990). Does infant carrying promote attachment? An experimental study of the effects of increased physical contact on the development of attachment. *Child Development*, 61(5), 1617-1627. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/2245751>.
- Bergelson, E. & Swingley, D. (2012). At 6-9 months, human infants know the meanings of many common nouns. *Proceedings of the National Academy of Sciences of the United States of America*, 109(9), 3253-3258.
- Boersma, P. & Weenink, D. (2013). Praat: Doing phonetics by computer [Computer program], Version 5.3.45, retrieved 30 December 2013 from <http://www.praat.org/>.
- Brugman, H. & Russel, A. (2004). Annotating Multimedia/ Multi-modal resources with ELAN. In: *Proceedings of LREC 2004, Fourth International Conference on Language Resources and Evaluation*.
- Dale, P. S., & Fenson, L. (1996). Lexical development norms for young children. *Behavioral Research Methods, Instruments, & Computers*, 28, 125-127.
- Dwyer, J. & Neuman S. B. (2008). Selecting books for children birth through four: A developmental approach. *Early Childhood Education Journal*, 35, 489-494.

- Falk, D. (2004). Prelinguistic evolution in early hominins: Whence motherese? *The Behavioral and Brain Sciences*, 27(4), 491-541. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/15773427>.
- Fenson, L., Dale, P., Reznick, S., Thal, D., Bates, E., Hartung, J., Pethick, S. & Reilly, J. (1993). *The MacArthur communicative development inventories*. San Diego, CA: Singular Publishing Group.
- Field, T. (2002). Infants' need for touch. *Human Development*, 45(2), 100-103. Retrieved from <http://www.karger.com/Article/Fulltext/48156>.
- Feldman, R., Singer, M., & Zagoory, O. (2010). Touch attenuates infants' physiological reactivity to stress. *Developmental Science*, 13(2), 271-278. doi:10.1111/j.1467-7687.2009.00890.x.
- Ferber, S. G. (2004). The nature of touch in mothers experiencing maternity blues: the contribution of parity. *Early Human Development*, 79(1), 65-75. doi:10.1016/j.earlhumdev.2004.04.011.
- Ferber, S. G., Feldman, R., & Makhoul, I. R. (2008). The development of maternal touch across the first year of life. *Early Human Development*, 84(6), 363-370. doi:10.1016/j.earlhumdev.2007.09.019.
- Franco, F., Fogel, A., Messinger, D. S., & Frazier, C. A. (1996). Cultural differences in physical contact between Hispanic and Anglo mother-infant dyads living in the United States. *Early Development and Parenting*, 5(3), 119-127.

- Gogate, L. J., Bahrick, L. E., & Watson, J. D. (2000). A study of multimodal motherese: The role of temporal synchrony between verbal labels and gestures. *Child Development, 71*(4), 878-894. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/11016554>.
- Graf Estes, K., Evans, J. L., Alibali, M. W. & Saffran, J. R. (2007). Can infants map meaning to newly segmented words? *Psychological Science, 18*(3), 254-259.
- Herrera, E., Reissland, N., & Shepherd, J. (2004). Maternal touch and maternal child-directed speech: effects of depressed mood in the postnatal period. *Journal of Affective Disorders, 81*(1), 29-39. doi:10.1016/j.jad.2003.07.001.
- Hertenstein, M. J. (2002). Touch: Its communicative functions in infancy. *Human Development, 45*(2), 70-94.
- Hoff, E. (2008). *Language development*. 4th edition. Belmont, CA: Cengage Learning.
- Jean, A. D. L., & Stack, D. M. (2009). Functions of maternal touch and infants' affect during face-to-face interactions: New directions for the still-face. *Infant Behavior & Development, 32*(1), 123-128. doi:10.1016/j.infbeh.2008.09.008.
- Jean, A. D. L., & Stack, D. M. (2012). Full-term and very-low-birth-weight preterm infants' self-regulating behaviors during a still-face interaction: Influences of maternal touch. *Infant Behavior & Development, 35*(4), 779-791. doi:10.1016/j.infbeh.2012.07.023.
- Jean, A. D. L., Stack, D. M., & Fogel, A. (2009). A longitudinal investigation of maternal touching across the first 6 months of life: Age and context effects. *Infant Behavior & Development, 32*(3), 344-349. doi:10.1016/j.infbeh.2009.04.005.

- Johnson, E. K. & Tyler, M. D. (2010). Testing the limits of statistical learning for word segmentation. *Developmental Science*, *13*(2), 339-345.
- Junge, C., Kooijman, V., Hagoort, P. & Cutler, A. (2012). Rapid recognition at 10 months as a predictor of language development. *Developmental Science*, *15*(4), 463-473.
- Jusczyk, P. W. (1999). How infants begin to extract words from speech. *Trends in Cognitive Sciences*, *3*(9), 323-328.
- Jusczyk, P. W. & Aslin, R. N. (1995). Infants' detection of the sound patterns of words in fluent speech. *Cognitive Psychology*, *29*, 1-23.
- Kooijman, V., Junge, C., Johnson, E. K., Hagoort, P. & Cutler, A. (2013). Predictive brain signals of linguistic development. *Frontiers in Psychology*, *4*(25), 1-13. doi: 10.3389/fpsyg.2013.00025.
- Makin, L. (2006). Literacy 8-12 months: What are babies learning? *Early Years*, *26*(3), 267-277.
- Meyer, M., Hard, B., Brand, R. J., McGarvey, M., & Baldwin, D. A. (2011). Acoustic packaging: Maternal speech and action synchrony. *IEEE Transactions on Autonomous Mental Development*, *3*(2), 154-162. doi:10.1109/TAMD.2010.2103941.
- Mol, S. E., Bus, A. G., de Jong, M. T., Smeets, D. J. H. (2008). Added value of dialogic parent-child book readings: A meta-analysis. *Early Education and Development*, *19*(1), 7-26.

- Moszkowski, R. J., & Stack, D. M. (2007). Infant touching behavior during mother-infant face-to-face interactions. *Infant and Child Development, 16*(3), 307-319. doi:10.1002/icd.510.
- Muir, D. W. (2002). Adult communications with infants through touch: The forgotten sense. *Human Development, 45*(2), 95-99. doi:10.1159/000048155.
- Nakata, T., & Trehub, S. E. (2004). Infants' responsiveness to maternal speech and singing. *Infant Behavior and Development, 27*(4), 455-464. doi:10.1016/j.infbeh.2004.03.002.
- National Association for the Education of Young Children (1998). Learning to read and write: Developmentally appropriate practices for young children; a joint position statement of the internal reading association and the national association for the education of young children. *Young Children, 53*(4), 30-46.
- Newman, R., Ratner, N. B., Jusczyk, A. M. & Jusczyk, P. W. & Dow, K. A. (2006). Infants' early ability to segment the conversational speech signal predicts later language development: A retrospective analysis. *Developmental Psychology, 42*(4), 643-655.
- Singh, L., Nestor, S., Parikh, C., & Yull, A. (2009). Influences of infant-directed speech on early word recognition. *Infancy, 14*(6), 654-666. doi:10.1080/15250000903263973.
- Singh, L., Reznick, J. S. & Xuehua, L. (2012). Infant word segmentation and childhood vocabulary development: A longitudinal analysis. *Developmental Science, 15*(4), 482-495.

- Seidl, A., Tincoff, R., Baker, C., & Cristia, A. (2014). Why the body comes first: Effects of experimenter touch on infants' word finding. *Developmental Science*, n/a–n/a. doi:10.1111/desc.12182.
- Sénéchal, M., LeFevre, J. A., Thomas, E. M. & Daley, K. E. (1998). Differential effects of home literacy experiences on the development of oral and written language. *Reading Research Quarterly*, 33(1), 96-116.
- Stack, D. M., & Arnold, S. L. (1998). Changes in mothers' touch and hand gestures influence infant behavior during face-to-face interchanges. *Infant Behavior and Development*, 21(3), 451-468. doi:10.1016/S0163-6383(98)90019-4.
- Stack, D. M. & Muir, D. W. (1990). Tactile stimulation as a component of social interchange: New interpretations for the still-face effect. *British Journal of Developmental Psychology*, 8, 131-145.
- Stern, D. (1985). *The interpersonal world of the infant: A view from psychoanalysis and developmental psychology*. London: Karnak Books.
- Sulzby, E. (1985). Children's emergent reading of favorite storybooks: A developmental study. *Reading Research Quarterly*, 20(4), 458-481.
- Tamis-LeMonda, C. S., Song, L., Leavell, A. S., Kahana-Kalman, R., & Yoshikawa, H. (2012). Ethnic differences in mother-infant language and gestural communications are associated with specific skills in infants. *Developmental Science*, 15(3), 384-397. doi:10.1111/j.1467-7687.2012.01136.x.
- Thompson, R. A. (2001). Development in the first years of life. *The Future of Children*, 11(1), 20-33.

- Tincoff, R. & Jusczyk, P. W. (2012). Six-month-olds comprehend words that refer to parts of the body. *Infancy*, *17*(4), 432-444.
- Topping, K., Dekhinet, R., & Zeedyk, S. (2013). Parent–infant interaction and children’s language development. *Educational Psychology*, *33*(4), 391-426. doi:10.1080/01443410.2012.744159.
- Weiss, S. J., Wilson, P., Hertenstein, M. J. & Campos, R. (2000). The tactile context of a mother’s caregiving : Implications for attachment of low birth weight infants. *Infant Behavior and Development*, *23*(1), 91-111.

APPENDICES

Appendix A: Other Resources

Table A. 1: Reference books

1	“Where is Baby’s belly button?”
2	“The ME Book”
3	“all of baby nose to toes”
4	“Dear Zoo”
5	“Where’s Spot?”
6	“I went walking”
7	“Peek-a-Moo!”

Adler, V. (2009). *All of baby nose to toes*. New York: Penguin Group Inc.

Campbell, R. (1982). *Dear zoo*. London: Macmillan.

Cimarusti, M. T. (1998). *Peek-a-moo*. New York, NY: Dutton Children’s Books.

Hill, E. (1980). *Where’s Spot?* New York, NY: G. P. Putnam’s Sons.

Katz, K. (2000). *Where is baby's belly button?* New York, NY: Little Simon.

Tymms, J. (2005). *The me book*. New York, NY: Golden Books.

Williams, S. (1989). *I went walking*. New York, NY: Red Wagon Books.

Table A.2: Target words in each book

Animals Books		Body Parts Books	
A1	A2	B1	B2
Camel (SW)	Puppy (SW)	belly (SW)	tummy (SW)
Bear (S)	Bird (S)	nose (S)	eye (S)
Cat (S)	Horse (S)	chin (S)	waist (S)
Sheep (S)	Cow (S)	leg (S)	feet (S)
A3	A4	B3	B4
Lion (SW)	Hippo (SW)	finger (SW)	eyebrow (SW)
Frog (S)	Snake (S)	mouth (S)	ear (S)
Mouse (S)	Dog (S)	knee (S)	heel (S)
Duck (S)	Pig (S)	toe (S)	hand (S)

Table A.3: Other Resources

1	Google Images
2	National Geographic
3	PeopleImages

Google Images, Retrieved on 10 June 2013 from

<https://www.google.com/imghp?hl=en&tab=wi>.

National Geographic, Animal photos. Retrieved 10 June 2013 from

<http://animals.nationalgeographic.com/animals/photos/>.

PeopleImages: Royalty Free Images and Stock Photos, Babies photos. Retrieved 10 June

2013 from <http://peopleimages.com/shoots#babies>.

Appendix B: Sample Book Text

Example – Book B1

Do you see the belly? Where's the belly?

Here's the belly.

Do you see the nose? Where's the nose?

Here's the nose.

Do you see the chin? Where's the chin?

Here's the chin.

Do you see the leg? Where's the leg?

Here's the leg.

Here's the belly.

Here's the nose.

Here's the chin.

And here's the leg.

Appendix C: Sample pages from the books

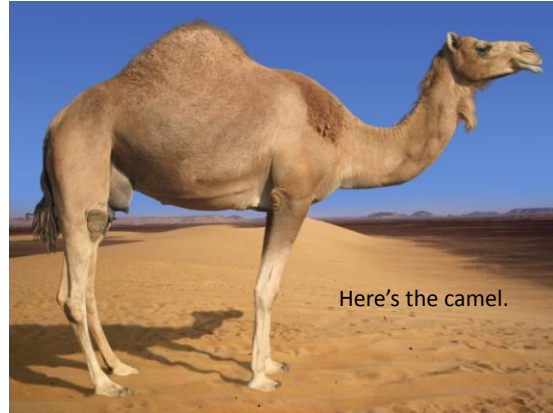


Do you see the finger?
Where's the finger?

Do you see the camel?
Where's the camel?



Here's the finger!



Here's the camel.

Appendix D: The different types of touch

Table D.1: The different types of touch

Brushing	A motion that begins in one location and ends in another performed either with one finger or the whole hand. Each movement in one direction was coded as one beat; going back on the opposite direction was coded as another beat.
Grabbing	Coded only when noticeable as a separate touch. No beats.
Moving	Mother moves infant's body part in any way (shaking, moving towards the book). Beats are counted based on the direction of the movement, once the direction changes, a new beat is coded.
Pinching	A squeezing motion with two fingers only. Coding starts when the fingers are stretched before the pinch, and ends with the fingers stretched again as in the initial position.
Poking	Coding starts with the actual touch on the body part and ends when the finger is pulled back, either to start a new poke or to end the whole touch. Each poke is coded as a separate annotation unless mothers do not pull their fingers off the infant's body.
Readjustment	Mother adjusts infant's position; location varies. No beats.
Resting	Mother is resting her hand on any of the infant's body parts. No beats.
Squeezing	A squeezing motion with the whole hand. Coding starts with the hand stretched before the squeeze, and ends with the hand stretched again as in the initial position.
Tapping	Touch with the whole hand. Similar to poking, coding starts with the actual touch on the body part and ends when the hand is pulled back, either to start a new tap or to end the whole touch. Each tap is coded as a separate annotation unless mothers do not pull their fingers off the infant's body.
Tickling	No beats.
Unspecified	All other types of touch that do not apply to any specific category. No beats.
Wiping	Mother wipes baby's drool. No beats.