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Conversation Initiation in Families With a Toddler Who Is Deaf or Hard of Hearing

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ABSTRACT

Purpose: The purpose of this work is to describe the conversation initiation rates in families of toddlers who are deaf and hard of hearing (DHH) as compared to those with typical development.
Method: Analysis of daylong acoustic recordings was used to describe the conversational dynamics in 78 families, comprising 51 families with a DHH toddler (23 boys, 28 girls) and 27 families with a typically developing (TD) toddler (16 boys, 11 girls). Number of conversational initiations was the primary variable of interest to describe conversational dynamics within families.
Results: Results of this study suggest that toddlers' conversation initiation rate does not differ by the sex or the hearing status of the child; however, mothers initiated conversations at a higher rate than fathers in both the DHH and TD groups.
Conclusions: Exploring conversation initiation provides a window into the broader development of conversational dynamics that may influence the course of language development in children, especially those with or at risk for a communication disorder. Results indicate that there was no difference in conversation initiation rate between families with DHH toddlers and families of TD toddlers, suggesting that this aspect of conversational dynamics is not influenced by pediatric hearing loss.

The role of conversation has long been of interest to understanding development. In the course of development, children learn not only the regularity and systematicity of language but also the roles we play as interlocutors. Language learning occurs within a social context, via intersubjectivity and conversational exchange (Hoff, 2006; Tomasello, 1992; Vygotsky & Cole, 1978). Relational factors, those which examine the way language is used to relate to others, facilitate language development, especially in the area of pragmatics (Mood et al., 2020). For example, the social feedback loop created when a caregiver responds to a child's vocalization is essential for teaching the child about the reciprocity of conversation (Tamis-LeMonda et al., 2014). The development of conversation hinges on the parent because the parent is the child's earliest and most frequent communication partner. It is thus worthwhile to examine the linguistic conversational dynamics of both the children and their parents as interlocutors to better understand communicative development.

Characteristics of Dynamic Communication

Another angle of inquiry involves the interactional characteristics of talkers. This line of research has explored the role talkers (Albert et al., 2018; Goldstein

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et al., 2003; Goldstein & Schwade, 2008; Warlaumont et al., 2014), circumstances (Ramírez-Esparza et al., 2014), familiarity with talkers (Iyer et al., 2016), and the natural versus laboratory environment (Hart & Risley, 1995; Ramírez-Esparza et al., 2014; Wells, 1979) have on communication. The role of the talker can be viewed from the communication partner's influence on the early speech and language development of the child. A growing body of literature demonstrates the importance of the contingent responses of communication partners (i.e., the social feedback loop) in the promotion of early speech and language in children (Albert et al., 2018; Goldstein et al., 2003; Goldstein & Schwade, 2008; Warlaumont et al., 2014). For example, Goldstein and Schwade (2008) demonstrated the importance of providing real-time, contingent responses to infant vocalizations. Infants provided with contingent feedback (i.e., within 2 s of the offset of the infant vocalization) restructured their vocalizations to incorporate the phonological structure of their mother's speech. Infants whose mothers provided noncontingent feedback did not restructure their vocalizations to match structures of their mother's speech. In another study, parents changed their phonological speech production structures in response to early infant vocalizations, presumably to enhance the experience and enrich the development of the child (Elmlinger et al., 2019). The contingent structure of social feedback provided to infants allowed infants to recognize the phonological patterns of their mothers and use them in the production of new vocal forms (Goldstein & Schwade, 2008).

The role of the talker can also be viewed from the perspective of the infant or child. More recent studies have focused on the specific characteristics of infant vocalizations that elicit parental responses (Albert et al., 2018). Albert et al. (2018) found that mothers responded contingently using sensitive speech capitalizing on joint attention (i.e., statements or actions directly related to the object the infant is focused on) and vocal imitation (i.e., duplication of infant's sound) based on their infant's degree of vocal maturity exhibited by resonance (i.e., fully resonant vowel production) and canonical syllable production (i.e., mature timing between consonant–vowel transition). The authors concluded that infants created social interactions that facilitated their own speech and language development by influencing the behavior of their caregivers with their vocalizations (Albert et al., 2018). There has been additional expansion of this in studies showing that children actively influence their own environment— their own communicative linguistic environment, in particular—and that those choices shape their development (Ferjan Ramírez et al., 2019; Pretzer et al., 2019; Saffran, 2020).

The role of circumstances and the role of the environment prompt additional interactional characteristics of talkers that have been shown to impact early speech and language development. The social context in which speech is directed to children shows the importance of one-on-one versus group interactions (Ramírez-Esparza et al., 2014). Adults interacting with children in one-on-one situations have the opportunity to respond contingently to child responses and thus promote speech and language learning. In contrast, infants interacting with adults as groups may experience fewer observed instances of contingent responses. A second consideration in this line of research is the use of child- versus adult-directed speech. Ramírez-Esparza et al. (2014) found that infants who experienced child-directed speech in the context of one-on-one interactions showed an increased rate of speech utterances. Variables such as speech style or register (i.e., child- or adult-directed) and social context (i.e., one-on-one interactions) reflect the quality of social interaction that is linked to concurrent and future speech development (Ramírez-Esparza et al., 2014). Other well-known features of child-directed speech include acoustic–phonetic characteristics such as increased fundamental frequency, amplitude, and duration (Clark, 2009; Fernald & Kuhl, 1987; Fernald et al., 1989), all features that are affectations of the speech produced by the adults presumably to positively influence the development or communicative circumstance of the child.

Conversation Dynamics of Development

Conversational variables also have an impact on a child's language development. The number of conversational turns between toddlers and adults has been found to be predictive of the child's language and vocabulary development (Gilkerson et al., 2018). Previous research has demonstrated differences in the conversational interactions of mothers and fathers with their children. Fathers tend to produce fewer words than mothers (Ferjan Ramírez, 2022; Pancsofar & Vernon-Feagans, 2006; Shapiro et al., 2021; Sheth & Ramírez, 2022). Furthermore, fathers use less child-directed speech (Shapiro et al., 2021), fewer contingent responses (Kelly et al., 2022), more directive or prohibitive language (Rowe et al., 2004; Tamis-LeMonda et al., 2012), and fathers tend to take fewer conversational turns with their children (Kelly et al., 2022; Pancsofar & Vernon-Feagans, 2006).

There have also been a number of studies that have looked at diversity of speech in parent–child dyads. The overall landscape is complex, showing that mothers and fathers use a similar degree of vocabulary diversity, that fathers use more "rare" words from the children's perspective, that fathers ask more questions and use more *wh*-words than mothers, and that fathers use more repetition (Conica et al., 2020; Leech et al., 2013; Pancsofar & Vernon-Feagans, 2006; Ratner, 1988; Rowe et al., 2017).

One particular area of interest in family communication dynamics is how conversations are mutually managed. In particular, there has been attention paid in the literature to who initiates a conversation as a factor in family communication strategy and in child development. Researchers have explored conversation initiation in a wide variety of contexts to bear on the role of interlocutors, their motivations, development, sex and age roles, and relationship preservation/maintenance (Goffman, 1974; Maltz & Borker, 2018; Nguyen et al., 2021; Tomasello et al., 2005; Uno, 2017). For example, Conti-Ramsden and Friel-Patti (1983) compared conversation initiation rates between dyads of mothers and either typically developing (TD) children or children with language impairment from 19 to 64 months of age. They found the proportion of child-initiated conversations was lower in the dyads of children with language impairment (34%) compared with dyads of TD peers (42%). Conversation initiation is a proxy for the larger communicative enterprise, including the learning and development of those dynamics, because those who initiate choose the topic, appear confident, and increase influence on their interlocutors. A recent report explored family conversational dynamics in families of TD children by looking at how mothers, fathers, and children initiate conversations among each other (VanDam et al., 2022) and found that children initiate more than their mothers and mothers more than fathers, but there was no difference between boys' and girls' rates of initiation.

Conversation Dynamics in Families With a Child With Hearing Loss

The foregoing discussion demonstrates a rich literature concerning the vocal and conversational dynamics within families and among family members. An area of interest extending these findings from families with TD children is how those family dynamics are influenced by other factors such as communicative disorder. Here, we are interested in family conversational dynamics in families with a child with hearing loss (HL) or a child who is deaf or hard of hearing (DHH) in which HL is the primary diagnosis. Our intent is to isolate the effects of HL and its consequences on conversational dynamics without comorbidities or other interactions. To this end, there are a number of studies of conversational exchanges and family dynamics in the literature concerning families with a child with HL.

Conversational turn count has been examined to explore if DHH and TD families use comparable conversational turn rate. That literature shows DHH children engage in a similar rate of conversations and have comparable exposure to adult words as their TD peers (Ambrose et al., 2014; Aragon & Yoshinaga-Itano, 2012; VanDam et al., 2012). Additionally, mothers of both DHH and TD children patterned similarly, tending to produce more overall words than fathers as well as take more conversational turns with their children who are DHH compared to fathers (Kondaurova et al., 2022; Kristensen et al., 2020; Löfkvist et al., 2022). Another study looked at the pragmatic abilities of school-aged DHH children in conversations (Paatsch & Toe, 2014). They found that DHH children had overall effective conversational strategies while engaged in conversations with their TD peers, but DHH children initiated the topics at a higher rate, thus holding the floor or controlling the conversation as compared with their TD peers. Other studies have linked the importance of conversational pragmatic skills in DHH children with high-level social and emotional skills (Holzinger & Fellinger, 2022) and other academic skills such as reading (Paatsch & Toe, 2020). There is also evidence that targeting high-level language, including conversational exchanges in the therapeutic intervention of DHH children, can increase language use and outcomes (Ambrose et al., 2023; Brock & Bass-Ringdahl, 2023). Another angle of research has looked at conversational synchrony within family conversations including a DHH child. In one longitudinal study on conversational synchrony with 4- to 60-month-old children, it was found that there was no group-level difference in interactional response latencies between TD and DHH mother–child dyads (Smith & McMurray, 2018). Smith and McMurray did find, however, that there were individual dyads with a DHH child that tended to synchronize less and have higher variability, suggesting a potentially subtle effect of HL on interactions between parents and a DHH child that differed from dyads with a TD child. In another study looking at children in mother–child dyads, it was found that DHH children were less synchronized as compared with both their chronological age–matched TD peers (about 32 months of age) and their hearing age–matched TD peers (about 17 months of age; Chen et al., 2019). Chen et al. (2019) concluded that these differences may lead to word-learning disparities and other long-term language development outcomes.

There have been a number of studies that investigated the quantity and quality of interactional exchanges between parents (almost exclusively mothers) and their DHH children. Spencer et al. (1992) examined communicative exchanges between dyads of mothers and 12- to 13-month-old infants, some of whom (both mothers and children) had HL. They found that a hearing mother engaged in fewer contingent communicative responses with a DHH child compared with dyads in which the hearing status of the duo was matched. G. Lee and Lee (2023) examined conversational exchanges in a group of 10 toddlers with cochlear implants (CIs) and their mothers. They found toddlers with CIs took fewer overall turns and contributed fewer vocalizations as compared to dyads with TD peers. A study by D. Lee et al. (2023) looked at communicative interactions within dyads of children with CIs and their mothers starting at about 18 months and then again 6 and 12 months later. They compared observations with TD peers. Contrary to the G. Lee and Lee finding, they did not find differences in the quantity of output between CI and TD peers in interactions, but they did find comparatively reduced type–frequency in the children with CIs. Su and Roberts (2019) looked at children 9–30 months of age with HL. They found parents of TD peers used more overall utterances in conversation than parents of DHH children. They also examined the rate of parent response to child utterances, finding reduced response rate for parents of children with HL, and relatively reduced intelligibility of responses by children with HL. These lower quantitive rates and reduced qualititive interaction could reduce the overall conversational experience and opportunity for learning and language development in children with HL. A study looking at 12- to 34-month-old children with CIs (Park et al., 2022) found that parents used fewer verbal responses to their children as compared with a sample of parents of typically hearing children. Finally, Brock and Bass-Ringdahl (2023) looked at four children with CIs examining interactive language and communication characteristics of the mother–child dyads. They found that mothers of the children with HL were less responsive to their children as compared with mothers of TD peers. Although methods and objectives differ among these studies, it has generally been found that differences between HL and TD peers in interaction with their parents or adults, if any, is relatively modest and does not seem to be focused in a particular developmental, communicative, or linguistic domain. Nevertheless, the observed differences show relatively reduced language use characteristics in the disordered samples.

The present report seeks to extend those findings by examining who initiates conversations in families in which the child has HL as compared with those with TD children. The extant literature on conversational dynamics with DHH children is with preschool- and school-aged children, and the literature on toddlers is sparse with regard to conversation initiation. The purpose of this report is to examine the family conversational dynamics of families with an HH toddler. In particular, we ask the following research questions. Does conversation–initiation rate differ between DHH and TD toddlers? If so, are there also sex effects? Does conversation–initiation rate differ between fathers and mothers? Do conversation–initiation rates of parents differ by hearing status or sex of the children with whom they are interacting?

Materials and Method

Participants

Seventy-eight families participated. All families included a mother and a father living with their toddler. All families were native speakers of English and spoke primarily English in their homes and with their children. All families lived in the United States in California, Georgia, Illinois, Michigan, Oregon, Washington, Arizona, Idaho, Iowa, Montana, Florida, Nebraska, New Jersey, New York, Rhode Island, Indiana, and Utah. Of the 78 families, four had five children, seven had four children, 14 had three children, 28 had two children, and 25 had one child. There were 39 total families with boys and 39 with girls. There were 51 families with a DHH toddler and 27 families with a TD toddler. Of the DHH families, there were 23 with boys and 28 with girls. Of the TD families, there were 16 with boys and 11 with girls.

In total, the 78 families contributed 686 days of observations. Each family contributed 1–15 daylong observations (M = 8.7 observations, SD = 4.1 observations, range: 1–15 observations). Two hundred twelve recordings were from TD families and 474 were from DHH families. The data are a subset of recordings available in the Cougar corpus (VanDam, 2018) in the HomeBank repository (VanDam et al., 2025). To control for the variable number of recordings from each family, all recordings were averaged across observations for each family. The child's age thus varied slightly between observations. We collected the age in months at each observation and then computed the mean for that child across all observations. Thus, for each of the 78 families, there was a single value representing the age of the child in months. The mean age of all children (n = 78) was 34.4 months (SD = 14.6 months, range: 19.6–44.4). The mean age of the boys (n = 39) was 34.4 (SD = 14.1) months, and the mean age of the girls (n = 39) was 34.5 (SD = 15.2) months. The mean age of the HH children (n = 51) was 36.8 (SD = 15.3) months, and the mean age of the TD children (n = 27) was 29.9 (SD = 12.3) months. Ages of the subgroups are as follows: HH boys (n = 23, M = 37.4, SD = 15.3), HH girls (n = 28, M = 36.3, SD = 15.5), TD boys (n = 16, M = 30.2, SD = 11.3), and TD girls (n = 11, M = 29.8, SD = 14.1). We subjected each age distribution (all, boys, girls, DHH, TD, DHH boys, DHH girls, TD boys, TD girls) to a Lilliefors test, assessing goodness of fit to the normal distribution. The only distribution with evidence of a normal distribution was the TD group. Because normality is assumed in a parametric statistical model and our age data do not meet that assumption, we tested for difference among pairwise comparisons in the age distributions using the Mann–Whitney U test. None of the pairwise comparisons were statistically significantly different ($p > .1$).

Demographic and personal factors of participants and their families were collected. Of the 78 total families, 68 reported race as White, one reported race as Native American, five reported race as Black/African, and four reported race as Mixed. Self-reported socioeconomic status (SES) is reported here by proxy of mother's attained level of education using the following scale: 1 = *completed elementary school*, 2 = *completed junior high*, 3 = *earned GED*, 4 = *completed high school*, 5 = *begun technical/vocational school*, 6 = *earned technical/vocational degree*, 7 = *begun bachelor's degree*, 8 = *earned bachelor's degree*, 9 = *begun graduate school*, 10 = *earned master's degree*, 11 = *begun doctoral degree*, 12 = *earned doctoral degree*. Lillifors tests revealed the only distribution with evidence of normality in SES distributions was HH boys. Thus, Mann–Whitney U test are used to evaluate difference. The mean SES of all families was 7.6 (SD = 2.2, range: 2–12). The SES of HH families (M = 7.2, SD = 2.2, range: 4–12) was significantly lower (p = .024, z = −2.25) than that of TD families (M = 8.4, SD = 2.1, range: 2–12). The SES of boys (M = 7.4, SD = 2.1, range: 4–10) was not significantly different (p = .39, z = .84) than that of girls (M = 7.9, SD = 2.3, range: 2–12). SES of the subgroups are as follows: DHH boys (M = 6.7, SD = 2.3, range: 4–10), DHH girls (M = 7.7, SD = 2.1, range: 4–12), TD boys (M = 8.4, SD = 1.2, range: 6–10), and TD girls (M = 8.3, SD = 3.1, range: 2–12).

TD children were reported by their caregivers to have no observed or suspected HL or other disorders or disabilities. There were no known disorders in the siblings of the TD families by family report. Children in the DHH group were administered threshold audiometry examinations by an experienced pediatric audiologist. Children in the TD group were both reported to be typically hearing by their parents and passed a screening at 20 dB HL at harmonics 500–4 kHz. All DHH children were identified early through newborn hearing screenings and received early intervention. Of the 51 DHH children, 43 were fitted with bilateral hearing aids and eight with bilateral CIs. All families in the DHH group used primarily or exclusively Spokane language by parent report. Better ear pure-tone average (BEPTA) was computed for all DHH children, and the Speech Intelligibility Index (SII; American National Standards Institute, 1997) was computed for each child with a hearing aid. None of the distributions (boys or girls by BEPTA or SII) were normally distributed. Mean BEPTA for all DHH children was 49.8 dB (SD = 15.8 dB, range: 20–107). Boys' BEPTA (M = 47.3, SD = 14.6, range: 20–85) was not different (p = .71, z = −0.36) from girls' BEPTA (M = 52.0, SD = 16.6, range: 29–107). Note that the max BEPTA of 107 dB is in the unaided condition and is observed in children with CIs (n = 8); this value reflects the limits of the audiometer. Boys' SII (M = 0.77, SD = 0.08, range: 0.59–0.91) was not different (p = .91, z = −0.11) from girls' SII (M = 0.75, SD = 0.15, range: 0.31–0.93).

Materials and Equipment

The Language ENvironment Analysis (LENA) was used for primary data collection of daylong audio files and initial automatic speech processing using the LENA software. The details of the LENA system have been described in the literature (Gilkerson & Richards, 2008; Gilkerson et al., 2017; Oller et al., 2010), and we closely follow the description and use a case described in a recent report by VanDam et al. (2022). The system records a daylong audio recording from the auditory perspective of a child wearing the device in a custom pocket on a shirt. The raw audio, recorded at sufficient quality (lossless 16-bit, 16 kHz, pulse code modulated [PCM]) to allow regular speech perception during playback if desired, is analyzed with a proprietary automatic speech-processing software that outputs a diarization record at centisecond resolution of onset–offset boundaries and a priori labels corresponding to specific talkers (among other labels). The encoding characteristics of the signal (such as PCM encoding) are sufficient for high-quality playback.

Following the description in the study of VanDam et al. (2022), the labels "FAN," "MAN," and "CHN" corresponding to respectively the mother, the father, and the target child wearing the recorder were used here. Other labeled segments were not considered. The concept of interest here was to determine who initiated conversations. To quantize that concept, a parser (VanDam, 2020) took as input the LENA-generated diarization files (the .ITS files) and traversed the entire file, one for each day. A conversation was defined as any consecutive sequence of segments labeled FAN, MAN, or CHN in any order and with any number of uninterrupted transitions between talkers. Soliloquized utterances made in isolation—those that are not bounded before or after by another talker—are not considered here. This definition requires that there are no intervening segments with labels other than FAN, MAN, and CHN. Then, for every conversation, the talker label of the first segment was tallied as the initiator of that conversation. For example, the sequence FAN–CHN–FAN would be counted as one conversation initiated by FAN. The definition used here will undoubtedly result in the inclusion of some conversations between adults (MAN and FAN) that do not also include the child (CHN). Here, the child is wearing the recorder, so those adult conversations are roughly within earshot and potentially able to be perceived by the child. Thus, a certain amount of conversational information is available to the child even if they are not participating. Relatedly, it is worthwhile to note that overlapping vocal or speech events are not accounted for explicitly here. Kondaurova et al. (2022) showed that DHH children have higher frequency of overlapping vocal events in conversation. The LENA system includes the label "OLN" that identifies human vocals with other environmental human or nonhuman sounds (Gilkerson & Richards, 2020), but because that label includes nonhuman overlapping sounds, it is not included in the present work. In total, 136,696 conversations/initiations were defined across all data used in this study. Note that a variable accessible in the LENA software and often reported in the literature, "conversational turn count," is not defined or used in the same way. In terms of conversational turn count in the LENA software, the sequence FAN–CHN–FAN would count as two conversational turns, a FAN-to-CHN transition and a CHN-to-FAN transition.

Procedure

Families were recruited from day care centers, preschools, and early development clinics. HH children and their families were recruited via a national network of curricular preschools for children with HL, many of which are connected to university clinics that have standing relationships with researchers. The study was reviewed and approved by the institutional review board (IRB) of the first author's university. IRB approval was granted to the first author via Washington State University IRB Protocol 19422. Parents were invited to participate in the study and were engaged in the informed consent process before signing consent and assent forms. Parents completed intake forms in writing or electronically, including demographic information and details of their children's development.

Families scheduled a recording day, and researchers provisioned them with a recorder, specialized clothing with a pocket to house the recorder, and written instructions and logging journal. Families were asked to conduct the recording on a typical day in which both parents were present. This typically was a weekend day. By parent report, none of the recordings were collected on holidays, birthdays, or special days. Parents were instructed to initiate recording immediately when the child awoke and continue uninterrupted until the final bedtime of the day. For bath or nap time, parents were instructed to place the recorder in the room or nearby and then to put it back on the child. Families were also asked to keep a written log of daily events and activities (in roughly 30-min blocks), indicating who was present and any unusual activity. The log also indicated the general health of the child and family. Parents were invited to indicate any portions of the audio they wanted deleted, although no families opted for deletion of any portions of the audio. The purpose of the log was to screen for unusual spans or days to account for anomalies. No anomalies were reported, and no recordings were excluded.

After the recordings were completed by the families, the recorder and clothing were returned to the researchers. The audio was uploaded to a lab computer and processed as described above, first by the LENA software and then using a custom parser to collect the variables of interest. There were 686 daylong recordings ranging in duration from 6.45 to 16.00 hr. The maximum duration is capped at 16.00 hr due the limits of the LENA recording device. The mean daylong recording duration was 10.71 hr (SD = 1.67 hr). There were a total of 7,347.06 hr of audio used in the present study.

Data Analysis

Total conversations and initiations were collected for each daylong recording. There is exactly one initiation per conversation. The total number of initiations varied by family and by talker within each family. To normalize the relative contributions of each talker, the number of initiations for mothers, fathers, and children was divided by the total number of conversation initiations (the sum of mothers, fathers, and children) to achieve a value of the proportion of conversations initiated. This proportion was used as the dependent variable for analyses.

It was determined through analysis (i.e., Lillifors tests) and inspection of histograms that distributions were not reliably normal. In addition, some distributions of interest (e.g., TD girls) had modest numbers of observations. Thus, assumptions of normality and large sample size required of the parametric model were violated, and nonparametric analyses were employed here. In particular, Mann–Whitney U tests were conducted to examine differences between groups. In addition, multiple regression models were employed to predict conversation initiations by mothers, fathers, boys, and girls while controlling for covariation. Computed p values are given preference over thresholds throughout this report for clarity of presentation where appropriate. Following recent discussion and recommendation from the American Statistical Association, quantitative analyses are reported here using the ATOM method: "accept uncertainty; be thoughtful, open, and modest" (Wasserstein et al., 2019).

Results

In 150,417 total conversations identified between parents and children, there were 41,777 conversations initiated by mothers, 17,336 initiated by fathers, 52,086 initiated by children to mothers, and 39,218 initiated by children to fathers.

Children's Proportion of Conversation Initiation

The proportion of conversations initiated by DHH toddlers (M = 0.63, SD = 0.11) and their TD peers (M =

0.62, *SD* = 0.10) was not different (*z* = 0.67, *p* = .42). The proportion of conversations initiated by DHH girls (*M* = 0.62, *SD* = 0.13) and DHH boys (*M* = 0.63, *SD* = 0.10) was not different (*z* = 0.01, *p* = .99). Similarly, the proportion of conversations initiated by TD girls (*M* = 0.62, *SD* = 0.09) and TD boys (*M* = 0.62, *SD* = 0.11) was not different (*z* = 0.16, *p* = .86). The pairwise comparisons between all other pairwise permutations are similarly not different (∀ *p* > .20). Note that the mean and error proportion values given for these first two questions reflect the total number of conversations initiated by the child; these values are the sum of the conversations initiated to mothers and those initiated to fathers.

Overall, children initiated a smaller proportion of conversations with their fathers (*M* = 0.26, *SD* = 0.04) than to their mothers (*M* = 0.35, *SD* = 0.04; *z* = 9.49, $p < 10^{-20}$). Boys initiated a smaller proportion of conversations to their fathers (*M* = 0.26, *SD* = 0.03) than to their mothers (*M* = 0.34, *SD* = 0.03; *z* = 6.76, $p < 10^{-10}$). Girls showed the same pattern of initiating a smaller proportion of conversations to their fathers (*M* = 0.25, *SD* = 0.05) than to their mothers (*M* = 0.34, *SD* = 0.03; *z* = 6.67, $p < 10^{-10}$). DHH children initiated a smaller proportion of conversations to their fathers (*M* = 0.26, *SD* = 0.04) than to their mothers (*M* = 0.35, *SD* = 0.04; *z* = 7.50, $p < 10^{-14}$). TD children showed the same pattern of initiating a smaller proportion of conversations to their fathers (*M* = 0.25, *SD* = 0.03) than to their mothers (*M* = 0.34, *SD* = 0.03; *z* = 5.86, $p < 10^{-8}$). There were no observed pairwise differences between DHH and TD boys to fathers, DHH and TD boys to mothers, DHH and TD girls to fathers, or DHH and TD girls to mothers; there was no difference in the patterning between DHH and TD boys or between DHH and TD girls (∀ *p* > .20). These relationships are shown in Figure 1.

Parents' Proportion of Conversation Initiation

The proportion of conversations initiated by mothers (*M* = 0.28, *SD* = 0.07) were greater than fathers (*M* = 0.11, *SD* = 0.05; *z* = 10.41, $p < 10^{-24}$). The proportion of conversations initiated by DHH parents (*M* = 0.39, *SD* = 0.08) and TD parents (*M* = 0.40, *SD* = 0.08) were not different (*z* = 0.76, *p* = .44).

Parents of DHH and TD children patterned similarly to parents pooled by hearing status: HH mothers (*M* = 0.27, *SD* = 0.06) initiated more than DHH fathers (*M* = 0.11, *SD* = 0.05; *z* = 8.38, $p < 10^{-16}$); TD mothers (*M* = 0.28, *SD* = 0.05) initiated more than TD fathers (*M* = 0.11, *SD* = 0.05; *z* = 6.10, $p < 10^{-8}$). Similarly, mothers and fathers patterned the same regardless of child hearing status: DHH mothers (*M* = 0.27, *SD* = 0.06) and TD mothers (*M* = 0.28, *SD* = 0.05) were not different (*z* = 0.70, *p* = .48); DHH fathers (*M* = 0.11, *SD* = 0.05)

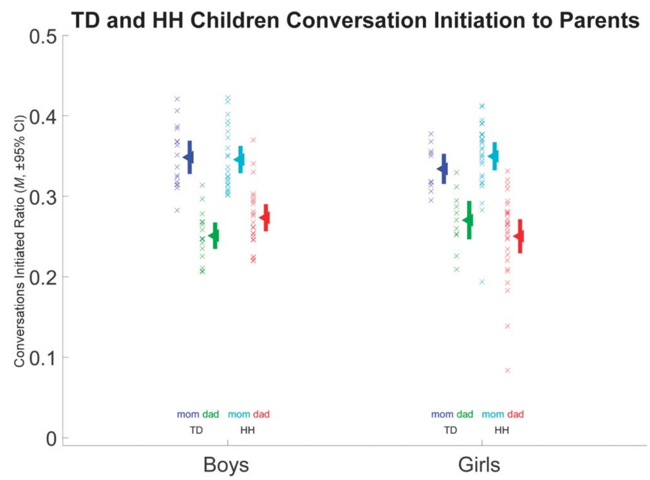


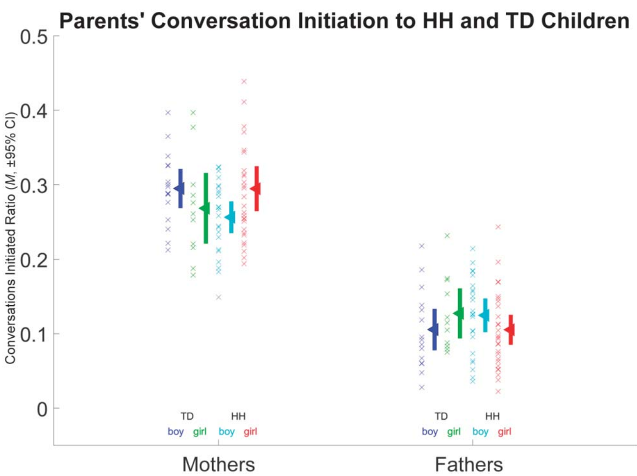
Figure 1. Children's conversation initiation to parents. Means and 95% confidence intervals (CIs) are shown for the proportion of conversations initiated by children in child–parent conversations by child sex, hearing status, and interlocutor. Saltire markers indicate individuals, filled triangles show the means for each category, and error bars are 95% CIs about the mean for each distribution. TD = typically developing; HH = hard of hearing.

and TD fathers (*M* = 0.11, *SD* = 0.05) were not different (*z* = 0.02, *p* = .98).

Because we know that mothers initiate more conversations than fathers, we consider each separately. Mother-initiated conversations to boys (*M* = 0.27, *SD* = 0.05) and to girls (*M* = 0.29, *SD* = 0.07) were not different (*z* = 0.31, *p* = .75). Similarly, father-initiated conversations to boys (*M* = 0.11, *SD* = 0.05) and to girls (*M* = 0.11, *SD* = 0.05) were not different (*z* = 0.52, *p* = .59). Mother-initiated conversations to DHH children (*M* = 0.28, *SD* = 0.07) and to TD children (*M* = 0.28, *SD* = 0.06) were not different (*z* = 0.70, *p* = .48). Father-initiated conversations to DHH children (*M* = 0.11, *SD* = 0.05) and to TD children (*M* = 0.11, *SD* = 0.05) were not different (*z* = 0.02, *p* = .98). For the interaction between the sex of children and hearing status on mothers' and fathers' conversation initiation rate, there were no differences (∀ *p* > .15). A marginal effect that the conversation initiation rate of mothers of TD boys (*M* = 0.30, *SD* = 0.05) was greater than mothers of DHH boys (*M* = 0.26, *SD* = 0.05; *z* = 2.10, *p* = .036) was observed; however, this result was not significant after correction for multiple comparisons. Parents' conversation initiation is shown in Figure 2.

We ran four multiple linear regression analyses, one each for mother-, father-, girl-, and boy-initiated conversations. For each, the response variable was the ratio of initiated conversations and the predictor variables were child age, family SES, child PTA, child SII, child sex, and hearing status of the child. Model performance was evaluated by overall model fit. For models that were statistically

Figure 2. Parents' conversation initiation to children. Means and 95% confidence intervals (CIs) are shown for the proportion of conversations initiated by children in child–parent conversations by child sex, hearing status, and interlocutor. Saltire markers indicate individuals, filled triangles show the means for each category, and error bars are 95% CIs about the mean for each distribution. TD = typically developing; HH = hard of hearing.



different from the null hypothesis (here, $H_0 = \beta_{age} = \beta_{SES} = \beta_{PTA} = \beta_{SII} = \beta_{sex} = \beta_{hearing} = 0$), the percentage of variance explained by the predictor variables is reported. The regression models were not significant for mother-initiated ($R^2 = .13$, $F = 1.16$, $p = .34$, RMSE = 0.002), father-intiated ($R^2 = .22$, $F = 2.15$, $p = .08$, RMSE = 0.0002), or girl-initiated ($R^2 = .04$, $F = 0.36$, $p = .86$, RMSE = 0.001) conversations. The model for boy-initiated conversations was significant ($R^2 = .25$, $F = 2.49$, $p = .048$, RMSE = 0.001), with the coeffcient ($\beta = .23$) of child age accounting for nearly all of the variance.

Discussion

The first set of analyses looked at the rate of toddlers' conversation initiation. DHH toddlers and TD toddlers initiate conversations at about the same rate within families. Boys and girls, regardless of hearing status, initiated conversations at about the same rate. All toddlers pooled together initiated 62% of family conversations with their parents. Overall, children initiated 35% of all conversations with their mothers and only 26% with their fathers. That difference was reliable, and it was not sensitive to the sex of the child or the hearing status of the child; that is, boys and girls performed comparably and DHH and TD children performed comparably.

The second set of analyses looked at the rate of parent-initiated conversations. It was found that mothers initiate 28% of family conversations and fathers initiate only 11%. Parents were not shown to be sensitive to the hearing status of the child or to the sex of the child overall, offering comparable rates of conversation initiation with all children.

Implications for HH Children

G. Lee and Lee (2023) found that mothers and their DHH toddlers engaged in only about half as many conversational turn-taking events as their TD peers. Several findings in the literature (Park et al., 2022; Su & Roberts, 2019) found parents of TD children responded in conversation as much as 2.5 times as often compared with their DHH peers. In contrast, other studies (Kondaurova et al., 2022; Kristensen et al., 2020) failed to find reliable differences in the conversational patterns of DHH and TD families. None of the prior work looked specifically at conversation initiation in families with DHH children. The present work offers little cumulative evidence of difference in conversational initiation related to hearing status of the child or other factors. Overall, the results for DHH children are positive because there is no clear distinction in the communicative ability or strategies observed here. That is, boys and girls with HL were not shown to be different in any domain examined, either in their own conversation initiations or when addressed by parents. This lack of difference suggests that the role of conversation initiation, a high-level communication strategy, may not be sensitive or influenced by pediatric HL.

Clinical Implications

This study showed that DHH toddlers and their families initiate conversations at about the same rate as TD families. Thus, practical implications for DHH families are likely to parallel those to TD families. Notably, fathers' increased involvement with their children has been associated with child vocabulary outcomes in TD children (Lankinen et al., 2020), and that is expected to follow in DHH children. Conversation initiation for both types of families, then, may serve as a proxy for involvement by interlocutors including fathers.

Recent work suggests looking at quality over quantity of father–child interaction (Palkovitz, 2019). A number of researchers have pointed out the unidimensionality of the literature looking at the role of fathers in children's development (Boller et al., 2006; Rodríguez Ruíz et al., 2019; Schoppe-Sullivan et al., 2004). Instead, it is suggested (Palkovitz, 2019) that a richer view of the father's role in child development would consider the quality of input to the child, including communicative input. Although, here, we do not consider (semantic) input, the observed lesser proportion of conversation initiation by fathers may not be properly interpreted to be a deleterious effect. This is left to future studies that consider both the content for quality and the potential for associating that content to outcome variables.

Another applied implication of the present work is the role that conversational competency plays in the early foundation for academic success for children with HL. Better spoken language skills in DHH children were shown to result in improved testing scores in math, reading comprehension, science, and social studies (Marschark et al., 2015). Others have pointed out that reduced conversational proficiency in DHH children is related to a reduced lexicon, reduced syntatic skills, and reduced literacy skills (Hrastinski & Wilbur, 2016; Luckner et al., 2005). The differential role that various interlocutors play may play a role in the learned behavior of communication in context (Carney & Moeller, 1998), and there is evidence that there is ample opportunity to better serve this population (Tomblin et al., 2020).

Limitations and Extensions of the Present Work

Although the results of this study are robust to many limiting factors associated with naturalistic human audio recording analysis, we acknowledge that certain limitations remain. For example, our approach relied on automated, unsupervised machine algorithms (VanDam & De Palma, 2019) to identify speakers and conversational turns, and this process is distinct from the human-based transcription analysis methods commonly employed in the literature (Cristia et al., 2021; Ferjan Ramírez et al., 2021). This distinction has been widely discussed (VanDam & Silbert, 2016), examining factors such as the sex of the talker (Lehet et al., 2021), speech register (Bergelson et al., 2019), linguistic diversity (Ganek & Eriks-Brophy, 2018; Gilkerson et al., 2015; Marchman et al., 2017), and the presence of speech disorders (Aragon & Yoshinaga-Itano, 2012; Bak et al., 2024; Dulin et al., 2023; Dykstra et al., 2013; Jones et al., 2019; VanDam et al., 2015; VanDam & Yoshinaga-Itano, 2019). In our study, we utilized the proprietary LENA software, which employs a diphone likelihood approach, to determine the speakers. This information was then used to calculate conversational initiations, as described in the Method section above. Although this method has its biases, it is important to note the robustness of our findings despite these considerations.

In addition, we acknowledge that there exists no standard, universally accepted definition of a conversation. In this work, conversations were defined by utterance adjacency as determined by the automatic diarization techniques, but a more semantic or topically defined notion of conversation may permit intervening auditory events or factors of interest depending on the research questions. It would be of interest to extend this work to investigate the role that intelligibility, semantic variability, type–token structure, or other interlocutors may play in who initiates conversations. The raw audio recording, for example, could be coded for intelligibility of child speech productions and modeled as a predictor variable for conversational exchanges, initiations, or relationship to other factors known to be important for development. It may be of interest to compare the role of parent-only conversations in which the child does not explicitly participate. It may also be possible to examine attempted conversations that were failed or aborted, resulting in communication breakdown. There is some evidence, for example, that DHH children were less skilled in some aspects of conversation (Lederberg & Everhart, 2000) and use longer pauses, higher repair rates, and fewer initiated turns in communication (Most et al., 2010). There may also be a fruitful application in the case of specific disorders in which, for example, researchers might predict a higher proportion of unrequited utterances or a lower proportion of initiated conversations as a function of the disorder or condition. As reported in the study of Kondaurova et al. (2022), DHH children's conversational timing is poorer and tolerance for overlapping speech is greater before they are intervened with amplification. Investigation in the role of overlapping vocal productions may be profitably investigated with the present findings.

Finally, although our report provides a descriptive account of observed patterns of TD and DHH family conversational initiations, it does not offer exhaustive insights into underlying mechanisms. Factors such as communicative opportunities, talker motivations, nonverbal communication, and higher-order social effects were not captured in the current study. In addition, factors that can influence family dynamics, such as individual personalities, changes in family schedules, and ages of children, as well as audiological variables, such as the audible range of hearing, etiology of HL, and interventions received, were outside the scope of the current work. Future work should consider conversational dynamics between families with a child with a CI (such as in the Toe & Paatsch, 2013, report) versus a hearing aid or early- versus late-identified children with HL to further elucidate the multifaceted underpinnings of conversations in DHH families. Overall, although our study acknowledges certain limitations inherent in its methodology and scope, it demonstrates consistent structural regularities between conversation initiations between mothers and fathers of DHH and TD children of both sexes and serves as a valuable foundation for future research in understanding familial communication dynamics, particularly within the context of HL.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to internal information that could compromise the privacy of research participants.

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