Environmental Influences on the Development of Child-Directed Speech Modifications in Young Children

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Background. Siblings play a big role in our early lives. Having an older sibling has been shown to contribute to later-born children's socio-emotional understanding and prosocial skill development (Barr & Hayne, 2003; Brody, 1998; Dai & Heckman, 2013; Downey & Condron, 2004; Kheirkhah & Cekaite, 2018). However, their influence is often overlooked in the domain of language. In particular, it's unknown whether older siblings contribute to later-born children's pragmatic abilities, and whether this relationship is influenced by an older sibling's gender.

Current Research. In this thesis, I focus on the role that older siblings may play in the development of their younger sibling's ability to adjust their speech for other listeners. This influence could potentially happen in two ways: First, older siblings could provide examples of modifications in their own speech directed towards their younger sibling. From this, younger siblings may learn to use these modifications with other listeners. Second, older siblings may act as a "bridge" to a large community of speakers and listeners (Mannle & Tomasello, 1987). If older siblings are less adept at understanding their younger siblings and accommodating their speech (than adults are), this may motivate later-born children to work on effective communication skills so they can be understood.

Methods. This investigation consisted of two parts: An at-home picture completion game, and a virtual guessing game that was completed over Zoom. In the at-home task, target children between the ages of 4-6-years-old, their older sibling (if applicable), and their caregiver were asked to direct each other to complete elements of incomplete images. In an online task via

Zoom, target children were asked to direct simulated listeners (i.e., a baseline adult, a toddler, and a non-native accented child) to select the correct target image out of a set of three.

Results. Due to time constraints surrounding data transcription and coding, this thesis focuses on the data from the at-home task. Older siblings had a significantly higher pitch and greater proportion of attention-grabbing devices when speaking to their younger sibling vs. their parent. Most notably, their speech to younger siblings was also more fluent (e.g., fewer “uhhs” and “umms”) than their speech to parents. Moreover, these patterns held for both older female and older male siblings, suggesting that there are no gender differences in children’s ability to modify their speech for a younger listener.

Implications. The findings from the first half of this two-part investigation demonstrate that, during a structured task, older siblings do modify their speech for their later-born siblings, and most notably, speak more fluently than when speaking to their caregiver. This both replicates and extends previous demonstrations of older siblings’ abilities to modify their speech for their younger siblings.

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The past two years have not been easy. While many tears have been shed, I have learned so much about myself, and have grown into a person I *truly* love, accept, and am so very proud of. I would not be the person I am today without the support of my closest friends, family members, and colleagues, and would like to take a moment to appreciate them.

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Introduction

For many of us, our siblings played a big role in our early lives. Brothers and sisters play a key role in family dynamics and are critical agents for early learning, socialization, and development (Carpendale & Lewis, 2006; Hoff, 2006; Howe, Ross, & Recchia, 2011; Howe & Recchia, 2014; Harrist, Achacoso, John, Pettit, Bates, & Dodge, 2014; Palacios, Kibler, Yoder, Baird, & Bergey, 2016). Sibling relationships can constitute some of the most important and lasting connections that we experience across the course of our lives (Howe & Recchia, 2014; Howe, Paine, Ross, & Recchia, 2022; Whiteman, McHale & Soli, 2012).

Young children may spend more of their early years interacting with their brothers and sisters than any other person, including their parents (Berger & Nuzzo, 2008; Dunn, 1993; Howe et al., 2022; Kitzmann, Cohen, & Lockwood, 2002; Tucker & Updegraff, 2009). These relationships are among the first that children engage in and have an important influence on their understanding of the world (Howe et al., 2022; Palacios, Kibler, Yoder, Baird, & Bergey, 2016; Tucker & Updegraff, 2009). Howe and Recchia (2014) highlight that the sibling relationship can act as a "training ground for learning to get along in the world; cooperating and sharing joyous experiences; expressing one's opinions, desires, and feelings; conveying one's knowledge and expertise; overcoming conflict; and standing up for one's beliefs and actions" (pg. 155). Despite the amount of time that children spend with their brothers and sisters as they grow, learn, and develop, siblings are often overlooked when considering influences on children's language development (Howe & Recchia, 2014; Howe et al., 2022; McHale, Updegraff, & Whiteman, 2012; Tsinivitis & Unsworth, 2021).

Older siblings

Outside the domain of language, the current literature suggests that having an older sibling, in particular, may have its perks: Interacting with older siblings can help to promote young children's emotional understanding, psychosocial competence (Brody, 1998), social-cognitive development, Theory of Mind understanding (Dai & Heckman, 2013; Kheirkhah & Cekaite, 2018), and social skill development (Hoff, 2006; Ross & Howe, 2009; Sawyer, Denham, DeMulder, Blair, Auerbach-Major, & Levitas, 2002). Further, children with older siblings tend to engage in more cooperative play with their peers, compared to those without siblings, demonstrating that sibling interactions can also play a role in prosocial skill development (Barr & Hayne, 2003; Downey & Condron, 2004).

It's important to note that not *all* siblings reap these benefits. As anyone with a brother or sister knows, conflict can arise easily over just about anything. While these conflicts are a normal part of siblings' interactions, most do not lead to hostility or aggression (Dunn & Munn, 1986; Martin & Ross, 1995; Persram et al., 2019; Ross, Filyer, Lollis, Perlman, & Martin, 1994). However, having an aggressive older sibling is associated with a risk of conduct problems, poor academic achievement, and poor peer relations (Bank, Patterson, & Reid, 1996). Conversely, younger siblings with older brothers and sisters who provide them with emotional support during family conflict display fewer signs of conduct and behavioural problems (Howe et al., 2022; Jenkins, 1992). Supportive sibling relationships can encourage emotion understanding and self-regulation, which sets children up for success with peer relations during their early years of school (Stornshak, Bullock, & Falkenstein, 2009).

Older siblings can also serve as role models for their younger brothers or sisters: Younger siblings may look to their older brother or sister to learn how to respond, think, or feel within different contexts and environments (Kheirkhah & Cekaite, 2018; Bandura, 1977; Saarni, Mumme, & Campos, 1998; Sheffield Morris, Silk, Steinberg, Myers, & Robinson, 2007; McHale et al., 2012; Pérez-Granados & Callanan, 1997; Tucker & Updegraff, 2009). Toddlers will observe and imitate their older siblings (McHale et al., 2012), and even young infants can complete a simple task without receiving explicit instructions, just by watching their older sibling do it (Barr, Hildreth, & Rovee-Collier, 2001). Older siblings can provide advanced models for their younger brothers and sisters, to help scaffold and create a stimulating learning environment for them (Barr & Hayne, 2003; Palacios et al., 2016). Thus, the extensive amount of time that siblings spend together during their early years provides them with many opportunities to interact, learn, and shape each other's behaviour and adjustment (McHale et al., 2012).

Sibling effects on language

Much research has looked at the impact of a mother's input on their child's language outcomes (e.g., Hoff, 2003), and over recent years, an increasing number of researchers have begun to investigate the role that fathers and siblings may play in language development. However, there is still much to learn about the latter two sources of input.

Bilingual families. Most of the existing literature on sibling effects on language development revolves around second language learners. In bilingual families where the home language is different than the community language, older siblings have been shown to offer valuable input to their younger siblings in the community language (Bridges & Hoff, 2014; Oshima-Takane, Goodz & Derevensky, 1996; Tsinivitis & Unsworth, 2021). Given their experience in school, older siblings may be more proficient in their second language than their caregivers. Thus, older siblings can become an important source of input at home to help support their younger siblings' second-language development (Bridges & Hoff, 2014). In one study of bilingual families, Bridges and Hoff (2014) found that preschoolers' interactions with their older siblings at home were more likely to be in English (the community language), and consequently, these preschoolers demonstrated better English vocabulary than their counterparts without siblings. In a later study, with Greek-Dutch speaking toddlers in the Netherlands, Tsinivitis and Unsworth (2021) found that children with older siblings scored higher on measures of Dutch receptive vocabulary, productive vocabulary, and morphosyntactic complexity than those without siblings, though no differences were found for Greek language measures (i.e., the home language). Both studies highlight that older siblings can serve as important sources of input for their bilingual siblings' second-language acquisition. However, there is less research investigating language-related outcomes in monolingual siblings, despite the fact that in some cultures, siblings play major caregiving roles (e.g., Gaskins, 2016).

Monolingual families. The research on monolingual families is limited and the findings thus far are quite mixed. Havron, Ramus, Heude, Forhan, Cristia, Peyre, and the EDEN Mother-Child Cohort Study Group conducted a large study to investigate the effect of having an older sibling on younger siblings' language development, as a function of age difference and sibling sex, in a French context. Language development was assessed by a composite score based on a battery of vocabulary, repetition, and sentence comprehrension tasks. They found that the composite language scores of children with one older sibling were lower than the only-children in the study, suggesting that having an older sibling is detrimental to younger siblings' language skills (Havron et al., 2019). However, additional analyses found that children with an older brother had worse language abilities compared to those with an older sister, or no sibling at all, suggesting that older brothers, in particular, may have a detrimental effect on language development. Havron and colleagues conducted a study with a Singaporean sample (Havron et al., 2022), and found similar results: Children with older siblings had lower language scores. However, this study did not find a significant impact of older sibling gender on younger sibling language abilities. In sum, the evidence on if, and particularly on *how,* older siblings in monolingual families impact their younger siblings' language abilities is mixed, and it is unclear if and how the older sibling's gender may impact this association.

Environmental influences on pragmatic competence

A different language domain in which we might see the effects of sibling input is young children's pragmatic development. The ability to appropriately use language in social contexts, also known as pragmatic competence, is a crucial element of effective communication, and is fundamental for our everyday interactions (Alduais, Al-Qaderi, & Alfadda, 2022; Bates, 1976; Nærland, 2011; Place & Becker, 1991). In other words, pragmatic competence is our ability to know "what to say, how to say it, and when to say it" (Alduais et al., 2022, pg. 4).

Pragmatic competence entails several abilities that are central to our daily lives: Knowing how and when to use requests, how to regulate volume and tone while speaking, turn-taking, (Place & Becker, 1991), sustaining a conversation, providing contingent information, being aware of our listener's knowledge states (Alduais et al., 2022; Vázquez, Delise, & Saylor, 2013), following conventional conversational rules, and making appropriate linguistic and acoustic adjustments for different listeners (Ciccia, 2011). Mastering these abilities allows us to form relationships, share experiences, and efficiently communicate with others (Alduais et al., 2022). Thus, it's crucial that children develop and practice their pragmatic skills so they can engage in effective social interactions with those they encounter in their daily lives (Place & Becker, 1991). As they go through early childhood, toddlers' pragmatic skills continue to develop (O'Neill, 2007). More specifically, young children become increasingly better at tailoring their speech to their listener's age, status, gender (Clark, 2003), knowledge and mental state (Nadig & Sedivy, 2002; Saylor, Baird & Gallerani, 2006; Vázquez, Delise, & Saylor, 2013).

Children's interactions with adults, caregivers, and peers are fundamental for their pragmatic skill development (Blum-Kulka, Huch-Taglicht, & Avni, 2004; Cekaite, 2012). Interactions with adults provide children with scaffolded models of how they should behave during interactions. For example, participating in adult-child interactions allows children to learn about the roles of communicative participants, genres of communication, and how to maintain a balanced conversation (Cekaite, 2012; Papafragou, 2018). On the other hand, peer interactions offer children a chance to practice implementing their pragmatic skills across situations and contexts without this scaffolding (Cekaite, 2012). Further, conversing with peers allows children to practice the skills, genres, and roles that aren't present in adult-child conversations (e.g., humourous topics, pretend play) (Cekaite, 2012). In sum, interacting with individuals of varying linguistic levels supports children in developing their pragmatic competence, helping them to become more sophisticated communicators, and leading to more successful interactions that develop their pragmatic competence further. However, there is not much research that directly investigates the role that interactions with siblings might play in this process.

Child-directed speech

The ability to modify our speech depending on the age and knowledge of our listener is a fundamental pragmatic skill. Speech to young children (i.e., child-directed speech, or CDS) is characterized by slower speed, increased repetition, shorter sentences, greater pitch and volume variability (Weppelman, Bostow, Schiffer, Elbert-Perez, & Newman, 2003), exaggerated positive affect (Masataka, 1992; Reilly & Bellugi, 1996), and less disfluency than adult-directed speech (Björkenstam, Wirėn, & Eklund, 2013; Newport, Gleitman, & Gleitman, 1977). Much research has addressed the benefits of child-directed speech for young children's language acquisition. For example, children who hear more CDS have larger expressive vocabularies and more efficient language processing at 24 months (e.g., Weisleder & Fernald, 2013).

While it's well known that adults will modify their speech for younger listeners, preschool-aged children have also demonstrated this ability (Dunn & Kendrick, 1982; Sachs & Devin, 1976; Shatz & Gelman, 1973; Tomasello & Mannle, 1985). In one study by Sachs and Devin (1976), four 3-5-year-old children were observed while interacting with their mother, a peer, an infant, a baby doll, and when role-playing as an infant themselves. They found that children differed in the way they spoke to younger listeners (including the baby doll) compared to their mothers or peers, and each child used characteristics that are demonstrated by mothers in their speech to children: Shorter preverb lengths, and more frequent use of names and imperatives. Similarly, Shatz and Gelman (1973) conducted three observational studies to examine 4-year-olds' capacity to adjust their speech as a function of the listener. Again, when interacting with a 2-year-old, children used shorter utterances, fewer complex sentences, and used more attention-grabbing phrases (e.g., "Hey!", "Look!") than when talking to a slightly older peer or an adult listener. The younger the listener was, the more likely children were to use these modifications. In another study, Weppelman et al. (2003) explored whether children made prosodic changes when directing speech to infants, one of the key markers of a CDS speech style. They found that the 4-year-olds in this study spoke slower when addressing infants, compared to adults. The findings of these studies suggest that children as young as 4 years of age can and will make syntactic, lexical, and prosodic modifications when speaking to younger listeners; these adjustments resemble the properties of child-directed speech from adults.

Researchers have also explored whether children make speech modifications towards their younger siblings. Dunn and Kendrick (1982) conducted a longitudinal study with sibling dyads, and collected speech samples from interactions within the home. Analysis of these recordings demonstrated that even 2- and 3-year-olds will make considerable adjustments in their speech for their infant siblings, with an increase in attention-getting phrases, repetitions, and shortened utterances. Similarly, Tomasello and Mannle (1985) found that preschool-aged children addressed their infant siblings using a high pitch, shorter utterances, and many directives and self-repetitions. These findings suggest that from an early age, children can and will modify the characteristics of their speech for their younger language-learning siblings.

Thus far, the evidence suggests that children are able to make adjustments in their speech for younger listeners regardless of whether they have younger siblings themselves. In their famous work, Shatz and Gelman (1973) found that children's ability to make speech adjustments in both task-oriented and spontaneous situations was independent of whether they had a sibling. Similarly, Weppelman et al. (2003) demonstrated that 4-year-olds' prosodic modifications towards infants were not different between children who had younger siblings and those who did not. From this, they suggest that specific experiences with infants may not be critical for the development of infant-directed speaking styles. However, there is limited evidence examining whether the sibling influence exists in the opposite direction – that is, whether having and interacting with an *older* sibling provides a benefit to younger siblings' pragmatic development. This is the goal of the present study.

Foreigner Talk

There is considerable evidence that both adults and children consider the age of their listeners and adjust their communication accordingly. However, younger listeners are not the only ones who might need speech modifications when they're spoken to.

Previous research has shown that adults will speak more slowly and carefully for second language learners compared to native speakers, in both natural and lab settings (Drach et al., 1969; Labotka & Gelman, 2020). A study by DePaulo and Coleman (1986) found that undergraduate women spoke to a non-native speaker with significantly more repetitions and paraphrasing. This simplified speech register is known as *foreigner talk*, which resembles child-directed speech in many ways, consisting of longer pauses, shorter utterances, more repetitions, slower speech rate, louder volume, and hyper-articulation, compared to speech to a native speaker (Labotka & Gelman, 2020).

While it is well established that adults engage in this speech register when interacting with a non-native speaker, much less is known about children's use of foreigner talk (Labotka & Gelman, 2020). Hirvonen (1985) found that 7-10-year-olds adjusted their sentence structure when engaging in a structured task and during free play with a non-native (vs. native) speaker. Similarly, Ravid, Olshtain, and Ze'elon (2003) found that 9-10-year-olds make linguistic and prosodic speech modifications when engaging in a picture completion game with a non-native listener. These findings suggest that older children consider the linguistic perspective of a non-native listener and adjust their speech accordingly.

In contrast, the findings in younger children are inconsistent: In Katz's (1981) case study, they found that a 5-year-old native-English speaking child made some modifications towards a non-native listener, including a slower speech rate and hyper-articulation. However, a study of 4-

7-year-old children found that many did not use foreigner talk, and those who did were inconsistent with their modifications (Andersen, 1990). Importantly, though, in this study, children were instructed to speak as if they were talking to a classmate who came from far away, as opposed to speaking directly to a non-native listener. In sum, the findings on children's use of foreigner talk are limited and have been inconsistent thus far.

The above studies show that children make modifications for younger listeners and that older children also make modifications for non-native listeners. However, to my knowledge, there is no work examining whether *having* an older sibling affects one's tendency to make such modifications for others. Given the amount of time that siblings spend with one another – particularly during their early years – it's possible that they can learn from interacting with each other, and additionally, from observing interactions between their sibling(s) and caregiver(s). Dunn and Shatz (1989) state that young children demonstrate high interest in conversations between their mother and sibling, and that it is unlikely for them to just "tune out" this source of input. These observed interactions offer an opportunity to learn, in addition to any input addressed directly to them. Thus, it's possible that later-born children may pick up on various aspects of communication both in interactions they are directly involved in, and those that they only observe.

Possible mechanisms of sibling influence

One study consistent with the possibility that older siblings influence a younger sibling's pragmatic development is that of Ikeda and Masataka (1999), which found that Japanese adults with older siblings were more likely to use prosodic modifications when reading a picture book to a 19-month-old, compared to those who were only children. The participants in this sample were university students and had no children. The authors highlight that these differences could not be explained by the participants' preferences for or experiences with picture books, nor any experiences with baby-sitting. This suggests that particular experiences – like having an older sibling – can indeed have long-lasting influences on our pragmatic language.

The present study aims to further investigate such environmental influences on children's ability to modulate their communication for a listener. There are at least two pathways that may explain an older sibling's influence on their younger sibling's pragmatic abilities. First, given that older children are capable of using child-directed speech, one possibility is that younger siblings may develop stronger abilities to modify their speech for others because they observe and experience differences in how their older sibling talks to them vs. their parents. In other words, younger siblings may learn both directly from interactions with their sibling, as well as indirectly from overheard conversations between their sibling and caregiver. If this is the case, children who have siblings who use more child-directed speech towards them should be more likely to use this speech style themselves with others (controlling for the parents' use of child-directed speech).

However, another way that sibling interactions may influence children's pragmatic development is if their older sibling does *not* modify their speech for them. The Father Bridge Hypothesis, put forth by Jean Berko Gleason (1975), suggests that since fathers are often less familiar with their young child's routine behaviours and methods of communication, they are less adept at understanding what their child is trying to say. To effectively communicate, young children must learn to adapt their speech to the less familiar listener, which prepares them for interactions with other less familiar adults. Thus, fathers act as a "bridge" for their young children to effectively communicate with unfamiliar adults (Berko Gleason, 1975).

Based on this, Mannle and Tomasello (1987) put forth the Sibling Bridge Hypothesis, in which the pragmatics of sibling-infant conversations may benefit the infant's communicative development. Like fathers, older siblings are likely less familiar with their younger sibling's language abilities and may often run into misunderstandings with their communication attempts. Because of this, young children may then have to figure out the reason for the communication failure and modify their communication so that they can be understood by their older sibling. This may, in turn, prepare young children to communicate with unfamiliar individuals (e.g., peers) more effectively, as these partners may share some of the same characteristics of siblings, but are less familiar. In sum, the idea is that older siblings may act as a "bridge" to a much larger community of speakers (and listeners), and thus, motivate younger siblings to work on and develop effective communication skills so they can be understood by any interaction partner. However, there is little work testing the Sibling Bridge Hypothesis. If this is the pathway by which older siblings influence children's pragmatic development, then children who hear *less* child-directed speech from their older siblings might be more likely to modify their speech appropriately for others.

Current research

In this project, I focus on the role that older siblings may play in the development of their younger sibling's ability to adjust their speech for other listeners (i.e., toddlers and non-native speakers). The project consists of two primary research questions:

1. Do older siblings use child-directed speech modifications (relative to how they speak to their parents) when directing their younger sibling during a collaborative task?

2. Do younger children make child-directed speech modifications for unrelated toddlers and non-native accented listeners? If so, does this depend on a) whether they have an older sibling and b) the degree to which their sibling makes modifications for them?

The study was designed to consist of two parts – a home recording portion (to assess child directed speech from siblings) and an online task to assess the target child's modifications for other listeners. However, due to time constraints surrounding data transcription and coding, this thesis will present only the first half of our two-part investigation into the role that older siblings may play in the development of their younger sibling's ability to adjust their speech for other listeners.

Experiment

Methods

Participants. The families of 40 target children – with and without siblings – between the ages of 4-6-years old were recruited. Eight families were excluded due to not following the instructions of the game (e.g., completing only one of the two pictures, completing the task with individuals other than the ones that were assigned). The final sample consisted of 32 target children (15 females, mean age = 4.91 years, range = 51-80 months). Twenty-nine of the children had at least one older sibling (14 females, mean age = 5 years) and 3 had no siblings (1 female, mean age = 4.33 years). Although families were recruited without regard for sibling status, our participants were skewed towards families with older siblings. For the present thesis, only families with an older sibling were analyzed.

Older siblings varied in gender, age, and age gap (19 females, mean age = 7.93, age range = 6-10, mean age gap = 2.93, age gap range = 2-5). Participants were recruited through the Infant and Child Studies Group (ICSG) participant database and resided in the Waterloo-Wellington region and surrounding areas. All participants were English-speaking monolinguals, typically developing, and had no language or auditory impairments. All parents gave informed consent for their children and were reimbursed with a $25 gift card to Amazon or Indigo as a token of appreciation for their participation.

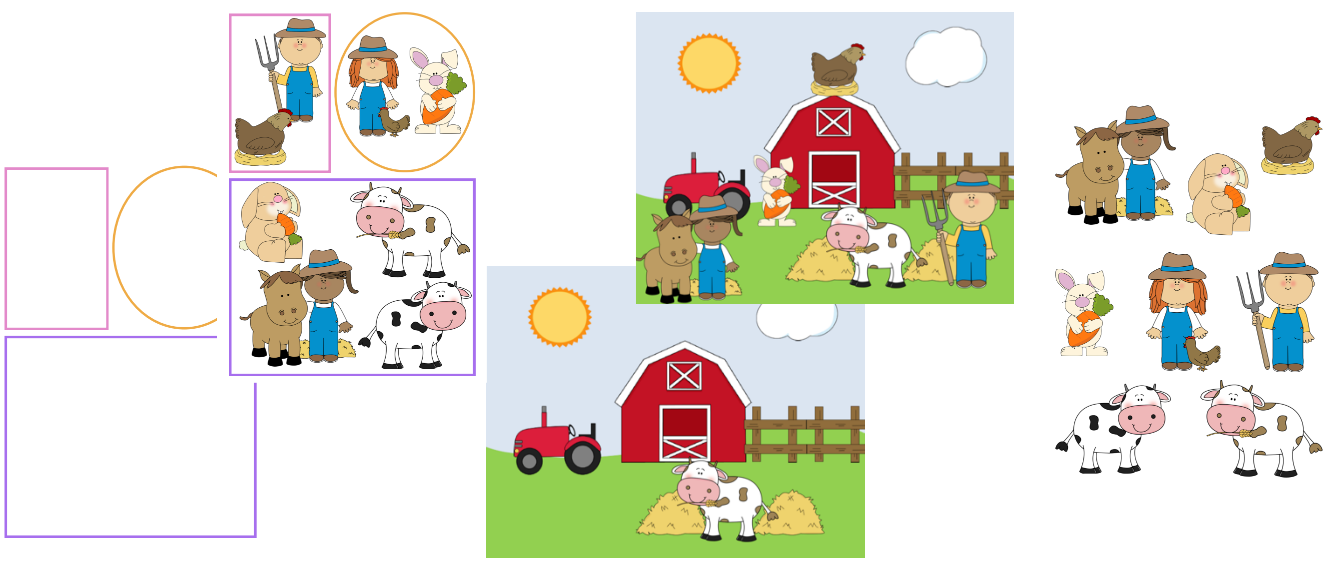
Materials

The experimenter dropped off a study box to families' homes that contained the physical study materials and a Language Environment Analysis (LENA) audio recording device. The LENA recording system assesses the auditory environment of infants and toddlers through a small 2-ounce audio recording device placed in the front pocket of a t-shirt, and a specialized analysis software (LENA, 2021). The recording device collects up to 16 hours of high-quality audio recordings without the use of bulky or heavy equipment, making it ideal for analyzing naturalistic interactions that occur within the home.

Picture completion task. Within the at-home study box, participants were provided with laminated cards, laminated picture cut-outs (see Figure 1 and Appendix A), and detailed instructions on how to complete the activity (see Appendix B). The laminated cards consisted of a complete and incomplete shape and scene picture, and laminated picture cut-outs that included objects and people that were present on the complete versions of the pictures. Skeleton pictures were missing key objects from the complete picture scene.

Figure 1

Materials for the Picture Completion Game



Virtual guessing game. Within their at-home study box, participants were provided with 8.5 x 11" physical cards that had various objects and shapes on them (see Appendix C). The cards were arranged and bound in the order of how they would be presented on the screen by the experimenter in the online task. Parents were instructed to not open or look at the game card book before their scheduled Zoom call with the experimenter.

In the virtual guessing game, participants interacted with simulated play partners. The audio recordings that were used for the simulated play partners were collected from families in the ICSG participant database. Eligible children were sent a link to a survey on Phonic.ai, an audio survey platform, where they were asked to repeat various statements (see Appendix D). Families were reimbursed for their time with a $5 Amazon gift card. To simulate that the participant was interacting with "live" people during test trials, video clips and images of real people were used in combination with the audio recordings. These video clips and images were collected from volunteers associated with the lab.

Design and Procedure

Data was collected between October 2022 and July 2023. Participants were asked to complete both the at-home and online tasks. In the at-home portion, target children were asked to play a picture completion game separately with their parent and – if applicable – their older sibling (order counterbalanced across participants), where one person directed the other to complete elements of incomplete images. The goal of this task was to collect speech from older siblings and parents. In the online portion, target children were asked to play an online guessing game over Zoom with the experimenter. The goal of this task was to collect speech from the target child to other listeners (i.e., adult, toddler, non-native).

At Home Picture Completion Task

While wearing a LENA audio recording device, participants played a picture completion game with their older sibling and/or caregiver in their home. Players were assigned one of two roles: Communicator or picture completer. The communicator started with a complete picture and a skeleton of the same picture, while the picture completer only had the skeleton. Cut-outs of the various objects that could complete the skeleton were placed in front of the picture completer. The target child and their sibling or caregiver were instructed to sit at a distance, with a divider in between them, so they could not see each other's pictures. The goal of the game was for the communicator to provide *verbal* descriptions to the picture completer about how to complete the skeleton picture with the cut-outs.

There were two picture completion trials per dyad. In the first trial, participants completed the shape sequence picture. The communicator was instructed to verbally describe which cut-out pictures belonged inside which shapes, without pointing or showing the other player. Using the communicator's directions, the picture completer was instructed to place their cut-out pictures in the correct shapes on their page. Play continued until both players agreed that they had completed the shape picture. After completing the picture, participants were told they could lift the divider to check their work. The second trial proceeded in the same way, with participants being asked to complete the scene picture. There were three versions of the scene pictures – a farm, park, and beach scene.

Families with siblings were instructed to play the game with three different dyads: 1) The parent as the communicator and the target child (i.e., younger sibling) as the completer, 2) the older sibling as the communicator and the target child as the completer, and 3) the older sibling as the communicator and the parent as the completer. The order of the three player dyads, as well as scene type (i.e., farm, park, or beach), were counterbalanced across participants.

Participants who were only children were instructed to play the game once with the parent as the communicator and the target child as the completer. The scene type (i.e., farm, park, or beach) was counterbalanced across participants.

Virtual Guessing Game

Within one week of completing the at-home picture completion game, target children (both with and without siblings) completed a task with an experimenter online over Zoom. The purpose of the game was to evaluate whether participants would make modifications in their speech for an unrelated toddler or a non-native accented child listener, relative to a native speaking adult listener.

The task was set up as a guessing game with simulated listeners of different linguistic levels (i.e., younger child, adult, non-native speaking child) as the child's play partner. The game was administered online by an experimenter. Participants viewed the experimenter's PowerPoint slides on their screen, which they were told displayed the other player's cards. They also had a physical book of game cards that had been delivered in the study box, which depicted multiple objects of the same type. On the participant's cards, one of the objects was circled (i.e., the target object). The goal of the game was for the participant to verbally describe the target object to their play partner. Participants completed a warm-up and practice trial with the experimenter, and then completed test trials with two simulated listeners: All participants completed the task with the baseline adult; the second listener was either the younger toddler or the non-native speaking child (between participants). The order of the two simulated listeners was counterbalanced across participants.

Task procedure. Participants joined a call on Zoom with an experimenter, who was a White, female, native-English speaker. Parents were asked to stay with their child during the call but were instructed to sit in a position where they could not see the screen, so they did not influence their child's responses.

Calibration. The experimenter shared her screen with the participant, which showed two animals (i.e., a bunny and an elephant), and a coloured box. Participants heard a pre-recorded female, native-English speaker read out three questions and were asked to verbally respond to her questions (see Appendix E). The purpose was to ensure that the participant could see the images on their screen and could clearly hear the audio stimuli.

Warm-up. Participants completed one warm-up trial with the experimenter. They were instructed to find the card in their game card book with the red square on it. The experimenter minimized her video to reduce distraction, but her photo remained on the screen. This procedure – of starting with a video and replacing it with a photo – allowed us to do the same with the simulated listeners to create a seemingly live display for participants.

The experimenter told the participant that they were going to play a guessing game together, and that they had to give the experimenter verbal clues about what they saw on their card. The experimenter asked participants what colour the object was on the card (see Appendix C). After they indicated the color, the experimenter made an incorrect guess (e.g., "Is it a lemon?", when the object was in fact a banana). Following the child's response, another incorrect guess was provided (e.g., "Is it a star?"). The experimenter then asked the participant what was on their card. The purpose of the warm-up procedure was to demonstrate that the listener on the screen could not see the participant's physical card, so they would need to use their words to provide clues for the listener to guess the correct object. The procedure for the warm-up trial was adapted from a task by Bacso, Nilsen, and Silva (2021).

Practice trial. Participants completed one practice trial with the experimenter. During the practice trial, participants saw two objects on their card, one of them with a red circle around it (see Appendix C). Participants were told that they had to give clues to the experimenter about which one was circled on their card. The experimenter showed her card on the screen, which did not have a circle around it. After the participant provided their description, one of the objects on the screen was circled with a green circle and the experimenter said, “Is it this one?”. The practice trial familiarized children with the experimental task of describing a target object from a set of objects.

Test trials. During the test trials, children played the guessing game with two out of three simulated listeners: 1) Charlie, a white, native-English speaking adult female (all children), 2) Sammy, a white, native-English speaking 2-year-old female or Alex, a white, Singaporean-accented 6-year-old female.

Participants completed eight test trials: four per simulated listener. Two of the four trials were feedback trials, in which participants received feedback indicating a lack of comprehension from the listener; the other two trials did not contain such feedback. Feedback was provided in order to see if and how participants would repair their communication, and if this differed based on who their listener was. For ease of experimental administration, participants received feedback on specific trials, regardless of the description they provided on their first attempt.

At the beginning of each simulated listener’s turn, the experimenter introduced them to the child, and participants saw a video of the listener smiling and waving on their screen, in a seemingly live display. Afterwards, the experimenter told the participant that she was going to move the listener’s video out of the way, but she would still be able to hear them and see their picture. The simulated listener’s display picture then replaced the video on the screen. The purpose of this introduction was to make the participant believe that they were interacting with a live person.

On each trial, participants had a card with three objects, and a red circle around the target object (see Appendix C). The experimenter told the participant that they had to use their words to describe which object was circled on their card to the listener, so that they could guess the correct object. On half of the trials, the listener guessed the correct object on their first try (i.e., no feedback trials). On the other half of the trials, the listener did not guess correctly on their first try (i.e., feedback trials).

During the trials with feedback, after the participant provided their description, the listener demonstrated confusion with one of 3 phrases (“I don’t know which one to pick!”, “Which one is it?”, “I don’t understand.”). The experimenter told the participant to try describing it to the listener again, so that they could guess the correct object. After providing a second description, a green circle appeared on the screen around the correct object, and participants heard the listener say, “Is it this one?”. The purpose of the feedback trials was to determine whether any differences in speech to the three listeners would be enhanced during a communication repair.

After completing four trials with the first listener, children were introduced to the next simulated player. Participants continued to play the game with the next simulated player, with different images and target objects, for an additional four trials. Although this task resembles referential communication tasks in which the outcome measure is typically the informativeness of the descriptions, in the present study, the task was used to elicit productions that could be analyzed for child-directed speech modifications.

Deception. At the end of the Zoom call, participants and their caregiver were given a full disclosure of the deception used in the study. Additional assent was obtained from their parent; all agreed to have their child’s data used.

Data preparation

As mentioned previously, due to time necessary for processing this type of audio data, this thesis focuses on data from the picture completion task only. More specifically, for target children with siblings, I compared older siblings' speech properties during the round they played with the target child vs. the round with their parent.

Recordings from the LENA device were manually transcribed by the author and one research assistant. Recordings were transcribed verbatim for each trial of the picture completion game – including any disfluencies, mispronunciations, or talk unrelated to the task. Speech that occurred between trials was not included in the analyses (e.g., discussion about checking their work, setting up for the next trial).

Utterances boundaries were defined using Huttenlocher, Vasilyeva, Waterfall, Vevea, and Hedges' (2007) criteria and the University of Chicago's Language Development Project utterance boundary guide (Language Development Project, n.d.): Utterances were determined based on criteria that included intonational contour/pitch resets, pausing, and conversational turns. More specifically, "an utterance consisted of a single intonational contour within a conversational turn. Intonational contour frequently includes falling or rising pitch (as in declaratives and questions, respectively), and often there is a pause preceding and following it" (Huttenlocher et al., 2007, pg. 1065). Additionally, any content interrupted by pauses longer than 2000ms was classified as two separate utterances.

Coding

MLUw. Both children and adults have been shown to use shorter utterances in speech to infants and young children (Sachs & Devin, 1976; Shatz & Gelman, 1973; Tomasello & Mannle, 1985). Thus, I measured the length of the older siblings' utterances in their speech to their younger sibling vs. parent, also known as their mean length of utterance in words (MLUw). This measure allows us to indirectly assess the complexity of a speaker's language, and is computed by dividing the total number of words by the total number of utterances (Nærland, 2011). Only fully transcribed, intelligible utterances were counted. Utterances that contained fillers (e.g., "uhh", "umm") were computed excluding the filler(s). Repetitions, stuttering, or false starts were counted once, during their fullest form, unless a repetition was aimed at stressing a specific thought or idea (e.g., "No, no no!"). Utterances with any overlapping noises (e.g., someone else talking, LENA device moving around) were included in the MLUw count (as well as in the attention-grabbing device, and disfluency counts, described below).

Pitch. Heightened pitch and pitch variability are the most characteristic features of child-directed speech (Weppelman et al., 2003). Thus, I analyzed the pitch of older siblings' speech when speaking to their younger sibling vs. their parent. The acoustic properties of older siblings' speech were analyzed using Praat (Boersma & van Heuven, 2001; version 6.2.22). Praat is used by many researchers to analyze, synthesize, and manipulate speech. The minimum, maximum, and average pitch of each intelligible utterance were obtained using the program's pitch analysis feature. Pitch variability was calculated by computing the standard deviation of the mean pitch. Utterances that contained noise were not analyzed for pitch.

Speech rate. Child-directed speech is also characterized by a slower speech rate (Weppelman et al., 2003). The speech rate of each intelligible utterance was measured by dividing the duration of the utterance (in seconds) by the number of syllables in the utterance. In utterances that contained fillers (e.g., uhh, um), speech rate was calculated by determining the length of the utterance, excluding the disfluency, and dividing by the total number of syllables, also excluding the filler. Utterances that contained noise (which made it hard to ascertain duration) were not analyzed for speech rate.

Attention-grabbing and attention-holding devices. Another marker of child-directed speech is the use of attention-grabbing and attention-holding devices (Dunn & Kendrick, 1982; Shatz & Gelman, 1973). When speaking to young children, individuals may use particular words to obtain and sustain the attention of their younger listener (e.g., "*hey*!", "*look*!"; Shatz & Gelman, 1973). Using Shatz and Gelman's (1973) criteria, I noted each instance of the following attention-grabbers and attention-holders in the older sibling's speech: "Hey", "see", "look", "watch", "no" (when used to stop the listener's action), the listener's name, and "now" and "okay" (when used as an attention holder, as opposed to a filler). The number of attention-grabbing and attention-holding devices was counted for each listener (i.e., younger sibling vs. parent). This was then converted into a proportion, by dividing by the number of words towards that listener (to control for the amount of speech).

Disfluencies. Adult-directed speech has been reported to contain more hesitations, repetitions, and disfluencies than child-directed speech (Björkenstam, Wirėn, & Eklund, 2013; Broen, 1972; Frye, 2022; Newport, Gleitman, & Gleitman, 1977). Thus, I noted the frequency of the older sibling's use of disfluencies when speaking to their younger sibling vs. parent. I coded for 4 types of disfluencies in older siblings' speech: Fillers (e.g., "uhh", "umm"), repetitions (e.g., "I want- I want that."), revisions (e.g., "I want- I need that."), and blocks (e.g., "I w-ant that."). The frequency of all disfluency types was summed for each listener (i.e., younger sibling vs. parent). This was then converted into a proportion, by dividing by the number of words towards that listener (to control for the amount of speech).

Results

Before completing the analyses, the data were examined for outliers that were +/- 3 SD from the mean for each measure. One participant's minimum pitch value was an outlier. When the participant was removed from the dataset, the patterns of significance were unchanged. Because of this, this data point was kept in the final analyses.

Older siblings' mean MLUw, pitch (min, max, mean, and variability) and speech rate, as well as mean proportion of attention-grabbing/holding devices and disfluencies were calculated, and paired samples *t*-tests were conducted to determine whether older siblings differed in the way they talked to their younger sibling versus their parent in the picture completion task. See Table 1 for means and standard deviations.

Table 1

Means and Standard Deviations for Older Siblings' Speech as a Function of Listener

Variable	Target Child	Parent
MLUw	8.51 *(2.26)*	8.38 *(2.81)*
Minimum pitch	158.59 *(28.30)*	145.77 *(30.01)*
Maximum pitch	396.83 *(38.00)*	390.48 *(34.97)*
Mean pitch	275.41 *(32.94)*	265.71 *(29.23)*
Pitch variability	32.60 *(10.43)*	30.60 *(10.41)*
Speech rate	0.339 *(0.043)*	0.343 *(0.049)*
Proportion of attention-grabbing/holding devices	0.025 *(0.024)*	0.007 *(0.009)*
Proportion of disfluencies	0.047 *(0.028)*	0.075 *(0.036)*

MLUw. Figure 2 displays the results for MLUw. A paired samples t-test demonstrated that older siblings' MLUw did not differ when speaking to their younger sibling vs. their parent, $t(28) = 0.26$, $p = .795$; $d = 0.05$.

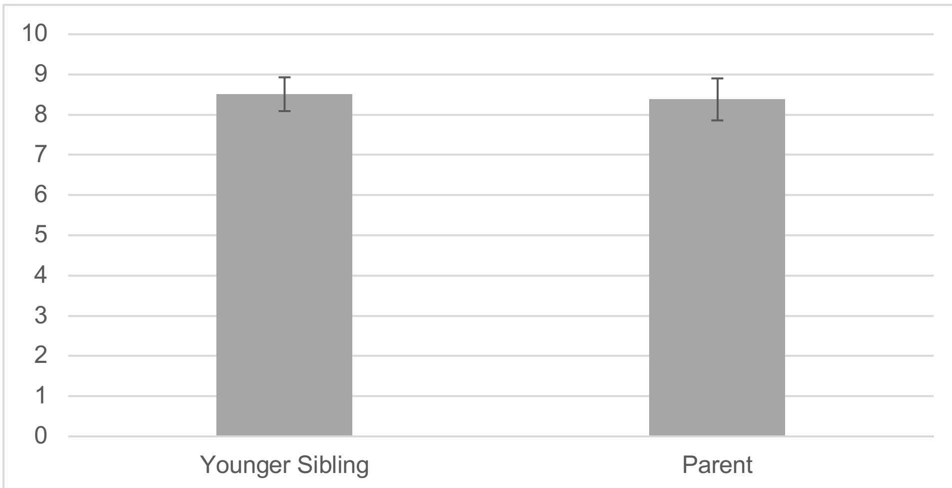


Figure 2. Older siblings' MLUw when speaking to their younger sibling vs. parent. Error bars represent standard error.

Pitch. Figures 3-5 display the results for the pitch variables. Paired samples t-tests indicate that older siblings' minimum pitch was significantly higher when speaking to their younger sibling vs. their parent, $t(28) = 2.95$, $p = .006$; $d = 0.55$, as was their mean pitch, $t(28) = 2.70$, $p = .012$; $d = 0.50$. However, older siblings' maximum pitch did not differ between the listeners, $t(28) = 1.07$, $p = .295$; $d = 0.20$.

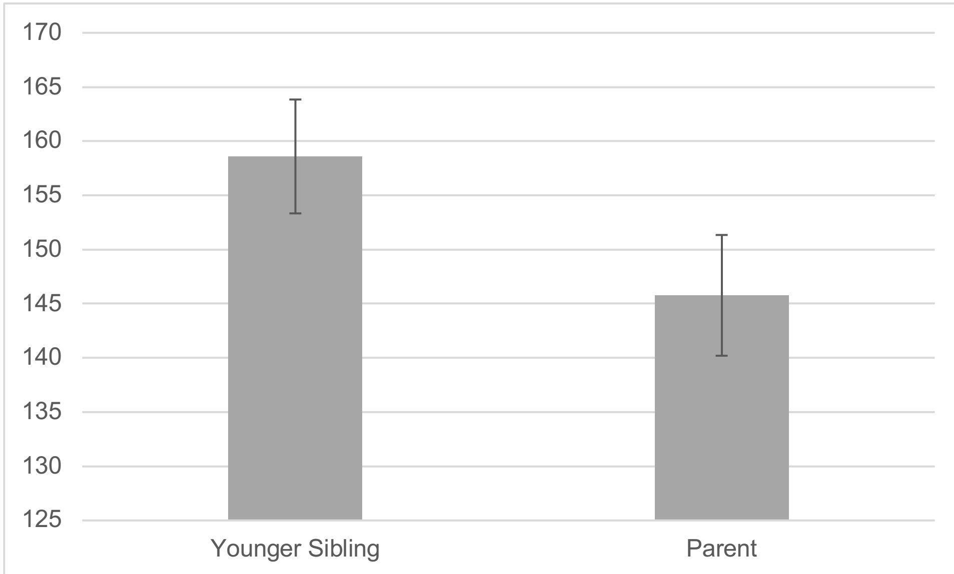


Figure 3. Older siblings' minimum pitch (in Hz) when speaking to their younger sibling vs. parent. Error bars represent standard error.

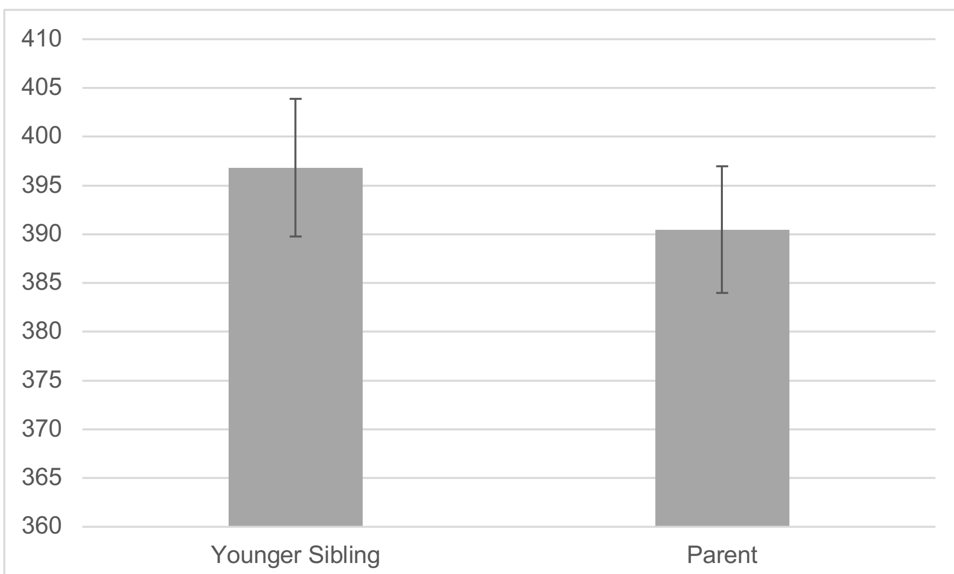


Figure 4. Older siblings' maximum pitch (in Hz) when speaking to their younger sibling vs. parent. Error bars represent standard error.

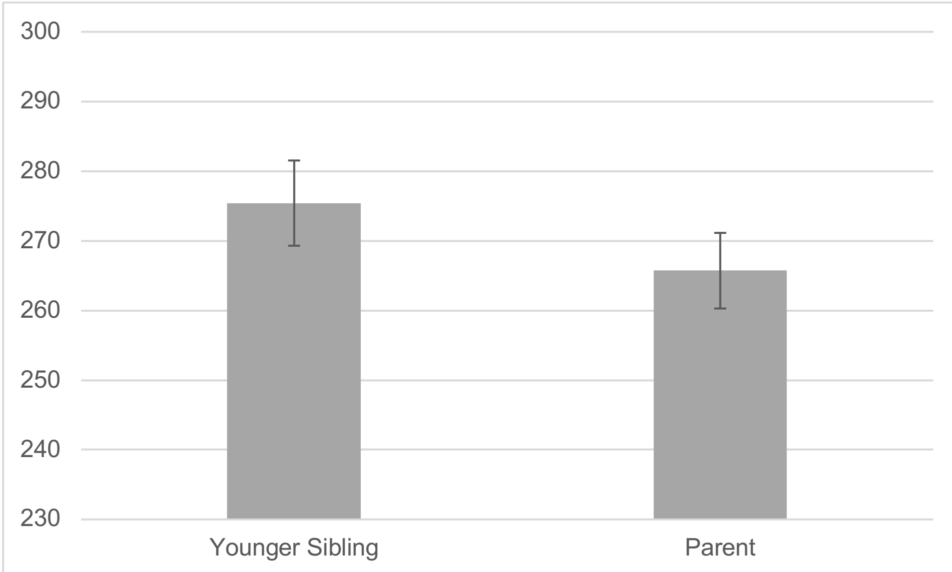


Figure 5. Older siblings' mean pitch (in Hz) when speaking to their younger sibling vs. parent. Error bars represent standard error.

Pitch variability. Figure 6 displays siblings' pitch variability. A paired samples t-test indicated that older siblings' pitch variability did not significantly differ when speaking to their younger sibling vs. their parent, $t(28) = 1.11$, $p = .275$; $d = 0.21$.

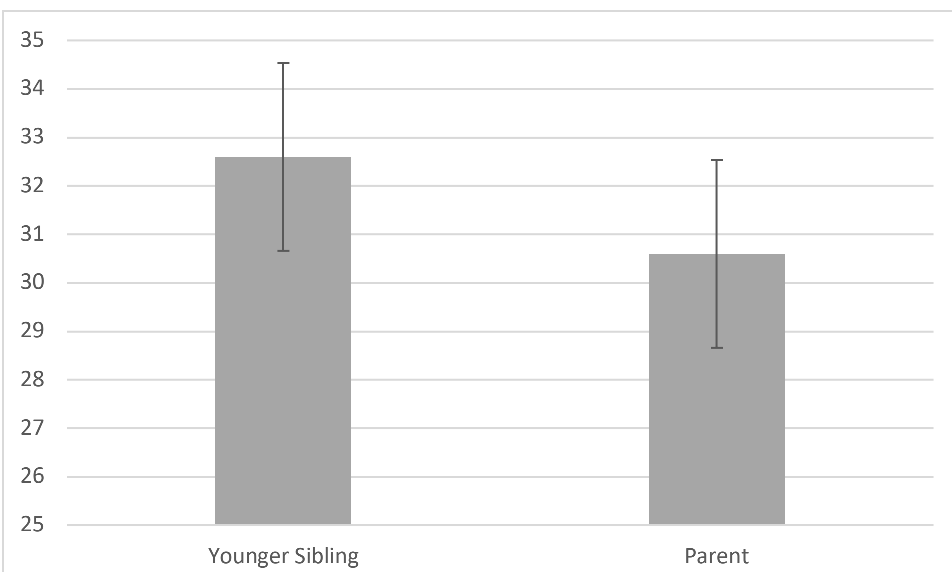


Figure 6. Older siblings' pitch variability (in Hz) when speaking to their younger sibling vs. parent. Error bars represent standard error.

Speech rate. Figure 7 displays siblings' speech rate. A paired samples t-test indicated that older siblings' speech rate did not significantly differ when speaking to their younger sibling vs. their parent, $t(28) = -0.524$, $p = .604$; $d = -0.10$.

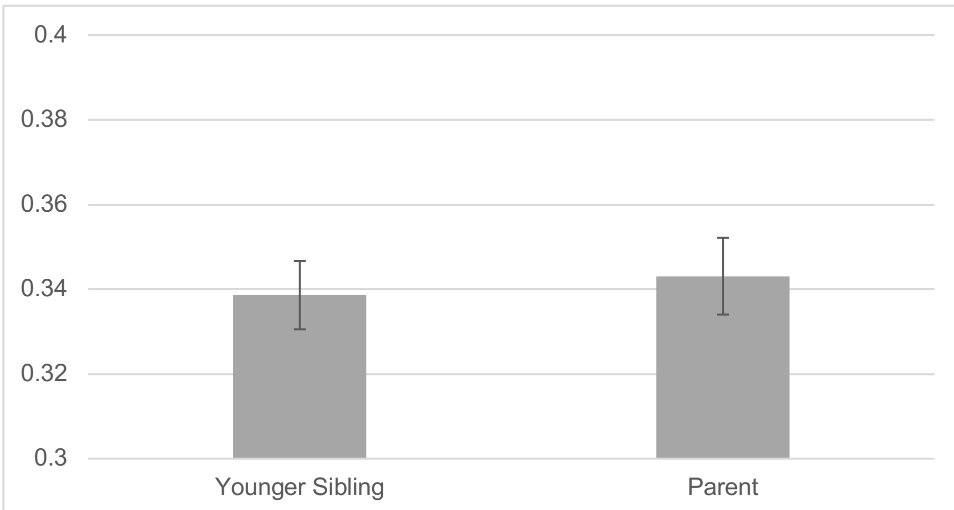


Figure 7. Older siblings' speech rate (syllables/second) when speaking to their younger sibling vs. parent. Error bars represent standard error.

Attention-grabbing and attention-holding devices. Figure 8 displays the proportion of attention grabbing/holding devices (out of the total number of words). A paired samples t-test indicated that older siblings used a significantly greater proportion of attention-grabbing and attention-holding devices when speaking to their younger sibling vs. their parent, $t(28) = 5.11$, $p < .001$, $d = 0.95$.

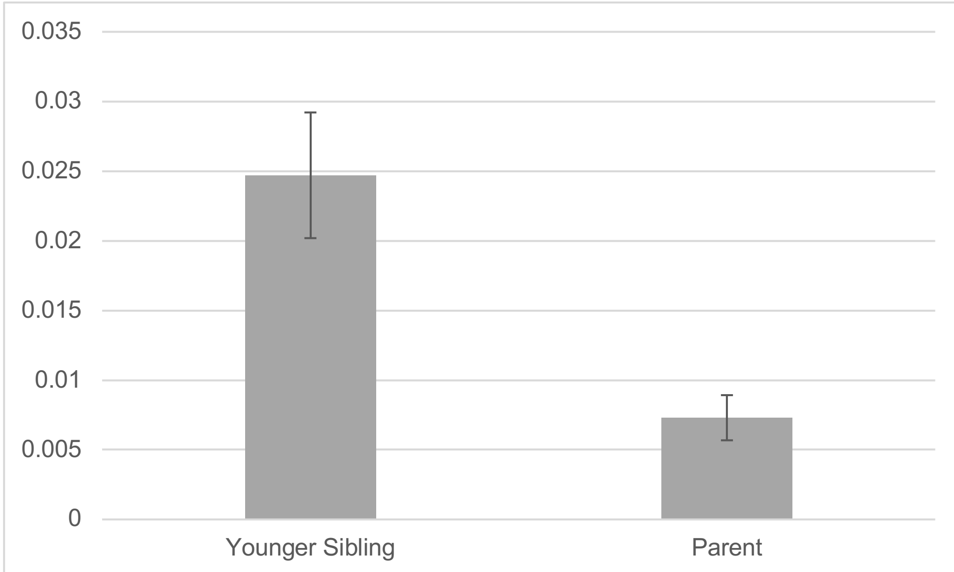


Figure 8. Older siblings' proportion of attention-grabbing and attention-holding devices when speaking to their younger sibling vs. parent. Error bars represent standard error.

Disfluencies. Finally, Figure 9 displays the proportion of disfluencies to each listener (out of the total number of words). A paired samples t-test indicated that older siblings had a significantly smaller proportion of disfluencies when speaking to their younger sibling vs. their parent, $t(28) = -5.35$, $p < .001$, $d = -0.99$.

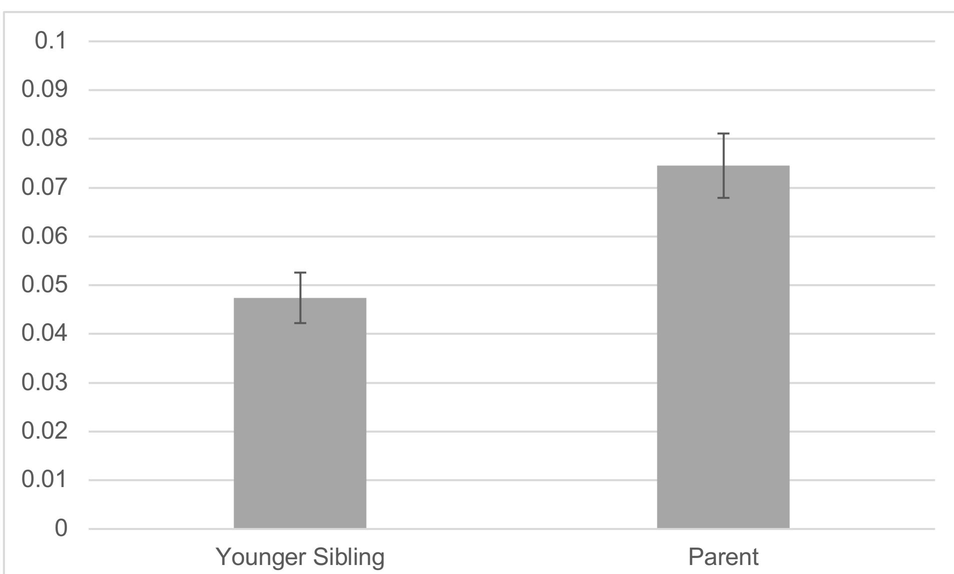


Figure 9. Older siblings' proportion of disfluencies when speaking to their younger sibling vs. parent. Error bars represent standard error.

Exploratory examination of older sibling gender differences. Despite the small sample size, we included another set of analyses to see if older siblings' gender played a role in the above effects. 2 x 2 repeated-measures ANOVAs were run for each variable, using the older sibling's gender as a between-subjects factor. Table 2 displays the means and standard deviations for each of the variables of interest by gender. There was a significant main effect of listener for older siblings' minimum pitch, $F(1, 27) = 8.77$, $p = .006$; $\eta^2 = .25$, mean pitch, $F(1, 27) = 6.08$, $p = .02$; $\eta^2 = .18$, proportion of attention-grabbing/holding devices, $F(1, 27) = 21.37$, $p < .001$; $\eta^2 = .44$), and proportion of disfluencies, $F(1, 27) = 23.70$, $p < .001$; $\eta^2 = .47$. No other main effects or interactions were significant.

Table 2

Means and Standard Deviations for Study Variables by Gender of Older Sibling

	Male		Female	
Variable	Sibling	Parent	Sibling	Parent
MLUw	9.08 *(2.83)*	9.33 *(2.90)*	8.21 *(1.92)*	7.88 *(2.70)*
Minimum pitch	160.23 *(27.29)*	143.69 *(22.42)*	157.72 *(29.51)*	146.87 *(33.84)*
Maximum pitch	380.01 *(46.72)*	385.51 *(33.01)*	405.68 *(30.26)*	393.09 *(36.56)*
Mean pitch	268.75 *(31.87)*	260.03 *(26.69)*	278.91 *(33.80)*	268.70 *(30.75)*
Pitch variability	29.44 *(12.00)*	28.94 *(12.73)*	34.26 *(9.43)*	31.47 *(9.24)*
Speech rate	0.34 *(0.05)*	0.34 *(0.05)*	0.34 *(0.04)*	0.34 *(0.05)*
Proportion of attention-grabbing/holding devices	0.021 *(0.02)*	0.006 *(0.01)*	0.027 *(0.03)*	0.008 *(0.01)*
Proportion of disfluencies	0.046 *(0.03)*	0.069 *(0.03)*	0.048 *(0.03)*	0.077 *(0.04)*

Note. There were 10 male and 19 female older siblings in our sample.

Discussion

This thesis presents the first half of a two-part investigation into the role that older siblings may play in the development of their younger siblings' ability to adjust their speech for other listeners. Participants completed both an at-home and an online task: In the at-home portion, target children played a picture completion game with their parent and their older sibling. In the online portion, target children were asked to play a guessing game over Zoom with the experimenter. Although only the results of the first part were analyzed for this thesis, I also discuss how the data for the online task may relate to data from the at-home task.

Picture Completion Task

I found that older siblings used higher pitch and a greater proportion of attention-grabbing and attention-holding devices when talking to their younger siblings (compared to when they talked to their parents). These findings are consistent with previous literature demonstrating that older siblings do make prosodic and lexical adjustments to their speech when speaking to their younger sibling (Shatz & Gelman, 1973; Tomasello & Mannle, 1985; Weppelman et al., 2003).

In contrast to previous findings, however, I did not find any significant differences in the older siblings' MLUw or speech rate towards their younger sibling vs. parent. This was somewhat surprising, as some studies of child-directed speech produced by children report that it is characterized by shorter utterances and slower speech (Dunn & Kendrick, 1982; Sachs & Devin, 1976; Shatz & Gelman, 1973; Tomasello & Mannle, 1985). I speculate that this might be due to the nature of our picture completion task.

Previous studies investigating children's use of CDS have utilized tasks of different natures: Shatz and Gelman (1973) asked 4-year-olds to describe a toy – either a dump truck with marbles, or a wooden ark with various animals and dolls – to an adult and a 2-year-old, and found that their descriptions to the toddlers contained shorter and simpler utterances. Children were only asked to explain how to use the toy, and the task ended after the 4-year-old demonstrated that they were finished (e.g., ending their explanation). In another one of their studies, five mothers were asked to make two audio recordings: One in which they were engaged in conversation with their 4-year-old, and another in which their 4-year-old was playing with their 2-year-old sibling. Each of the 4-year-olds had shorter utterances when interacting with their younger sibling. However, Shatz and Gelman's task was unstructured, such that children were not given any explicit instructions to describe or explain something to their younger sibling, and were simply observed during free play.

We speculate that there are two possible reasons why our task did not produce the same difference in utterance length: First, given the defined nature of the task (where the speaker had to refer to specific missing elements of the picture) and children's sensitivity to the Gricean maxim of quantity (i.e., provide the appropriate amount of information) in other work (Panzeri & Foppolo, 2021), older siblings may have provided the same amount of information to both partners, regardless of their age and linguistic perspective. Second, it's possible that the older siblings may have overcompensated for their younger sibling's knowledge, providing them *more* information than they normally would, to ensure that they fully understood where the cut-outs should be placed. One way to disentangle these possibilities would be to look more closely at the content of the utterances to each listener.

Like MLUw, a slower speech rate is also one of the main characteristics of CDS, and has been reported to be present in CDS produced by children (Weppelman et al., 2003). In the present study, speech rate was statistically equivalent for the two listeners (younger sibling vs.

their parent). While considerable evidence has emerged that adults have a slower speech rate when speaking to young children, there are almost no studies investigating children's use of this particular modification. To my knowledge, only one other study has investigated children's speech rate when interacting with a younger child (Weppelman et al., 2003). Again, that task was unstructured: Children were asked to show an infant how to use a Mr. Potato Head toy and two Winnie the Pooh books. Numerically, I also found slower utterances in speech to the younger siblings, but the difference by listener did not reach significance. If children do, in fact, make this type of modification, our structured task may have attenuated the difference.

Notably, I also found that older siblings were more disfluent when addressing their parent than when addressing their younger sibling. Previous literature has shown that spontaneous adult-adult speech typically consists of more pauses, repetitions, and hesitations compared to child-directed speech (Björkenstam et al., 2013; Broen, 1972; Frye, 2022; Newport, et al., 1977). However, to our knowledge, ours is the first study to explore children's use of disfluencies in speech to children vs. adults. This finding suggests that when speaking to their younger siblings, older siblings may be considering their sibling's linguistic and cognitive perspectives. Thus, they may take the extra time to ensure that the signal that they're providing is fluent and clear in order for the sibling to understand and efficiently process it. Although I found that older siblings' speech rate did not differ when speaking to their younger sibling vs. parent (i.e., suggesting that they did not take extra time), it's possible that older siblings may be pausing more between utterances to formulate their utterances when speaking to their younger sibling, though future research should investigate this.

Given that our task was structured, it would be interesting to see whether this finding holds in natural interactions between siblings. If it does, this will have important implications, suggesting that siblings are providing well-formed input that can be used in the service of learning about language structure.

In sum, this study replicates previous findings surrounding children's ability to use child-directed speech modifications (e.g., pitch, attention-grabbing devices) towards their younger siblings. More notably, this is the first study to demonstrate that young children's child-directed speech contains fewer disfluencies, such as repetitions, revisions, fillers, and blocks, than their adult-directed speech. The exploratory examination of gender effects suggested that male and female siblings made similar amounts and types of modifications while interacting with their sibling (vs. parent).

Virtual Guessing Game

The goal of the second half of our investigation is to see whether children with older siblings – especially those who make speech modifications for them – are more likely to make such modifications towards unrelated toddlers and non-native accented listeners within the virtual guessing game. In other words, I will first ask whether, overall, target children make modifications in the virtual guessing game for the toddler and non-native listener (relative to the adult listener). I will then ask whether the degree to which they do this is a function of a) older sibling status (yes or no) and b) among those target children with older siblings, the degree of modification in their sibling's speech (relative to when they interacted with the parent). In other words, I will ask whether the degree of target children's modifications in the virtual guessing game is related in continuous fashion to the modifications that their older siblings made during the picture-completion task.

The inclusion of two types of listeners (toddler and non-native) will provide insight into whether any potential modifications are cognitively driven or linguistically driven: If young children make modifications for the toddler only (relative to the baseline adult), it will suggest that their modifications are driven only by consideration of their listener's cognitive abilities. On the other hand, if young children also make modifications for the non-native accented child (who is older and more cognitively advanced), it will suggest that they are sensitive to their listener's linguistic perspective. Such modifications would suggest young children understand that someone with a non-native accent may have different linguistic abilities than them in their native language, and may need additional modifications to ensure that their signal is understood. This would be consistent with research that suggests that 5-6-year-olds are more tolerant of grammatical errors in non-native speech than native speech (Rett & White, 2022).

If I find that children with older siblings are more likely to make such modifications for unrelated toddlers and non-native accented listeners (compared to those without siblings), this suggests that siblings are in fact an important environmental influence on the development of this pragmatic ability. There are two possible ways in which older siblings might exert this influence on their younger siblings. First, consistent with the Sibling Bridge hypothesis, younger children may be adapting to the challenging conversational style provided by their siblings – which then prepares and motivates them to develop ways to effectively communicate with other individuals in their environments and communities. Consistent with this possibility would be finding that the *degree* to which their older sibling makes modifications is *negatively* correlated with younger siblings' own modifications in the online task. In other words, those children whose older siblings do less to accommodate them may be the ones whose pragmatic skills are more developed.

Another possibility is that younger siblings are detecting the difference in the way their older siblings talk to them vs. adults, and they might then use these modifications as a model for how to talk to others. On this account, I would expect that the relationship would go the other way – in other words, I would expect to see a *positive* correlation between the degree to which an older sibling makes modifications and their younger sibling's own modifications in the online task. That is, if I see that children who have older siblings that simplify their speech for them are the ones who are most often simplifying their signals towards the listeners in the online task, this suggests that later-born children are in fact learning this from their older sibling. In other words, children whose older siblings do more to accommodate them may also be the ones whose pragmatic skills are more sophisticated.

At present, there is no difference between older male and female siblings in the nature of their modifications for their younger siblings (relative to their parent). This is interesting in light of Havron and colleagues' (2019) "older brother effect". In their study of French-speaking children, they found that having an older sister was associated with better language scores. More specifically, they found that children with older sisters and no siblings scored similarly, but that children with an older brother scored significantly lower. They note that it's unclear whether older sisters encourage language development, or whether they just hinder later-born children's abilities less than older brothers do (perhaps because older brothers demand more parental attention). My findings thus far suggest that the advantage of having an older sister (compared to an older brother) in that work is not because older sisters provide more modifications in their speech. It remains to be seen whether other aspects of the sibling relationship (e.g., amount of speech or time spent together) lead to differences in the effects of older sisters vs. brothers on younger siblings' language ability.

Limitations

The results of the first half of our two-part investigation should be considered in the light of some limitations: First, participants completed the picture completion task in their home, with no supervision from the experimenter. Although I provided detailed instruction sheets and videos to parents to explain how to play the game, some families did not complete the activity as instructed. For example, some families completed the rounds out of order, with family members that weren't instructed to play in a given round, or they only completed one of the pictures (e.g., shape *or* scene but not both). Second, I noticed issues with some participants' audio quality: For some participants, multiple utterances had to be excluded due to unintelligibility, or due to overlapping noises in participants' homes (e.g., crying babies, television on in background, movement of the LENA device creating fuzziness in audio quality). Next, I did not include all kinds of disfluencies in the counts. In particular, I excluded pauses (e.g., I want … that) and prolongations (e.g., I want thaaaaaat), as these were challenging to determine given the somewhat irregular speech styles of some children. Pauses, in particular, might be informative to look at in the future.

Regarding the second half of our investigation, due to the nature of the online task (i.e., participants playing a game with seemingly "live" individuals over Zoom), it's possible that I may fail to see differences across listeners. While running the task, my impression was that some of the youngest participants (i.e., 4-year-olds, and some 5-year-olds) were speaking almost identically to each of the three listeners (perhaps because the different listeners were not salient enough or because they were in a task "set"). Additionally, many of the participants appeared confused when their play partner "did not understand which object to pick", despite them giving a clear description of the target object on the first pass. It's possible that children felt that their explanations were clear, and then were not sure how to make it clearer for the other person to understand. In most cases, children repeated what they said in their first attempt, or raised their volume. Thus, due to the nature of the task, young children may have thought that they weren't understood/heard because of technical difficulties in the call – and thus, that the modifications they had to make to be understood by the listener involved adjusting their volume, rather than other aspects of their speech. This could have potentially been avoided by implementing a more real-time, interactive approach to the virtual guessing game. For example, instead of having participants hear feedback responses regardless of the quality of their description, I could have tailored the feedback based on the description (only providing feedback for underinformative trials). I did initially consider this approach when designing the task, but decided against it as I was concerned about everything running smoothly from the experimenter's end, especially in a Zoom format. That said, the types of repairs anecdotally observed (e.g., repetitions) are often seen in live settings with tailored feedback as well, unless that feedback is more specific (Nilsen & Mangal, 2011).

Conclusion

To conclude, the findings of the first half of our two-part investigation highlight that older siblings make speech modifications for their younger siblings during a collaborative task – including adjusting their pitch, using attention-grabbing and attention-holding devices, and most notably, by using fewer disfluencies. If I find in the second half of our investigation that children's use of such modifications with other listeners is related to having a sibling (or to their sibling's modifications), this will provide some of the first empirical evidence that older siblings are an important environmental influence on later-born children's pragmatic abilities.

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Appendices

Appendix A

Picture Completion Game Materials

This appendix contains the rest of the materials for the Picture Completion Game, including the other two types of scenes: park and beach.

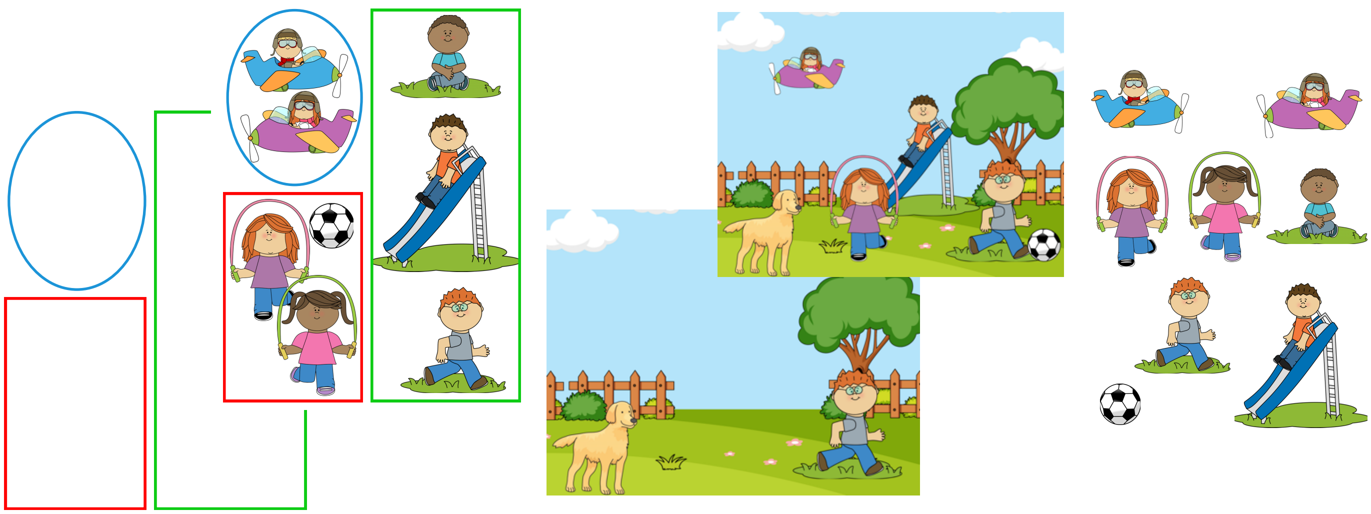


Figure A1. Park shape and scene pictures, and cut-outs.

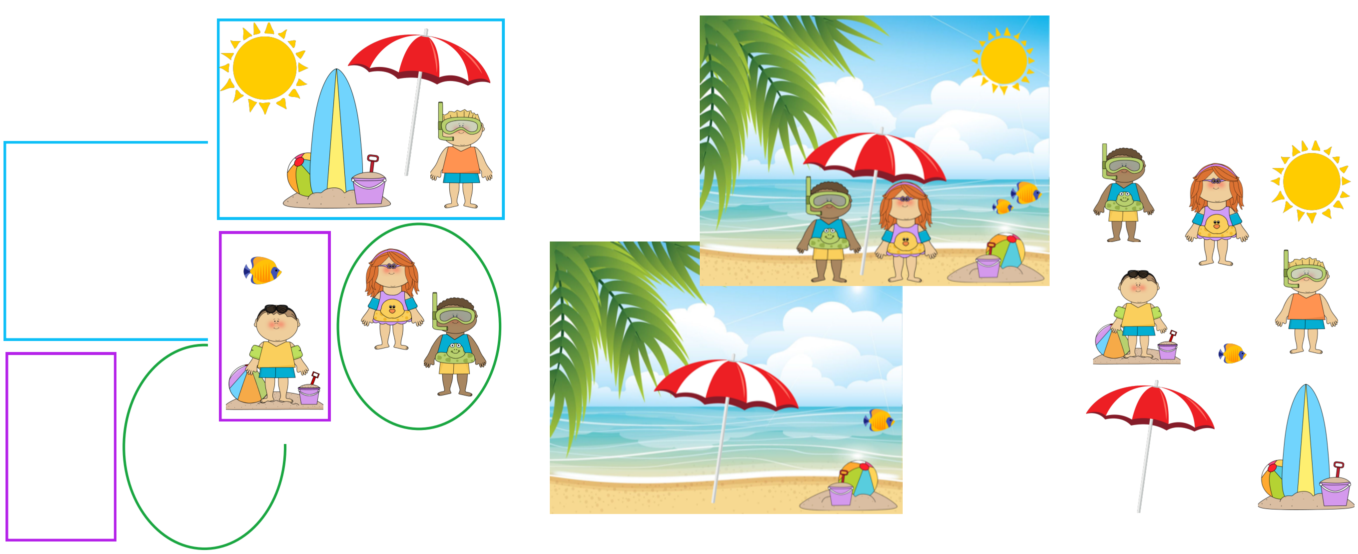


Figure A2. Beach shape and scene pictures, and cut-outs.

Appendix B

Picture Completion Game Instruction Sheets

This appendix contains some of the instruction sheets sent home to parents in each at-home study box.

Picture Completion Game

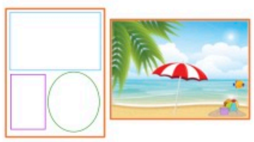
General Instructions

In this game, there will be two players: One player will be the communicator, and the other player will be the completer.

The goal of the game is for the communicator to provide verbal directions to the completer so that they can make their incomplete pictures complete – using the communicator's directions and the cartoon cut-outs provided.

The communicator will start with complete pictures, and the completer will start with incomplete pictures and cartoon cut-outs (*see examples below*).

Example of complete pictures for communicator.



Example of incomplete pictures for completer.

Example of cartoon cut-out options that the completer can choose from.

The **communicator's job** is to help the **completer** figure out what objects and/or people are missing from their pictures and where to put the cartoon cut-outs to make them complete. The **communicator** should help the **completer** only by using their words, *not* by pointing or showing the completer where to put the cartoon cut-outs. The two players should not look at each other's pictures during the game.

Once the two players think the completer's pictures might be complete, then they can look at each other's pictures and see how they did!

After completing the first round, you can move on to round #2. You will do the same thing, but with new players and pictures. You will find the pictures and players for round 2 in folder #2, and the pictures and players for round 3 in folder #3. As mentioned previously, you may play all the rounds during the same time period, or at different times.

- If *both of your children* are assigned to play the game together, you may stay in the room to supervise, and answer questions.
- If *only one of your children* is assigned to play the game this round, ensure that your other child is not in the same room while the round takes place.

2

Picture Completion Game

Game Set-up

1. Check the outside of the folders in your package to see who will play the game in the first round. You will see a number on each folder, which corresponds to the round. (For example, #1 means this is the folder you should use for the first round; the players for this round are listed on the folder.) **Please ensure that only players involved in the round are in the room.**
2. The two players should sit apart, so that they cannot see each other's pictures, by sitting at opposite ends of a table with a divider/barrier in between them.

3. **Communicator's side**: The communicator should have in front of them a page with pictures in coloured shapes, and the complete version of a scene (farm, beach, *or* park).

Completer's side: The completer should have in front of them a page with empty, coloured shapes, the incomplete version of a scene (farm, beach, *or* park), and cartoon cut-outs.

4. Before starting, please review the "How to Play" section and read the "Child Instructions" to your child/children. **Make sure your child/children know the rules and objectives of the game before playing.**

3

Appendix C

Cards for the Virtual Guessing Game

This appendix contains the cards that participants received in their at-home study box and used for the virtual guessing game.

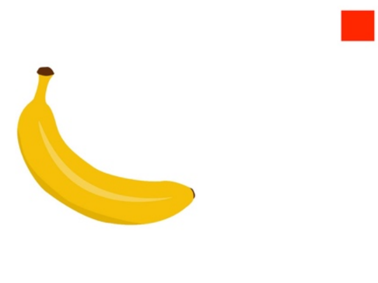


Figure C1. Card for the warm-up trial.

Figure C2. Card for practice trial.

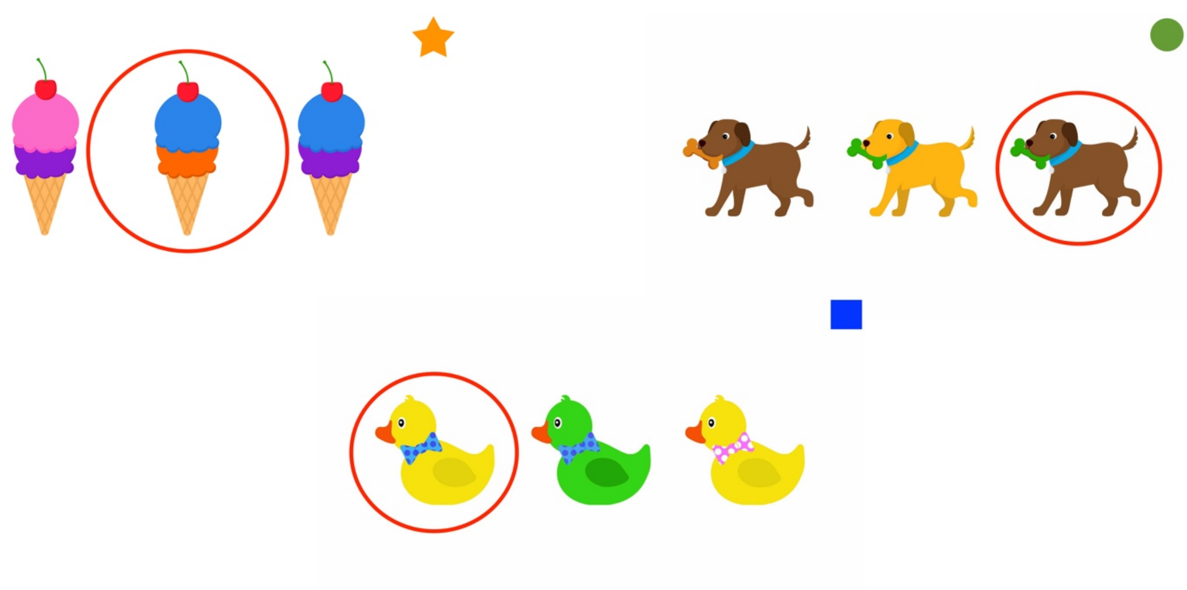


Figure C3. Cards for the test trials.

Appendix D

Script for Audio Recordings

This appendix contains the script sent to volunteers to record audio stimuli for our virtual guessing game.

Script for the baseline listener:

“Hi! My name is Charlie. I am excited to try this game with you!”
“I got it!”
“Yes!”
“Is it this one?”
“Which one is it?”
“I don’t know which one to pick!”
“That was fun! Bye!”

Script for the younger listener:

“Hi, I’m Sammy.”
“I’m two years old.”
“Yes! Let’s play the game!”
“Got it!”
“Yes!”
“Is it this one?”
“Which one is it?”
“I don’t know which one!”
“That was fun! Bye!”

Script for the non-native accented listener:

“Hi, my name is Alex.”
“I am six years old.”
“Yes! I want to play with you!”
“I got it!”
“Yes!”
“Is it this one?”
“Which one is it?”
“I don’t know which one to pick!”
“That was fun! Bye!”

Appendix E

Calibration for Virtual Guessing Game

This appendix contains the PowerPoint slides used to calibrate participants before beginning the virtual guessing game.

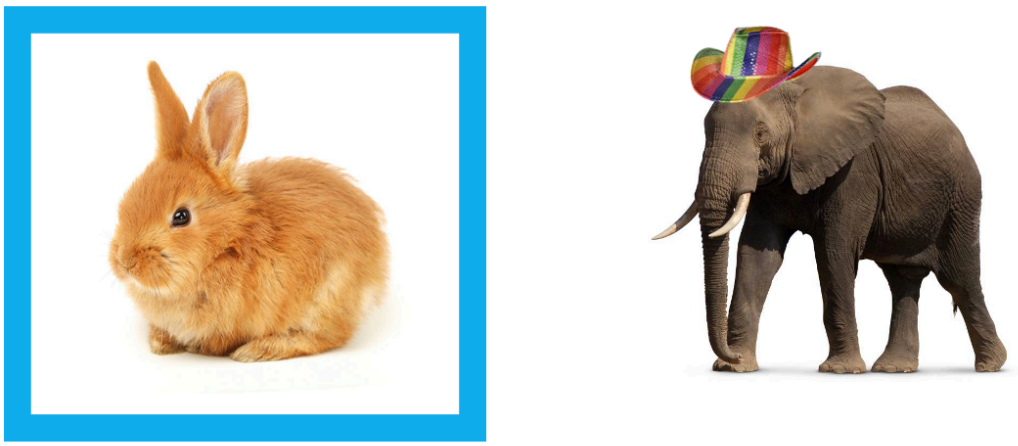


Figure E1. Participants saw this image on their screen, and heard a female, native-English speaker say the following questions, pausing between each one to allow the child to answer: *"Do you see the animals on your screen?"*, *"What colour box is the bunny in?"*, and *"Which animal has the hat on its head?"*.

Appendix F

Test Trial Slides for Virtual Guessing Game

This appendix contains the test trial slides shown to participants during the virtual guessing game.

Figure F1. Test trial for the younger listener.

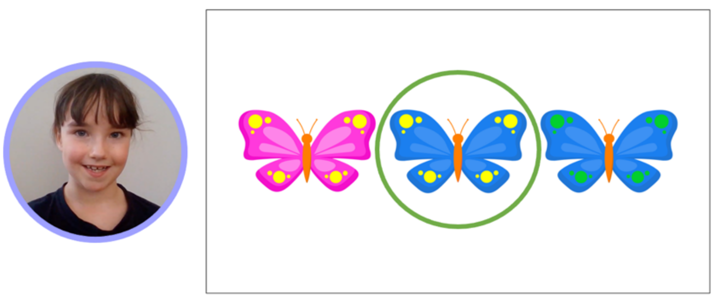


Figure F2. Test trial for the non-native accented listener.

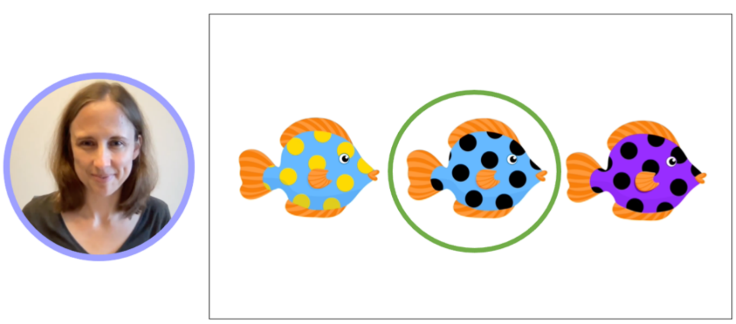


Figure F3. Test trial for the baseline listener.