



MOTHER-INFANT INTERACTIONS:

How Mothers of Hearing-Impaired Infants Interact With
Their Babies Through Speech and Touch

Student Authors



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Mentors



Amanda Seidl is a professor in the Department of Speech, Language, and Hearing Sciences at Purdue University. The overarching goal of her research is to discover how language comes to the child. Seidl's current research program focuses on early predictors of language.

Specifically, this work explores ways in which measures of early speech perception, production, and input to the child relate to later language in both typical children and children at risk for delays and disorders.



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her PhD work, focusing on the effects of caregiver touch on infant word segmentation and word learning.

Abstract

Since the majority of their caregivers are hearing and use spoken language, most hearing-impaired infants (HII) are faced with a different language-learning problem than their age-matched hearing (AM) peers. A hearing mismatch occurs when a caregiver and her child receive variant levels of auditory input due to their different hearing abilities. Given that HII do not treat speech as a primary mode of communication, it is possible that their caregivers may exploit non-speech modalities when interacting with their infants—similar to deaf parents of deaf infants. However, due to mismatched hearing statuses, parents of HII may have a difficulty in utilizing the modality that best corresponds with their infants' abilities.

It is imperative to understand how hearing caregivers interact with their HII in order to explore the most relevant method of communication to enhance infants' language learning. We video- and audio-recorded play interactions between mothers of HII (4 cochlear implant users; 2 hearing aid users) and mothers of AM peers (6 hearing). Mothers were given three toys and asked to play with their child, "as they would at home." We measured pitch, duration, and intensity in their production of the names of the toys. We also measured the number and types of touches mothers produced. Results revealed that mothers of HII and AM peers had very similar measures for pitch, duration, and intensity. However, the number and type of touches were distinct: HII were touched more than three times more frequently than AM peers. Thus, findings from this study suggest that mothers of HII may exploit non-speech modalities when they have a hearing mismatch with their child.

Begle, A., Chapleau, A., Haga, A., Held, M., Isbell, K., Loerch, S., . . . Tordi, S. (2016). Mother-infant interactions: How mothers of hearing-impaired infants interact with their babies through touch. *Journal of Purdue Undergraduate Research*, 6, 2–8. <http://dx.doi.org/10.5703/1288284316158>

Keywords

cochlear implants, hearing aids, caregiver-child interaction, language learning, touch, speech, hearing impairment, language acquisition, aural habilitation, infant-directed speech

INTRODUCTION

Hearing-impaired infants (HII) are faced with a different language-learning problem than age-matched hearing (AM) peers: although the majority of their caregivers are hearing and use spoken language, these HII do not have access to spoken language. This lack of access to spoken language deprives the brain of exercising certain areas along the peripheral auditory processing pathway (Houston, Pisoni, Kirk, Ying, & Miyamoto, 2003). This absence affects neurobiological development because the number of neuronal connections along the peripheral auditory pathway will be reduced through the process of synaptic pruning. Synaptic pruning is the process of reducing the synaptic density of unused neurons, while increasing the synaptic density of the frequently used neurons. Therefore, children born deaf will have fewer neuronal connections devoted to hearing and processing speech (Shepherd & Hardie, 2001). As a result, during interactions with others, speech sounds are less significant to deaf infants than are other sensory modalities, such as sight, touch, and so forth (Houston et al., 2003).

A hearing mismatch occurs when a hearing caregiver and his or her hearing-impaired child receive variant levels of auditory input due to their different hearing abilities. Given that HII do not treat speech as a primary mode of communication (Houston & Bergeson, 2014), it is possible that their caregivers may come to exploit other non-speech modalities—similar to deaf parents of deaf infants. For example, deaf parents of HII tap their child's body to alert them when a sign is coming (Koester, Brooks, & Traci, 2000). Thus, the tactile modality is used in these deaf-deaf dyads to initiate an interaction instead of using speech, a less significant sensory modality for the HII. However, due to mismatched hearing statuses, hearing parents of HII may be less sensitive to these differences and less able to exploit other modalities due to less experience with them. For example, hearing parents of HII have been shown to tap objects more frequently than tapping their child during play interactions in order to achieve joint attention (Waxman & Spencer, 1997).

Despite this hearing mismatch, studies show that caregivers of HII use infant-directed speech (IDS) when interacting with their infants (e.g., Bergeson, Miller, & McCune, 2006). IDS is a form of speech with higher fundamental frequency, slower tempo, and hyperarticulated vowels that is used by caregivers when addressing young infants (Cristia, 2013). Studies show that IDS helps engage and sustain hearing infants' attention

during interactions. Furthermore, mothers adjust the features of IDS according to the age and responsiveness of the infant. For example, mothers tend to speak differently to a 6-month-old than they do to a 12-month-old (Lam & Kitamura, 2010). Given that IDS changes with age and language experience, it is possible that hearing caregivers will speak and interact with their HII differently than their hearing AM peers in order to meet the communication needs and hearing level of their hearing-impaired child. Specifically, we might predict that IDS to HII might be louder and slower than that to AM peers since this exaggeration might aid in HII attention and speech perception.

Although we know that caregivers of HII use IDS, we do not know how they might utilize other modalities that may be more accessible to the HII: Exploring caregivers' use of other modalities is the purpose of this paper. It is imperative that we understand how hearing caregivers interact with their HII in all modalities in order to explore the most relevant method of communication to enhance infants' language learning. Knowledge of this information may lead to better intervention with children and their mothers because if we know that touch leads to optimal language learning, we may be able to inform mothers of this finding so that they are aware of the benefits of touching their infants in this manner during interactions.

METHODS

Participants

Twelve children and their mothers participated in this study. Each mother provided informed consent for herself and her child before beginning the study. The children were divided into two groups according to hearing ability. The first group included hearing-impaired children who had hearing aids or cochlear implants (HII). The second group included children who had hearing within normal limits (AM). In order to compare data for this study, each hearing-impaired child was age-matched to a child whose hearing was within normal limits. The age ranges for these children were between 30.5 and 42.4 months ($M = 31.9$, $SD = 5.44$). The hearing-impaired children were tested at Indiana University, Purdue University, and the University of Louisville, while the children whose hearing was within normal limits were all tested at Purdue University.

Materials

Three toys were used in a play session between the mother and the child. The toys used can be seen in Figure 1 and include a dog, a cat, and a ball. These toys were chosen because they are familiar to most young children and are widely available in most households.



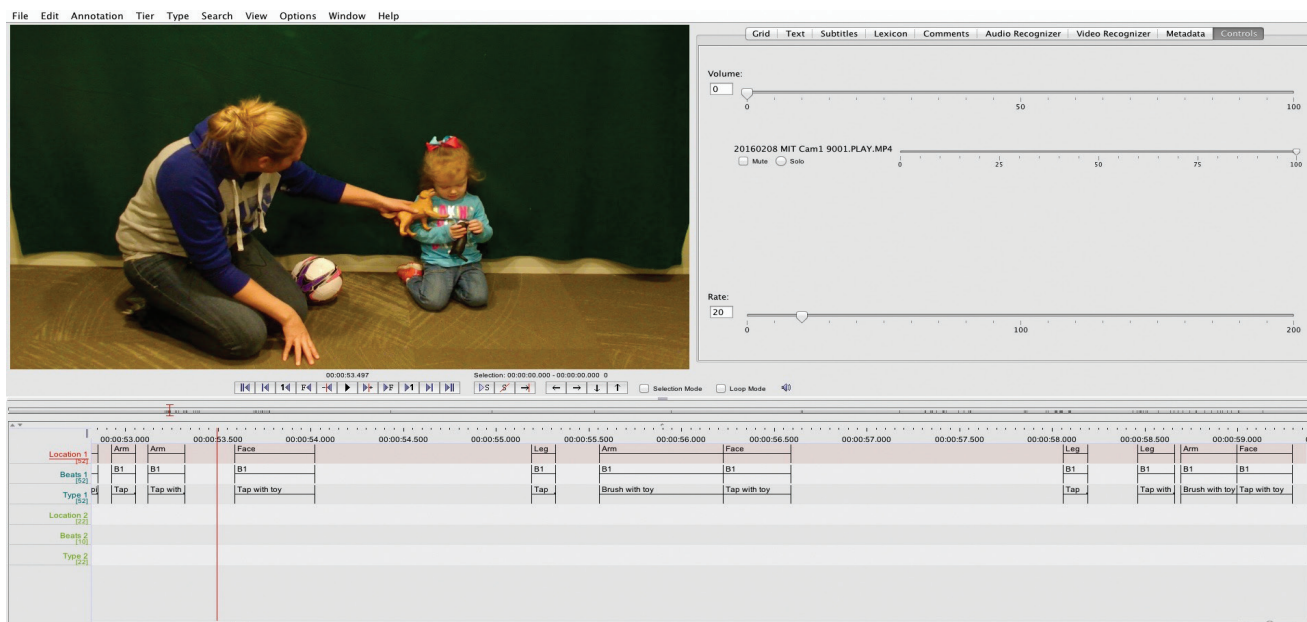
■ **Figure 1.** Toys that the mother and child played with.

Procedure

Each mother-child dyad participated in a naturalistic play interaction in a single-walled sound booth. Two cameras were placed in the booth. One camera was connected to a wireless lavalier microphone clipped on the mother's shirt. Mothers were instructed to sit on the floor with their child facing them as shown in Figure 2. They were asked to do their best to stay in the vicinity of the area visible from the cameras and were asked to play with their child with the three toys in "the same way as they would do at home." Both audio and video data were recorded for later analysis and coding.



■ **Figure 2.** Play session with caregiver, infant, and toys.



■ **Figure 3.** Sample screenshot showing the tagging and stamping of touches in ELAN.

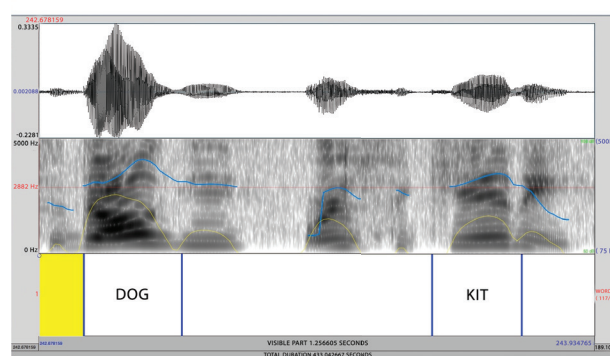
Analysis and Coding

Touch coding. Videos were coded using ELAN, which is a program that allows for the tagging and time stamping of action sequences (Figure 3; Brugman & Russel, 2004). A template to note location, beats, and the type of touch was created to ensure unified coding of all the videos. We used this to mark when the mother intentionally touched the child using her hands or a toy. The beginning and end time of each touch event were precisely marked and later measured. A new touch was coded if the location on the child’s body changed or if the type of touch changed. Data was extracted from ELAN using the tier statistics option, which listed the number of touches for each type and tier in the template.

Speech coding. Speech extracted from the videos was coded in Praat, which is a program that allows for analysis and tagging of audio files (Figure 4; Boersma & Weenink, 2013). To do this, we marked the beginning and end of each target word (“dog,” “cat,” and “ball”) corresponding to the name of each one of the three toys. If mothers used the word “doggy,” we only coded “dog”; in the case that the mothers named the cat toy “kitty,” we coded “kit”; and finally in the case that mothers named the cat toy “kitty-kat,” we coded “kat.” We observed no different names for the ball. In this way, all of our acoustic measurements were based on monosyllables.

The data was then extracted using a custom-written Praat (Boersma & Weenink, 2013) script. The script extracted the following measures for each of the coded words: average fundamental frequency (ERB), duration (seconds), and intensity (dB). Average fundamental frequency is the mother’s average pitch for each target monosyllable, duration is the length of each target monosyllable, and the intensity is the loudness of each target monosyllable.

Target words were excluded from the data if they were sung or whispered by the mother, or if there was any background noise. In these instances, data was not representative of the mothers’ typical speech. One participant’s data was only used in the duration measure because of a technical issue with the microphone.



■ **Figure 4.** Sample screenshot showing the two words “dog” and “kitty” and their tagging in Praat.

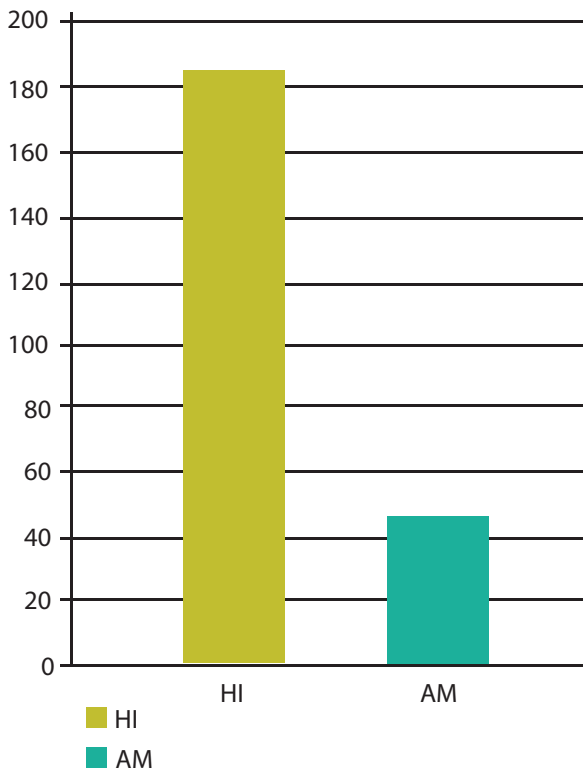


Figure 5. Number of touches for HII and AM.

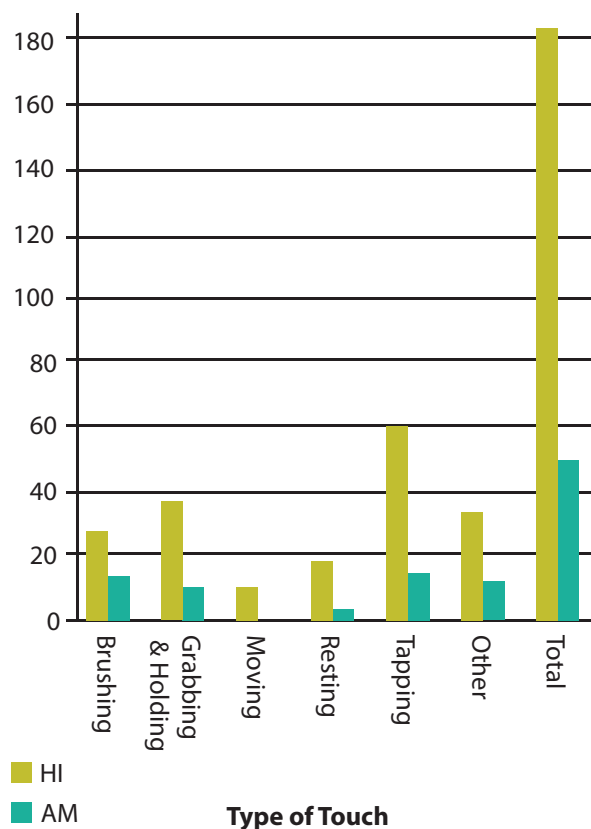


Figure 6. Frequency and types of touches for HII and AM.

RESULTS

Analyzing the free-play videos revealed that there was a difference in the number of touches produced by the mothers of HII and AM peers (Figure 5). We did a chi-square test to explore whether this data pattern (Table 1) was statistically distinct from expectation. This chi-square came out as highly significant ($\chi^2 = 83.31, p < .0001$) because touch frequency was over three times more frequent for HII versus touches on AM peers. We also examined whether the percentage of each type of touch was different for each group, since we might predict that mothers of HII would use a higher percentage of attention-getting touches than mothers of AM peers (e.g., more taps). Table 1 reveals, however, that the percentage of each touch type was fairly similar across the groups (e.g., both mothers of HII and AM children use grabbing and holding 20% of the time). Thus, while mothers of HII clearly touch their infants more than mothers of AM peers, they appear not to do so in fundamentally different ways (Figure 6).

Table 2 shows the averages for f_0 , duration, and amplitude for the mothers of HII and the mothers of AM peers. Inspection of the table shows that these averages are very similar for these two groups. However, given that we specifically hypothesized that mothers of HII might exaggerate acoustic cues to their HII, we wanted to statistically compare f_0 , duration, and amplitude in these two groups of mothers. For each mother, we computed her average pitch, duration, and amplitude for all target words. We then ran an ANOVA comparing HII and CM on each measure. Results revealed that HII and AM did not differ statistically on any measure ($F_s < .06, p_s > .8$). In sum, contrary to our predictions, mothers of HII did not specifically exaggerate target words in their f_0 , duration, or amplitude when interacting with their HII, but behaved in a manner similar to mothers of AM peers.

DISCUSSION

Our results revealed that, during free-play interactions, mothers of HII touched their infants significantly more than mothers of AM peers. Nonetheless, there was not a difference in the types of touches being used by mothers of HII and AM peers. Thus, the only difference we found between the behaviors of mothers of HII and AM peers was in the amount of touch used. Mothers of HI infants touched their infants more than 3 times more frequently than mothers of infants with normal hearing. Why would mothers of HII engage in so much more touch? There are two possibilities that come to mind here. First, it is possible that mothers

Group	Brushing	Grabbing & Holding	Moving	Resting	Tapping	Other	Total
HII	27 (15%)	36 (20%)	10 (5%)	18 (10%)	60 (33%)	33 (18%)	184
AM	12 (24%)	10 (20%)	0 (0%)	2 (4%)	14 (29%)	11 (22%)	49

■ **Table 1.** Type of touches.

	f0 Avg (ERB)	Intensity (dB)	Duration (seconds)
HII	7.01971262 (1.65337223)	64.440224 (8.97131016)	0.24428032 (0.12729941)
AM	6.76344379 (1.64784108)	66.8392826 (7.39485436)	0.25105297 (0.09901397)

■ **Table 2.** Averages and standard deviations of f0 average, intensity, and duration.

of HII treat their infants as if they were younger; since younger infants (e.g., 4-month-olds) are more often held, carried, and supported, this would lead to more touching behavior. However, this hypothesis would suggest that the type of touch would differ radically between groups since younger infants are more often held and carried, as mentioned. However, as we see when we examine Table 2, this is not the case. A second hypothesis is that HII are touched more because mothers have, in the past, found that their infants responded positively to touch, (i.e., touch garnered infants’ attention and yielded positive affect from the infant). Once the mother gains her infant’s attention, more touches may continue to be used to maintain this attention while playing or interacting. This hypothesis could be tested by conducting an experiment that would look at whether mothers of HII use more touches when the child is more responsive as compared to when the child is less responsive to touch. Thus, although our data seems to support the hypothesis that mothers are touching their HII infants in order to encourage greater interaction, it is premature to conclude this without further experimental data.

Another important finding from our study is that although we observed a significant amplification in the number of touches to HII as compared to AM peers, the same was not true for our speech measures. Specifically, mothers of HII did not exaggerate speech cues such as f0, intensity, and duration during their interactions. One possibility for this null result is that the lack of exaggerated infant-directed speech

may be attributable to the fact that within these trials mothers were using words that they believed their child should already know. If this were the case we might expect to see differences only when novel words are used, something we are examining right now in our lab. Another possibility is that, given that these parents know that their child is hearing impaired, they might already know that exaggerating certain speech cues will not necessarily impact their infant’s learning or lead to better infant attention. In sum, these findings suggest that mothers of HII may have found a non-speech modality that supports their child’s interactions and may rely on this cue in their interactions instead of relying upon speech cues.

Finally, we believe that our results may have implications for speech therapists and parents of HII seeking ways to aid in their communication with their HII. Given that mothers in our study naturally used the tactile modality to support their dyadic interactions with their infants, it may be that in the future we could harness this modality for use in therapy situations to increase language learning with HII, since the best therapies exploit our natural tendencies. Specifically, we would like to explore whether our research could realistically be applied in a clinical setting as well as to the everyday lives of parents of HII to help improve the language outcomes of children with hearing loss trying to learn spoken language. Since our results showed an increase in number of touches used by the mothers in play with children with hearing impairment when compared to the mothers of their AM peers, it is possible that this

heightened use of touch helps maintain HI infants' attention. This may in turn help the infant focus on her caregiver's speech stream more intently. If this attention-getting strategy allows the infant a better opportunity to hear the speech provided, we may be able to use these strategies in the clinical setting by guiding speech language pathologists in implementing the use of touch as well as training and encouraging parents of hearing-impaired infants to use even more touch when interacting with their child in everyday life. Further research would allow us to address these interesting possibilities.

ACKNOWLEDGMENTS

The authors would like to thank all of the families for their participation in the study.

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