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The Dynamics of Caregiver-Infant Interactions: Exploring Multimodal Behavior, Language, Acculturation, and Infant Attention

By

ANDREA RAMIREZ BARAJAS

DISSERTATION

Submitted in partial satisfaction of the requirements for the degree of

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in the

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of the

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DAVIS

Approved:

Katharine Graf Estes, Chair

Lisa Oakes

Tamara Swaab

Committee in Charge

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ABSTRACT

Despite extensive research demonstrating that caregiver-infant interactions support infants' learning and development (Bornstein, 2017; Tamis-LeMonda et al., 2008; Yu & Smith, 2016), less is known about how caregivers' behaviors vary across cultural and linguistic contexts. Research examining caregiver-infant interactions has demonstrated that caregivers' behaviors are related to infants' attention and engagement with objects and events in their environment (Tamis-LeMonda et al., 2012; Yu & Smith, 2016). However, less is known about how caregivers' acculturation and behaviors contribute to the organization of caregiver-infant interactions and infants' responses.

The current dissertation examined how caregivers' communicative behaviors and acculturation as well as linguistic experiences relate to infants' attention and engagement during interactions. Study 1 examined Spanish-English bilingual and English-speaking monolingual caregivers' speech and gesture behaviors in relation to 8- to 20-month-old infants' attention. Study 2 investigated Mexican American mothers' utterance functions in relation to their acculturation levels and language use. Study 3 examined Mexican American mothers' speech and touch directed toward their 18-month-old infants and the extent to which coordination of these behaviors was associated with mothers' acculturation levels. Findings from these studies begin to address gaps in research on caregiver-infant interactions across cultural and linguistic contexts, with Mexican American and Latine families. Taken together, the three studies demonstrate that variability in caregivers' communicative behaviors and language use is an important feature of caregiver-infant interactions and may provide infants with diverse opportunities to attend to and learn from their social and physical environment.

# CHAPTER 1

# GENERAL INTRODUCTION

Through everyday interactions, caregivers provide infants with opportunities to attend to relevant information and learn about objects and events in their environment (Adolph et al., 2010; Tamis-LeMonda et al., 2008). Decades of research investigating caregiver-infant interactions have demonstrated that these exchanges contribute to infants' cognitive, linguistic, and socioemotional development (Bornstein, 2017; Hirsh-Pasek & Burchinal, 2006; Tamis-LeMonda et al., 2008). Research on caregiver-infant interactions has examined these interactions from a variety of perspectives, including multimodal approaches, cultural differences, and dynamic interactions (Adolph et al., 2010; Bornstein, 2017; Hsu & Fogel, 2003; Keller et al., 2009; Rogoff, 2003; Super & Harkness, 1986; Tamis-LeMonda et al., 2008; Whiting & Whiting, 1975). Contemporary perspectives have moved beyond viewing caregiver behavior as a unidirectional source of input and instead conceptualize caregiver-infant interactions as reciprocal processes in which both partners influence and respond to one another.

## Dynamic Systems Theory and Reciprocal Caregiver-Infant Interactions

Dynamic Systems Theory (Thelen & Smith, 1994) proposes that development is an emergent process resulting from the continuous interactions among biological, behavioral, and environmental systems. Within caregiver-infant interactions, behaviors such as speech and touch can be understood as actions that occur within an ongoing and changing caregiver-infant system. Caregivers adjust their behaviors based on infants' behaviors and cues, and infants reciprocally respond to these changes (Hsu & Fogel, 2003; Thelen & Smith, 1994). Research has demonstrated that caregiver-infant interactions involve reciprocal coordination, with caregivers adjusting their vocalizations, gestures, and behaviors in response to infants' attention and engagement (Bornstein, 2017; Fogel, 1993; Tamis-LeMonda et al., 2001). For example, caregivers are more likely to provide language input when infants attend to objects, creating opportunities for infants to learn associations between caregiver cues and their environment (Tamis-

LeMonda et al., 2008; Yu & Smith, 2016). Similarly, research examining multimodal behaviors has shown that caregivers combine speech, gesture, and touch to support infants' attention and learning (Gogate et al., 2000; Iverson & Goldin-Meadow, 2005). This work therefore illustrates the reciprocal and context-dependent nature of caregiver-infant interactions and provides a basis for considering these interactions within a dynamic systems framework.

Recent theoretical models emphasize the importance of interactions in supporting early learning. Masek et al. (2021) proposed the Reciprocal Model of Contingent Interactions, Attention, and Language Development, which highlights how caregivers coordinate their speech with object-directed actions and infants' visual attention during interactions. Through these interactions, caregivers can maintain and guide infants' attention, supporting their learning (Masek et al., 2021). Prior research supports this model by suggesting that caregivers' responsiveness to infants' attentional states and actions is associated with infants' learning opportunities and developmental outcomes (Tamis-LeMonda et al., 2008; Yu & Smith, 2016).

Caregiver-infant interactions occur within a broader social and cultural context that may shape how caregivers communicate with infants and how infants experience interactions. Cultural practices are associated with caregivers' beliefs about infant development (Buhler-Wassmann & Hibel, 2025), the ways they direct infants' attention, and how caregivers interact with infants (Bornstein, 2017; Rogoff, 2003). Research across diverse cultural groups demonstrates variation in caregiver speech, object play, and everyday routines, suggesting that there is not a universal pathway through which caregivers support learning (Bornstein et al., 1990; Keller et al., 2009; Wang et al., 2025). Caregivers may also differ in their use of verbal and nonverbal behaviors, including gesture and touch, as culturally meaningful forms of communication that may guide infants' attention (Gogate et al., 2006).

Developmental frameworks have emphasized that caregiver-infant interactions evolve as caregivers and infants respond to one another, but have given less attention to how cultural context may shape these processes. Bornstein et al. (1990) demonstrated that mothers from United States, France, and

Japan varied in how they responded to infants' behaviors directed to an object or a person. U.S. mothers supported infants' object interactions more, encouraging them to explore their environment; whereas Japanese mothers more often oriented infants towards themselves, emphasizing social and emotional bonding. French mothers demonstrated a distinctive pattern that supported both emotional boding and exploration of their environment. These finding emphasized how caregiver-infant interactions may vary across cultural contexts..

In addition, Bornstein et al. (2012) found cultural differences in moment-to-moment contingencies between mothers' and infants' person- and object-directed behaviors among European Americans, Japanese, and Japanese American immigrant families, providing evidence that patterns of caregiver-infant responsiveness vary across cultural contexts. Cultural variation is also evident in caregivers' language use, including differences in the ways caregivers verbally respond to infants and engage them around objects and social partners (Tamis-LeMonda et al., 2008). These findings suggest that cultural context may be associated with differences in caregivers' behaviors and in the ways caregivers' respond to and coordinate with infants' attention and behavior within ongoing interactions.

**Multimodal Caregiver Communication**

A central feature of dynamic caregiver-infant interactions is the use of multiple modalities. Rather than providing infants with a single behavior, such as speech, touch, or gesture, caregivers provide a rich and complex environment in which infants are exposed to multiple behaviors that may support attention and learning (Kosie & Lew-Williams, 2024). These behaviors often occur simultaneously, creating redundant and complementary cues that may help infants identify relevant information in their environment (Bahrick et al., 2004; Kosie & Lew-Williams, 2024). Considering that infants' attention is limited and rapidly changing, multimodal cues may provide infants with additional information about which aspects of the environment are socially and linguistically important (Kosie & Lew-Williams, 2024; Suarez-Rivera et al., 2019).

Recent research demonstrates that caregivers' multimodal behaviors are associated with infants' attention and language learning across development. Caregivers' coordination of speech with gestures and object-directed actions can support infants' ability to identify referents and establish mappings between words and objects (Abu-Zhaya et al., 2017; Gogate et al., 2006). Research examining caregiver behaviors during interactions has demonstrated that caregivers adapt their interactions based on infants' visual attention, using verbal and nonverbal cues to guide and maintain infants' attention to objects and events (Chen et al., 2021; Schroer et al., 2022; Suárez-Rivera et al., 2019). These findings suggest that caregivers do not produce isolated behaviors but instead provide integrated verbal and nonverbal cues that support infants' learning within ongoing interactions.

Redundant and complementary cues may be particularly important during infancy. Speech provides linguistic information, whereas touch and gestures provide social cues that may direct infants' attention. Prior work has emphasized that tactile and visual cues can highlight relevant objects and actions, allowing infants to combine information across modalities during learning experiences (Seidl et al., 2015). Therefore, examining caregivers' use of multimodal behaviors may provide insight into how caregiver-infant interactions support infants' development. Importantly, the ways in which caregivers may coordinate these multimodal cues may vary across cultural and linguistic contexts, raising questions about whether patterns of multimodal caregiver behaviors are similar across caregivers with different cultural and linguistic experiences.

**Culture and Caregiver-Infant Interactions**

Caregivers' communication strategies occur within culturally informed beliefs about development, socialization goals, and ways of engaging with infants (Bornstein, 2017; Ispa et al., 2004; Rogoff, 2003). Cultural frameworks may influence how caregivers interpret infants' behaviors and respond to infants' cues. Research examining cultural variation in caregiver-infant interactions has underlined differences in the ways caregivers use verbal and nonverbal cues when interacting with infants. Côté et al. (2008) found that Latine immigrant mothers engaged in more person-directed

interactions than European American mothers, underscoring the importance of physical proximity and social exchanges in caregiver-infant interactions. Luo and Tamis-LeMonda (2016) found that Mexican immigrant mothers used more nonverbal behaviors, including gestures and hands-on guidance, during play interactions compared with African American and Dominican immigrant mothers. These findings suggest that caregiver behavior may reflect not only the goal of conveying information but also culturally meaningful ways of supporting infants' social engagement.

Cultural patterns of caregiving can vary across dyads. Parenting practices among Mexican-origin families may reflect differences in cultural and linguistic experiences. Prior research by Ispa et al. (2004) found that parenting behaviors among European American, African American, and Mexican American mothers varied in caregiver warmth and maternal intrusiveness. Furthermore, Cabrera et al. (2006) showed that Mexican American families maintain strong emotional involvement and close family relationships while simultaneously adapting to experiences within the U.S. cultural context. Thus, examining caregiver-infant interactions requires attention not only to cultural group differences but also to variability in caregivers' cultural experiences. These experiences may be closely linked to the environments children are part of and how children respond to caregiver interactions.

**Dissertation**

Motivated by a dynamic systems perspective (Thelen & Smith, 1994), this dissertation investigates caregiver-infant interactions as multimodal and context-dependent processes. Across three studies, the dissertation examines caregivers' communicative behaviors and how caregiver behavior varies across linguistic and cultural contexts. Study 1 examines how bilingual and monolingual caregivers coordinate speech and gestures during interactions with their infants and how these behaviors relate to infants' attention. Study 2 examines the relation between Mexican American mothers' acculturation levels and their language use with their infants. Study 3 investigates how Mexican American mothers' acculturation levels relate to the use of tactile and verbal cues during interactions with their infants. The current studies aim to address gaps in the developmental literature by examining caregiver-infant

interactions across diverse cultural and linguistic contexts in multiple modalities. Collectively, the studies build upon previous empirical work and existing theoretical frameworks to provide insight into the multimodal and context-dependent nature of caregiver–infant communication.

# CHAPTER 2

## STUDY 1: BILINGUAL AND MONOLINGUAL INFANTS' ATTENTION TO PARENTAL SPEECH AND GESTURES

From early in development, infants learn about objects and their environment through dynamic interactions with caregivers (Bruner, 1975; Tamis-LeMonda et al., 2014; Tomasello & Farrar, 1986; Tomasello & Todd, 1983; Vygotsky, 1978; Yu & Smith, 2012). During these interactions, caregivers provide labels for objects (MacRoy-Higgins & Montemarano, 2016; Tomasello & Farrar, 1986; Yu & Smith, 2012; Yu et al., 2019), descriptions of objects (Hirsh-Pasek et al., 2015; Kuchirko et al., 2020; Ninio & Bruner, 1978), and modify their speech and gestures to support infants' attention (Chen et al., 2021; Suárez-Rivera et al., 2022). A growing body of research demonstrates that these caregiver behaviors are associated with longer episodes of infant attention (Schatz et al., 2022; Schroer & Yu, 2022; Suárez-Rivera et al., 2019; Suárez-Rivera et al., 2022). More recently, Kizildere et al. (2025) found that spatial language, object labels, and deictic gestures were associated with longer episodes of infant attention during play, while Mahlke et al. (2026) found that infants' sustained attention was associated with parents' object-focused speech. These findings highlight the role of caregiver behavior in shaping infants' moment-to-moment attention during interactions.

Caregiver-infant interactions are inherently multimodal. Caregivers frequently coordinate speech with gestures and object-directed actions to direct infants' attention and support learning. During those interactions, caregivers may engage in object-focused talk while simultaneously looking at, manipulating, or gesturing toward objects, creating opportunities for infants to maintain attention to a common referent (Masek et al., 2021). These multimodal behaviors may provide infants with more salient and informative cues than speech-only or gesture-only input by allowing infants to integrate information across communicative channels. Examining these moment-to-moment exchanges provides insight into how caregivers influence when and for how long infants attend to objects and social partners (Yu & Smith, 2016).

Caregiver speech is one of the primary communicative behaviors associated with infant attention. Suárez-Rivera et al. (2019) found that joint attention episodes between caregivers and their 12- to 16-month-old infants were longer when caregiver talk was present. Similarly, Schroer and Yu (2022) reported that infants' attention to objects increased following the onset of caregiver speech. These findings indicate that caregiver speech does not simply coincide with infant attention but may contribute to infants' attention to objects. However, most of this work has been conducted with monolingual dyads and has treated speech as a binary outcome (i.e., present versus absent), leaving less clear how speech interacts with other caregiver behaviors and across different linguistic contexts.

One way caregivers may support infant attention is by coordinating speech with gestures. Gestures provide infants with visual information that can complement spoken language, potentially making objects and actions more salient during interactions. Research examining caregiver-infant interactions has shown that coordinated gesture and speech are associated with infant attention and learning (Chen et al., 2021; Schatz et al., 2022; Suárez-Rivera et al., 2022). Suárez-Rivera et al. (2022) demonstrated that caregivers' multimodal behaviors were associated with infants' attention, suggesting that infants may benefit from information across modalities. Similarly, the Reciprocal Model of Contingent Interactions, Attention, and Language Development proposes that caregiver behaviors and infant attention are associated with caregivers responding to infants' attentional states and using multimodal cues to support continued attention (Masek et al., 2021). Therefore, these findings suggest that examining speech and gesture independently as well as in combination may provide a more complete understanding of how caregiver behavior relates to infant attention.

Although research has established an association between caregiver speech, gesture, and infant attention, much of this work has focused on monolingual caregiver-infant dyads. There is limited understanding of whether these associations occur similarly in bilingual environments. Bilingual infants experience linguistic input across two languages, and caregivers may use different languages during everyday interactions. Research with French-English and Spanish-English bilingual caregiver-infant

dyads showed that parents frequently used more than one language when interacting with their infants (Bail et al., 2015; Kremin et al., 2022). This variability in caregivers' speech provides an important context for examining whether caregiver behaviors associated with infant attention are similar across linguistic backgrounds. Specifically, comparing bilingual and monolingual dyads can help determine whether associations between caregiver behaviors and infant attention are robust across different language environments.

The linguistic context of bilingual interactions may also be relevant to infants' moment-to-moment attention. Bilingual caregivers may use Spanish and English in different proportions and may adapt their behaviors across languages. Recent work by Ramirez Barajas et al. (2025) found that bilingual caregivers differed in their use of infant-directed speech across English and Spanish, suggesting that characteristics of caregiver communication may vary depending on the language used with infants. Other research has similarly demonstrated that bilingual speakers may modify their gestures according to the language they speak (Nicoladis et al., 2009; Pika et al., 2006; So, 2010). Although these findings suggest that language context may influence caregiver communication, relatively little is known about whether the language caregivers use during bilingual interactions is associated with infants' moment-to-moment attention. Investigating Spanish- and English-language interactions within bilingual dyads may provide an opportunity to determine whether infants' attention varies as a function of the language in which caregiver behaviors are produced.

Understanding caregiver speech and gesture within bilingual interactions is particularly important because bilingual infants may experience more variability in linguistic input than infants in monolingual environments. Bilingual and monolingual interactions may support infants' attention if caregivers' speech and gesture have similar associations across linguistic contexts. Furthermore, changes in the language used by bilingual caregivers (e.g., English, Spanish) may provide an additional source of variation in infants' experiences during play. Thus, exploring caregiver behavior across monolingual and bilingual

dyads, and investigating how bilingual parents use their two languages, can clarify whether the relation between caregiver communication and infant attention is consistent across language contexts.

**Current Study**

Although research has demonstrated that caregiver speech, gestures, and multimodal behaviors are associated with infants' attention, we have limited understanding about how these behaviors function within bilingual environments. Bilingual caregivers may coordinate multiple languages and adapt their behaviors within complex linguistic environments. We examined monolingual and bilingual infants' attention in relation to the type of parental behavior used during play. We compared infants' attention to objects across events when parents produced speech-only, gesture-only, gesture-and-speech, and no input (no speech or gesture) behaviors. We predicted that both bilingual and monolingual infants would demonstrate longer attention during gesture-and-speech behaviors compared to speech-only, gesture-only, or no input (no gesture or speech) behaviors. This prediction was based on the possibility that combining verbal and nonverbal cues may provide infants with multiple, coordinated to integrate information (Chen et al., 2021; Schatz et al., 2022; Suárez-Rivera et al., 2019; Suárez-Rivera et al., 2022).

Additionally, we investigated how bilingual infants' attention varied depending on the language caregivers used during interactions. Specifically, we examined how infants' attention differed when bilingual caregivers used Spanish versus English during object-directed behaviors. Language use may be associated with infant attention because bilingual caregivers may adapt their behaviors across languages, potentially creating differences in the input infants receive across language contexts (Fish et al., 2017; Ramirez Barajas et al., 2025; Spinelli et al., 2017). Recent research suggests that bilingual caregivers systematically modify infant-directed speech across languages, producing distinct speech characteristics in Spanish and English (Ramirez Barajas et al., 2025). These findings raise the possibility that language-specific differences in caregiver communication may be associated with differences in infants' attention. Monolingual and bilingual caregiver–infant dyads engaged in free-play with a set of toys. We examined

caregivers' gesture and speech, when produced independently or in combination, and assessed how these behaviors were associated with infants' attention to the toys.

## Method

### *Participants*

Participants were Spanish-English bilingual parents ($n$ = 20; 17 mothers, 3 fathers) and monolingual English-speaking parents ($n$ = 20; 16 mothers, 4 fathers). Infants were 8 to 20 months old (bilingual group: $M$ = 13.64 months, $SD$ = 3.42; monolingual group: $M$ = 15.36 months, $SD$ = 2.66). The difference in age across groups was significant ($t$ (32.84) = −2.29, $p$ = .03). All infants were born full-term and were typically developing, with no known hearing or vision impairments. Spanish-English bilingual parents spent an average of 76.75 hours per week ($SD$ = 8.93) with their infants during awake time. On average, they reported speaking to their infants in Spanish 57% of the time ($SD$ = 25.24) and in English 43% of the time ($SD$ = 20.58). English-speaking monolingual parents spent an average of 77.73 hours per week ($SD$ = 5.54) with their infants during awake hours.

All bilingual parents had Spanish language experience beginning at birth; 67% of parents, exposure to English started in the preschool years (around or before five years of age), while 33% of parents were exposed to English during adulthood. Sixteen bilingual parents' primary language was Spanish, and four reported English as their primary language. All English-speaking monolingual parents' primary language was English. Caregiver–infant dyads resided in rural, urban, and suburban communities across Yolo, Sacramento, and Solano counties in Northern California. Among bilingual parents, eight participants identified as White (seven Hispanic, one non-Hispanic), two identified as Mexican (and Hispanic), seven identified as Mexican-American (and Hispanic), two identified as American-Indian (one Hispanic, one not Hispanic), and one participant did not report race or ethnicity. Among monolingual parents, fourteen identified as White (three Hispanic, 11 non-Hispanic), three identified as Asian-American (non-Hispanic), and three identified as both African American and White (one Hispanic and

two non-Hispanic). The study was approved by the UC Davis Institutional Review Board (IRB), and participants provided informed consent before participating. All participants were recruited through the Center for Mind and Brain at the University of California, Davis. Data were collected from 2018 to 2020.

### *Stimuli*

The target objects were a set of 10 small plastic toys (see Figure 2.1). Each object displayed a written label corresponding to the object's name. For bilingual parents, each toy contained both a Spanish and English label (e.g., dog – perro), while toys presented to monolingual parents contained an English label only (e.g., dog).

**Figure 2.1**

*Labeled toy objects stimuli*




### Procedure

The first author, a Spanish-English bilingual, conducted the experiment. During the study, the researcher interacted with bilingual parents in both Spanish and English. For the English-speaking monolingual participants, the instructions and materials were provided in English. Parents wore a Tascam DR-10L digital audio recorder with a lavalier microphone. Video cameras mounted on two walls recorded the sessions.

Parents participated in a series of infant-directed speech and adult-directed speech tasks. Adult-directed speech tasks were not included in the present analyses. The IDS tasks were object-labeling, free-play, and book-reading (order counterbalanced across participants). In the object-labeling task, parents were asked to play with the objects with their infant and to name each object using the provided label. In the free-play task, the parent was instructed to play with their infant as they would normally do at home. The dyads were given the same set of toys in both tasks. The book reading task was not included in the present analyses.

Bilingual parents received instructions in both English and Spanish and were instructed to use both language labels if they typically used both English and Spanish at home. Between the tasks, the experimenter entered the room to provide further instructions to the parents. A timer was used to help parents keep track of time remaining during each task. Each task lasted six minutes; at the four-minute mark, a timer sounded to indicate that two minutes remained.

## Data Preparation

### *Parental Utterance and Language Coding*

Audio recordings collected during the IDS task were manually transcribed and annotated for language use (Spanish, English, and language mixing utterances) using Praat (Boersma & Weenink, 2023). Native Spanish-English bilingual research assistants annotated the bilingual recordings; native monolingual English-speaking research assistants annotated the monolingual recordings. The first author served as a second coder to review, verify, and correct all transcripts. Parental speech was segmented into utterances following procedures described in previous research (Schroer & Yu, 2022; Suárez-Rivera et al., 2019). No minimum utterance duration was required; however, speech separated by less than 400 ms of silence was coded as a single utterance (Yu et al., 2016; Pereira et al., 2014; Yu & Smith, 2012). A pause of at least 400 ms marked the beginning of a new utterance.

Each utterance was categorized as either Spanish, English, or language mixing. Spanish utterances contained only Spanish-language content (e.g., *Ven para acá*), whereas English utterances consisted exclusively of English words (e.g., *Look at the dog!*). To classify separate Spanish or English utterances, consecutive speech sequences had to be separated by a pause at least 400 ms. Language mixing utterances were classified into two forms: intra-sentential and inter-sentential language mixing. Intra-sentential language mixing occurred when an utterance consisted primarily of one language with one or a few words from the other language (e.g., *Mira the red truck*). Inter-sentential language mixing occurred when speakers alternated languages across consecutive sentences (e.g., *You like the red truck! Esta te gusta a ti.*). When pauses between mixed-language speech sequences were shorter than 400 ms, the entire sequence was coded as a single language mixing utterance. Language mixing utterances were excluded from the present analyses because the analyses focus exclusively on comparing bilingual parents' language use of English and Spanish.

Across all participants, parents produced 8,341 utterances. Monolingual parents produced 4,020 utterances, and bilingual parents produced 4,321 utterances, including 2,589 Spanish utterances, 1,225 English utterances, and 507 language mixing utterances. The present analysis focused on Spanish and English utterances; therefore, 3,814 utterances were included in the analyses.

### *Parent and Infant Behaviors*

Trained research assistants used Datavyu (Datavyu Team, 2014) software to code parent and infant behaviors frame-by-frame at approximately 33 frames per second. Research assistants were unaware of the research hypothesis and research questions.

Research assistants coded parents' deictic gestures, including pointing and showing, because these behaviors are commonly used by parents to direct infants' attention toward objects during interactions (Goldin-Meadow, 2007; Tomasello, 2003; Suárez-Rivera et al., 2019). Pointing gestures were defined as communicative gestures in which the parent extended a single index finger toward a toy or the

infant to direct the infant's attention. The onset of a pointing gesture was marked when the parent initiated movement of the hand toward the pointing location, with the extended index finger becoming visible during the movement. The offset was marked when the parent initiated the return of the hand to its resting position and the index finger was no longer extended (Iverson et al., 1999; McNeill, 1992; Tomasello et al., 2007). The duration of each pointing gesture included the entire period during which the parent maintained the pointing gesture toward the infant or a toy. If the parent touched or briefly tapped the referent while maintaining an extended index finger to indicate the object, the gesture was coded as a pointing gesture because its primary communicative function was to direct the infant's attention. Touching or tapping an object without an extended index finger or without a clear referential intent was not coded as a pointing gesture.

Showing behavior was defined as the parent holding and displaying an object (e.g., a ball) to the infant. The onset of a showing behavior was marked when the parent grasped the object and began moving it toward or positioning it within the infant's visual field**,** typically at the infant's eye level. The offset was marked when the parent initiated lowering the object, returned it to a resting position, or moved the object away from the infant such that it was no longer within the infants' visual field. (Bakeman & Adamson, 1984).

Research assistants coded infants' attention to the toys based on their head orientation. A head orientation event was defined by an onset time, when the infant initiated a head movement toward the toy, and an offset time, when the infant's head returned to the center position and aligned with the body. The duration of each attention event included both the orienting movement toward the toy (e.g., dog or cat) and the sustained period during which the infant remained oriented toward the toy. Infant attention was not coded when the infant was outside the camera's view or when the infant's head orientation could not be reliably identified. The coding approach was consistent with observational coding approaches used to assess infant attention during social and object interactions (Bakeman & Adamson, 1984; Bornstein & Tamis-LeMonda, 1990).

**Coding Reliability**

To establish coding reliability for parent and infant behaviors, each session was coded by two research assistants. We calculated percentage agreement between coders based on frame-by-frame coding. If agreement between the first and second coders was at or above 90%, data from the first coder were included in the analyses ($n$ = 20 participants). If agreement was below 90% ($n$ = 20 participants), a third research assistant coded the session, and percentage agreement between the first and third coders was calculated. If agreement between the first and third coders was at least 90% ($n$ = 15 participants), data from the first coder were used. If agreement between the first and third coder remained below 90%, agreement between the second and third coder was calculated, and data from the second coder were used if agreement between the second and third coders was above 90% ($n$ = 5 participants). Across all sessions, average agreement between the first and second coders was 94% (range = 90% to 98%).

Average agreement between coders was 90% for infant attention (range = 85% to 95%), 91% for parental pointing (range = 84% to 98%), and 93.5% for parental showing (range = 87% to 100%).

**Bout Preparation**

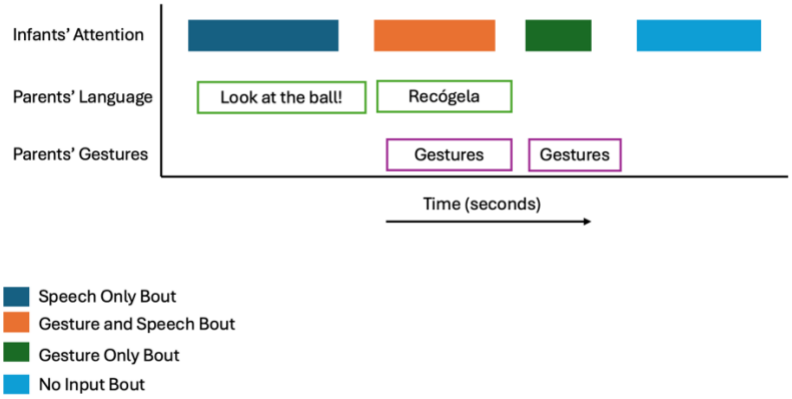
For the analyses, we examined infants' attention in relation to parents' behaviors. We segmented infants' attention to the toys into *attention to toy bouts*. We defined a bout as a period of successive frames (~33 ms per frame; 30 frames per second) of infant attention to a toy, with bouts separated by at least 200 ms (6 frames). Periods of successive frames that were separated by less than 6 frames were combined into a single bout (Kizildere et al., 2025). The dataset included 1,363 bouts across 40 participants.

For each infant attention bout, we determined whether parent speech and/or gesture occurred. Figure 2.2 illustrates four categories of infant attention bouts: (1) Speech-only: only parent speech occurred at any point during the infant attention bout (622 bouts); (2) Gesture-only: only parent gesture occurred during an infant attention bout (58 bouts); (3) Gesture-and-speech: parent gesture and speech occurred during any part of the infant attention bout (515 bouts); and (4) No Input: no parent speech or

gesture occurred during the infant attention bout (168 bouts). We also classified each attention bout that co-occurred with speech based on which language the parent used. Monolingual infants had 610 attention bouts accompanied by English speech. Bilingual infants had 121 bouts accompanied by English speech, and 406 bouts accompanied by Spanish speech, for a total of 527 language-accompanied bouts. In total, monolingual and bilingual infants had 1,137 attention bouts accompanied by speech. In addition, bilingual infants had 33 gesture-only bouts and 106 no input bouts. Monolingual infants had 25 gesture-only bouts and 62 no input bouts.

**Figure 2.2**

*Visualizations of different types of infant attention bouts*




For the analyses, we also examined parent behaviors independently of infants' attention. Using the same bout definition described above, we filtered parent behaviors into bouts. A parent behavior was defined as a period of successive frames (~ 33 ms per frame; 30 frames per second) during which a parent engaged in a behavior, with bouts separated by at least 200 ms (6 frames). Periods of successive frames separated by fewer than 6 frames were combined into a single bout (Kizildere et al., 2025). Across all parents, 6,360 parental behavior bouts were identified independently of infant attention, including 106 gesture-only bouts, 1,066 gesture-and-speech bouts, and 5,188 speech-only bouts.

## Statistical Analyses

Statistical analyses were conducted to examine the associations of parent language background, parental behavior, and parent language use with infant attention during the free-play interactions. All analyses were conducted in R (R Core Team, 2025). Linear mixed-effects models (LMMs) were fitted using the *lme4* package (Bates et al., 2015), with statistical tests of fixed effects obtained using the *lmerTest* package (Kuznetsova et al., 2017). Generalized linear mixed-effects models (GLMMs) were also fitted using the *lme4* package for Poisson or binomial distributions. Estimated marginal means and pairwise comparisons were obtained using the *emmeans* package (Lenth, 2025).

Infant attention bout duration and parental behavior bout duration were positively skewed and were log-transformed prior to analysis to reduce skewness and improve model fit. Categorical predictors were contrast coded prior to model estimation. For models using treatment coding, the reference categories were specified to facilitate interpretation of model coefficients. Significant interactions were followed up with pairwise comparisons of estimated marginal means using the Tukey method. Model assumptions were assessed using the *performance* package (Lüdecke et al., 2021) and *DHARMa* (Hartig, 2022) packages.

### *Descriptive language group comparison of infant attention*

We first examined bilingual and monolingual infants' overall attention during the free-play interaction. Independent-samples *t*-tests were used to compare the total number of infant attention bouts and attention bout duration between bilingual and monolingual infants. Additionally, we compared the number of attention bouts accompanied by English parental speech between bilingual and monolingual infants using an independent-samples *t*-test. Lastly, within the bilingual subsample, we conducted a paired-samples *t*-test to compare the number of infant attention bouts accompanied by Spanish versus English parental speech.

### *Frequency of parental behavior bouts across parent language background*

We examined the frequency of parental behavior bouts and whether it differed as a function of parent language background (monolingual vs. bilingual), independently of infant attention. A linear mixed-effects model (LMM) was fitted using the *lme4* package (Bates et al., 2015), and the significance of fixed-effects was evaluated using the *lmerTest* package (Kuznetsova et al., 2017). The frequency of parental behavior bout types was included as the outcome variable. Behavior bout type, parent language background, and their interaction were included as fixed effects. Participant was included as a random intercept to account for the repeated observations within each participant. The model was specified as:

*Frequency ~ Behavior Type x Parent Language Background + (1| Participant)*

The fixed-effects coefficients (β) in the model represent the estimated differences in parental behavior bout frequency associated with each predictor, relative to the reference categories. Bilingual parents and gesture-and-speech bouts were specified as the reference categories for parent language background and behavior bout type. Estimated marginal means and pairwise comparisons were obtained using the *emmeans* package (Lenth, 2025). Pairwise comparisons were adjusted using the Tukey method.

### *Duration of parent behavior bouts across parent language background and behavior type*

A linear mixed-effects model (LMM) was fitted to examine duration of parental behavior bouts independently of infant attention as a function of behavior bout type (speech-only, gesture-only, gesture-and-speech, and no input) and parent language background (monolingual vs. bilingual). Because bout duration was positively skewed, duration was log-transformed prior to analysis. Residual diagnostics were examined for both the untransformed and the log-transformed models. The residuals from the untransformed model showed substantial deviations from normality, whereas the log transformation substantially improved the normality of the residuals. Therefore, the log-transformed duration measure was retained for the analysis. Log-transformed bout duration was included as the outcome variable, with behavior bout type, parent language background, and their interaction included as fixed effects.

Participant was included as a random intercept to account for the repeated observations within each participant. The model was specified as:

*Log (Bout Duration) ~ Behavior Bout Type x Parent Language Background + (1| Participant)*

In the model, monolingual parents and gesture-and-speech bouts were specified as the reference categories. Estimated marginal means and pairwise comparisons were used to examine differences among parental behavior types. Back-transformed estimated marginal means were reported as geometric means, and differences between conditions were interpreted as relative rather than absolute differences in bout duration. Comparisons were adjusted using the Tukey method.

***Infant attention in relation to parental behavior and parent language background***

A linear mixed-effects model (LMM) was fitted to examine infant attention bout duration as a function of parental behavior and parent language background. Infant attention was measured as the duration of each infant attention bout. Infant bout duration was positively skewed; therefore, duration was log-transformed prior to analysis. Residual diagnostics were examined for both the untransformed and the log-transformed models. The residuals from the untransformed model showed substantial deviations from normality, whereas the log transformation substantially improved the normality of the residuals. Therefore, the log-transformed duration measure was retained for the analysis. Parental behavior type, parent language background, and their interaction were included as fixed effects. Infant age (centered) and biological sex were included as covariates to account for developmental and sex-related differences in attention duration. Participant was included as a random intercept to account for the repeated attention bouts within each infant. The model was specified as:

*Log (Infant Attention Duration) ~ Behavior Bout Type x Parent Language Background + Infant's Age + Biological Sex + (1 | Participant)*

In the model, bilingual parents and gesture-and-speech bouts were specified as the reference categories. Estimated marginal means were calculated using the *emmeans* package, and pairwise

comparisons were conducted using the Tukey-adjusted *p*-values to account for multiple comparisons. Back-transformed estimated marginal means were reported as geometric means, and differences between conditions were interpreted as relative rather than absolute differences in bout duration.

***Bilingual parents gesture-and-speech bouts across language use***

A generalized linear mixed-effects (GLMM) model with a binomial distribution and logit link was fitted to examine whether bilingual parents' behavior bout type (gesture-and-speech vs. speech-only bout) varied as a function of language use (Spanish vs. English), independently of infants' attention. Gesture-only bouts were not included because they did not contain speech, and therefore could not be classified by language. Parental behavior type was coded as a binary outcome and language use were the fixed-effects. Participant was included as a random intercept to account for repeated observations within participant. The model was specified as:

*Bilingual Parent Behavior Type ~ Parent Language + (1 | Participant)*

Spanish was specified as the reference category in the model. Because the model included a single two-level fixed effect, no post-hoc pairwise comparisons were required.

***Bilingual infant attention bouts across language use***

For the last analysis, we examined whether bilingual infants' attention bout duration differed as a function of parent language use and parental behavior type. Only attention bouts from bilingual infants were included in this analysis. A linear mixed-effects model (LMM) was fitted with log-transformed infant attention duration as the outcome variable. Residual diagnostics were examined for both the untransformed and the log-transformed models. The residuals from the untransformed model showed substantial deviations from normality, whereas the log transformation substantially improved the normality of the residuals. Therefore, the log-transformed duration measure was retained for the analysis.

Parent language use (Spanish vs. English) and parental behavior type (gesture-and-speech vs.

speech-only bouts) were included as fixed effects. Gesture-only and no input attention bouts were excluded because these bouts were not accompanied by parental speech, and therefore could not be classified by parent language use. Infant age (centered) and biological sex were included as covariates, and participant was included as a random intercept to account for repetitions within infants. The model was specified as:

*Log (Infant Attention Duration) ~ Parent Language Use x Parent Behavior Type + Infant Age + Biological Sex + (1 | Participant)*

Estimated marginal means were calculated to characterize infants' attention bout duration across language use and parental behavior type. Back-transformed estimated marginal means were reported as geometric means, and differences between conditions are interpreted as relative rather than absolute differences in bout duration. Pairwise comparisons were conducted to examine differences among conditions, with *p*-values adjusted using the Tukey method.

**Results**

***Descriptive language group comparison of infant attention***

We first compared bilingual and monolingual infants' attention bouts during free-play interactions. Independent-samples *t*-tests were conducted to compare the total number of infant attention bouts and infant attention bout duration across languages groups. Bilingual infants contributed 666 attention bouts, whereas monolingual infants contributed 697 attention bouts. There was no significant difference between bilingual and monolingual infants in the total number of attention bouts, $t(37.35) = -0.23$, $p = .800$. Similarly, infant attention bout duration did not differ significantly between bilingual ($M = 2.11$, $SD = 5.00$) and monolingual ($M = 2.79$, $SD = 11.05$) infants, $t(1354.90) = -0.63$, $p = .529$.

We next examined parental utterance production during infant attention bouts that were accompanied by speech. Across both groups, 2,219 utterances were produced during these attention bouts. Bilingual parents contributed 1,047 utterances, including 225 in English and 822 in Spanish; whereas

monolingual parents produced 1,172 English utterances. An independent-samples *t*-test indicated that the number of parental utterances produced during infant attention bouts did not differ significantly between monolingual and bilingual groups, $t(37.13) = -0.53$, $p = .600$. In addition, within the bilingual group, a paired-samples *t*-test examined differences in the number of English- versus Spanish-language utterances produced during infant attention bouts. Bilingual parents produced significantly more Spanish than English during bouts, $t(19) = -3.39$, $p = .003$.

Lastly, we examined whether bilingual and monolingual infants differed in the distribution of attention bouts across types of parental input. Infants' attention bouts were categorized based on the accompanying parental behavior: speech-only, gesture-only, gesture-and-speech, and no-input bouts. Independent-samples *t*-tests were conducted separately for each category to compare the proportion of infant attention bouts falling into each parental category across languages groups.

Monolingual infants had a significantly higher proportion of speech-only attention bouts compared to bilingual infants, $t(28.15) = -2.28$, $p = .03$. In contrast, the proportion of gesture-only attention bouts did not differ significantly between bilingual and monolingual infants, $t(17.17) = 1.52$, $p = .15$, nor did the proportion of gesture-and-speech attention bouts $t(18.24) = 1.72$, $p = .10$. Finally, the proportion of no input bouts did not differ significantly between bilingual and monolingual infants, $t(16.71) = 0.94$, $p = .36$.

***Frequency of parental behavior bouts across parent language background***

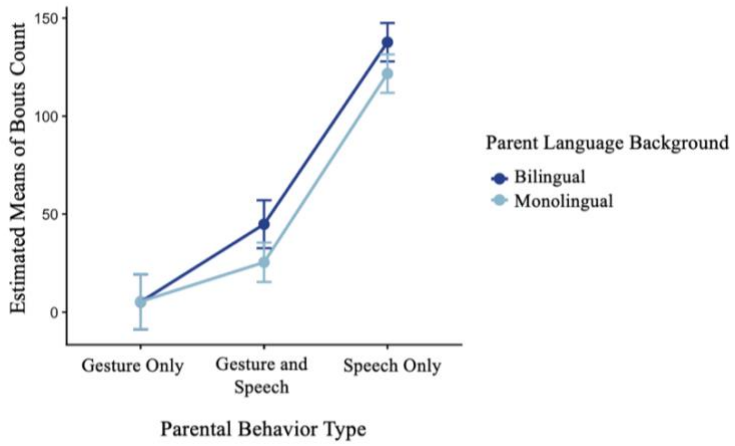
Across all parents, 6,360 parental behavior bouts were identified independently of infant attention, including 106 gesture-only bouts, 1,066 gesture-and-speech bouts, and 5,188 speech-only bouts. The frequency of parental behavior bouts differed significantly across the three behavior types. Tukey-adjusted pairwise comparisons demonstrated that speech-only bouts were produced more frequently than gesture-only bouts (estimate = 124.40, $SE = 12.10$, $t(66.7) = 10.27$, $p < .001$). Speech-only bouts were also produced significantly more frequently than gesture-and-speech bouts (estimate = 94.60, $SE = 10.50$,

$t(57.5) = 8.98$, $p < .001$). In contrast, gesture-only and gesture-and speech bouts did not differ significantly in frequency (estimate = 29.80, *SE* = 12.70, $t$ (61.3) = 2.36, $p = .056$). Thus, speech-only bouts were the most frequently produced behavior type, while gesture-only and gesture-and-speech bouts occurred at lower frequencies.

There was no significant main effect of parent language background, $F(1, 86) = 1.50$, $p = .224$. In addition, the interaction between behavior type and parent language background was not significant, $F(2, 86) = 0.33$, $p = .719$. Therefore, the pattern of bout frequencies across behavior types did not differ significantly between monolingual and bilingual parents. These findings suggest that although the frequency of parental behavior bouts varied across behavior types, the distribution of behaviors was similar across parent language groups. Figure 2.3 illustrates these findings.

**Figure 2.3**

*Estimated mean number of parental behavior bouts by behavior type and parent language background.*




***Duration of parent behavior bouts across parent language background and behavior type***

Next, we examined whether parental behavior bout duration differed as a function of behavior type and parent language background. A linear mixed-effects model predicting log-transformed bout duration revealed a significant main effect of behavior bout type. Relative to gesture-and-speech bouts,

gesture-only bouts had a significant lower geometric mean duration, $\beta = -1.38$, $SE = 0.08$, $t(6335.58) = -18.19$, $p < .001$. On the back-transformed scale, this corresponded to approximately 0.25 times the geometric mean duration of gesture-and-speech bouts, or approximately 75% lower. Speech-only bouts also had a significantly lower geometric mean duration relative to gesture-and-speech bouts, $\beta = -1.51$, $SE = 0.03$, $t(6132.19) = -55.08$, $p < .001$, corresponding to approximately 0.22 times the geometric mean duration of gesture-and-speech bouts, or approximately 78% lower.

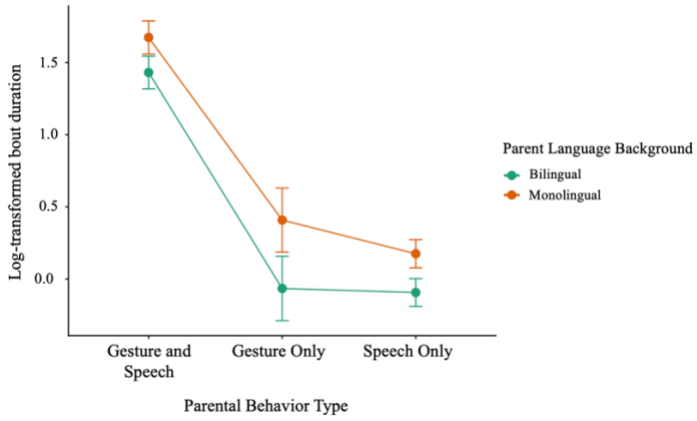
There was also a significant main effect of parent language background, $\beta = -0.12$, $SE = 0.04$, $t(62.48) = -2.95$, $p = .004$. Because monolingual parents served as the reference group, the negative coefficient indicates that bilingual parents produced shorter parental behavior bouts than monolingual parents. On the back-transformed scale, this effect corresponds to approximately 0.78 times the geometric mean duration, indicating that bilingual parents had approximately 22% greater geometric mean bout duration than monolingual parents.

Back-transformed estimated marginal means indicated that the estimated geometric mean duration for gesture-only bouts was 0.93 s for bilingual parents and 1.50 s for monolingual parents. For gesture-and-speech bouts, the geometric mean duration was 4.18 s for bilingual parents and 5.33 s for monolingual parents. For speech-only bouts, the geometric mean duration was 0.90 s for bilingual parents and 1.18 s for monolingual parents. These values should be interpreted as estimates of geometric mean duration rather than arithmetic means.

The interaction between behavior bout type and parent language background was not significant for gesture-only bouts relative to gesture-and-speech bouts, $\beta = -0.12$, $SE = 0.08$, $t(6335.58) = -1.52$, $p = .128$, or for speech-only bouts relative to gesture-and-speech bouts, $\beta = -0.01$, $SE = 0.03$, $t(6132.19) = -0.47$, $p = .638$. Although parent language background was associated with differences in bout duration, the pattern of bout duration across behavior types did not significantly differ between monolingual and bilingual parents (see Figure 2.4).

**Figure 2.4**

*Estimated marginal means of log-transformed parental bout duration by parental behavior type and language group.*




***Infant attention in relation to parental behavior and parent language background***

We examined whether infant attention bout duration differed as a function of parental behavior type and parent language background. The linear mixed-effects model revealed significant differences in infant attention bout duration across parental behavior types, as well as a significant interaction between parental behavior type and parent language background.

Relative to gesture-and-speech bouts, infant attention bouts were significantly shorter during gesture-only bouts, $\beta = -0.85$, $SE = 0.16$, $t(1310.57) = -5.43$, $p < .001$, no input bouts, $\beta = -0.59$, $SE = 0.12$, $t(815.41) = -5.04$, $p < .001$, and speech-only bouts, $\beta = -0.21$, $SE = 0.09$, $t(553.32) = -2.31$, $p = .021$. Gesture-and-speech bouts were associated with longer infant attention bouts than the other parental behavior types.

There was also a significant main effect of parent language background, $\beta = 0.29$, $SE = 0.12$, $t(44.74) = 2.37$, $p = .022$, with monolingual infants showing relatively longer attention durations than bilingual infants overall. However, this main effect was moderated by a significant interaction between

parent language background and parent behavior type, suggesting that the association between parent behavior type and infant attention duration differed between bilingual and monolingual dyads. The interaction between parent language background and no-input bouts were significant, $\beta$ = -0.54, *SE* = 0.17, $t(1994.06) = -3.13$, $p = .002$, as was the interaction between parent language background and speech-only behaviors, $\beta$ = - 0.26, *SE* = 0.12, $t(803.32) = -2.02$, $p = .028$. In contrast, the interaction between parent language background and gesture-only bouts was not significant, $\beta$ = - 0.30, *SE* = 0.24, $t(1338.03) = -1.25$, $p = .213$ (see Figure 2.5).

Back-transformed estimated marginal means indicated that bilingual infants had an estimated geometric mean attention duration of 2.74 s during gesture-and-speech bouts, 1.17 s during gesture-only bouts, 1.52 s during no-input bouts, and 2.22 s during speech only bouts. With monolingual infants, the corresponding estimated geometric mean attention were 3.67 s, 1.16 s, 1.18 s, and 2.29 s. These estimates represent geometric means obtained by back-transforming the model estimates from the log-transformed outcome.

Follow-up comparisons indicated that, with bilingual infants, gesture-and-speech bouts were associated with significantly longer attention than gesture-only bouts ($p <$. 001), and no input bouts ($p <$. 001), but did not differ significantly from speech only bouts ($p$ =.125). Speech-only bouts were also associated with significantly longer attention bouts than gesture-only bouts ($p < .001$) and no-input bouts ($p = .004$). Gesture only and no input bouts did not differ significantly ($p = .004$). Gesture-only and no-input bouts did not differ significantly ($p = .441$).

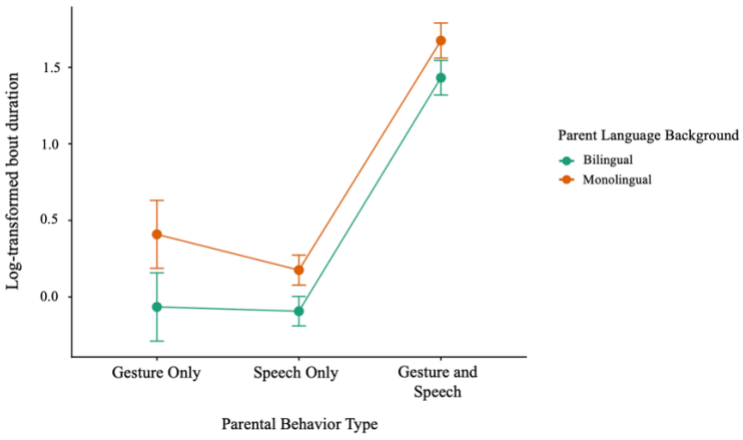
Among monolingual infants, gesture-and-speech bouts were associated with significantly longer attention bouts than gesture-only bouts ($p <$. 001), no-input bouts ($p < .001$), and speech-only bouts ($p <$. 001). In addition, speech-only bouts were also associated with longer attention bouts than gesture-only bouts ($p < .001$) and no input bouts ($p < .001$). Gesture-only and no-input bouts did not differ significantly ($p >$. 999).

Comparisons between language groups further showed that monolingual infants had significantly longer attention bouts than bilingual infants during gesture-and-speech bouts ($p$ = .023). The estimated geometric mean duration was 3.67 s for monolingual infants and 2.74 s for bilingual infants during gesture-and-speech bouts. In contrast, bilingual and monolingual infants did not differ significantly in attention duration during gesture-only bouts ($p$ = .979), no-input bouts ($p$ = .146), or speech-only bouts ($p$ = .779). Hence, although monolingual infants showed longer attention durations overall, the difference between language groups was evident specifically during gesture-and-speech bouts.

Lastly, neither infant age, $\beta = -0.02$, $SE = 0.02$, $t(22.26) = -0.99$, $p$ = .331, nor infant biological sex, $\beta = 0.07$, $SE = 0.10$, $t(20.98) = 0.68$, $p$ = .504 was significantly associated with infant attention bout duration. Overall, infant attention duration varied across parental behavior types, with gesture-and-speech bouts associated with the longest attention bouts across both parent language background groups. However, the magnitude of these differences varied by parent language background, as indicated by the significant interaction between parental behavior type and parent language background.

**Figure 2.5**

*Estimated marginal means of log-transformed infant attention duration by parental behavior type and parent language background*



***Bilingual parents gesture-and-speech bouts across language use***

In follow-up analyses, we examined whether bilingual parents' behavior types differed as a function of language use. The model revealed no significant effect of language use on the likelihood of producing gesture-and-speech rather than speech-only bouts, $\beta$ = - 0.17, $SE$ = 0.52, $z$ = - 0.32, $p$ = .747. Thus, bilingual parents were similarly likely to combine gestures with speech when speaking Spanish and English.

***Bilingual infant attention bouts across language use***

Lastly, we investigated whether Spanish-English bilingual infants' attention bout duration differed as a function of parents' language use and parental behavior type. Within the bilingual infant subsample, 666 infant attention bouts were identified, including 406 Spanish-language bouts, 121 English-language bouts, 106 no input bouts, and 33 gesture-only bouts. Gesture-only and no input bouts were excluded from the model because they did not contain parent speech, resulting in 527 language accompanied attention bouts included in the analysis.

The model revealed a significant main effect of parent language use, with infant attention duration being longer during Spanish-language bouts than English-language bouts, $\beta = -0.29$, $SE$ = 0.13, $t(286.11) = -2.29$, $p$ = .023. The main effect of parental behavior type was not significant, with attention duration during speech-only bouts being relatively shorter during gesture-and-speech bouts, $\beta = -0.17$, $SE$ = 0.09, $t(80.33) = -1.81$, $p$ = .074. The interaction between language use and behavior bout type was also not significant, $\beta = -0.10$, $SE$ = 0.18, $t(438.88) = -0.53$, $p$ = .597, indicating that the difference in infant attention duration between Spanish- and English-language bouts did not significantly differ as a function of parental behavior type. Infant age was not significantly associated with infant attention duration, $\beta$ = −0.02, $SE$ = 0.01, $t(13.98) = -1.40$, $p$ = .185.

Back-transformed estimated marginal means indicated that infant attention duration was longest during Spanish gesture-and-speech bouts (geometric mean = 3.03 s, 95% CI [2.61, 3.49]), follow by Spanish speech-only bouts (geometric mean = 2.56 s, 95% CI [2.22, 2.94]), English gesture-and-speech bouts (geometric mean = 2.27 s, 95% CI [1.81, 2.86]), and English speech-only bouts (geometric mean = 1.74 s, 95% CI [1.36, 2.23]). These values represent geometric mean durations obtained by back-transforming the model estimates from the log-transformed scale.

Furthermore, pairwise comparisons showed that Spanish gesture-and-speech bouts were associated with significantly longer infant attention durations than English speech-only bouts ($p$ = .001). Spanish speech-only bouts were also associated with significantly longer attention durations than English speech-only bouts ($p$ = .032). However, Spanish and English gesture-and-speech bouts did not differ significantly ($p$ =. 114), nor did Spanish gesture-and-speech and Spanish speech-only bouts ($p$ = .307). English gesture-and-speech and Spanish speech-only bouts also did not differ significantly ($p$ = .807), and English gesture-and-speech and English speech-only bouts did not differ significantly ($p$ = .373).

These findings indicate that bilingual infants' attention duration was associated with the language used by their parents during the interactions, with longer attention durations observed during Spanish-language input than English-language input. Nevertheless, the nonsignificant interaction indicates that there was no evidence that the association between parental language use and infant attention duration differed between gesture-and-speech and speech-only parental behaviors (see Figure 2.6).

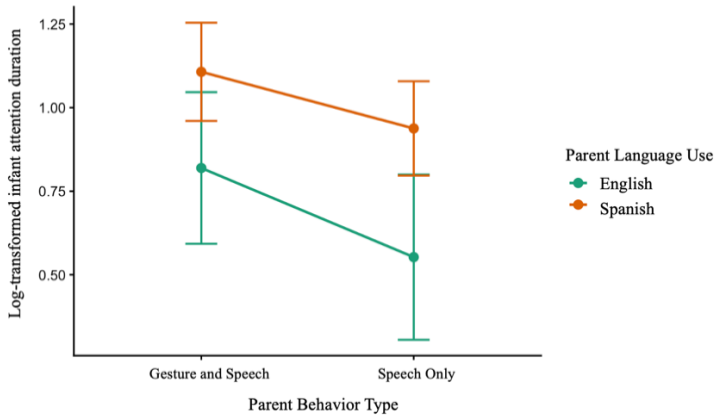
To explore possible explanations for the difference in attention during Spanish and English, we fit a linear mixed-effects model including language use (English vs Spanish), the proportion of Spanish exposure reported at home, and their interactions as fixed effects and participant as a random effect. Because infant attention duration was positively skewed, attention duration was log transformed prior to analysis. The model revealed no significant difference in log-transformed infant attention duration between Spanish and English bouts, $\beta = 0.19$, $SE = 0.32$, $t(252.44) = 0.60$, $p = .551$. The proportion of

language exposure reported at home was also not significantly associated with log-transformed infant attention duration for English bouts, $\beta = -0.005$, $SE = 0.005$, $t(91.11) = -1.06$, $p = .292$. In addition, the interaction between language use and home language exposure was not significant, $\beta = 0.003$, $SE = 0.005$, $t(343.87) = 0.59$, $p = .557$, suggesting that the association between home language exposure and infant attention duration did not significantly differ between Spanish and English bouts.

Estimated marginal means were back-transformed to the original scale of measurement, The estimated geometric mean attention duration was 1.90 s for English bouts (95% CI [1.59, 2.28]) and 2.78 s for Spanish bouts (95% CI [2.49, 3.11]). These estimates represent geometric mean attention durations.

**Figure 2.6**

*Estimated marginal means of log-transformed infant attention duration by parental behavior type and caregiver language.*




## General Discussion

The present study investigated Spanish-English bilingual and English speaking monolingual parents' gesture and speech behaviors during play interactions with their 8- to 20-month old infants and examined how these behaviors were associated with infants' attention. We first examined the frequency of parental behavior types as a function of parental language background. Across bilingual and monolingual

parents, speech-only behaviors occurred more frequently than gesture-only and gesture-and-speech behaviors. This pattern suggests that parents relied primarily on speech during play interactions. One possible explanation is that speech may be a common way for parents to label and describe objects during interactions with infants.

Furthermore, the overall pattern of parental behavior was similar across bilingual and monolingual parents. Bilingual parents produced comparable frequencies of speech-only, gesture-only, and gesture-and-speech behaviors to monolingual parents, despite differences in their language experiences and use. Parent language background was not associated with how frequently parents produced speech-only, gesture-only, and gesture-and-speech behaviors. These findings suggest that bilingual and monolingual parents may use similar patterns of multimodal behavior during play, even when their linguistic experiences and language use differ.

We next examined bilingual and monolingual infants' attention as a function of parental behavior type and parent language background. We predicted that Spanish-English bilingual and monolingual English-speaking infants would exhibit longer attention to objects during gesture-and-speech behaviors compared to speech-only or gesture-only behaviors. Prior research suggests that gesture-and-speech behaviors provide infants with cues that can support attention and learning (e.g., Suárez-Rivera et al., 2022; Schroer & Yu, 2022). The findings provided partial support for this prediction.

Infant attention duration differed across parental behavior types, with no input, gesture-only, and speech-only bouts being shorter in comparison to gesture-and-speech bouts. However, follow-up comparisons suggested that this pattern differ by parent language background. Among bilinguals infants, attention during gesture-and-speech bouts was longer than attention during gesture-only and no input bouts, but did not differ significantly from attention during speech-only bouts. Among monolingual infants, in comparison, attention during gesture-and-speech bouts was significantly longer than infant attention during gesture-only, no input, and speech-only bouts. Thus, although gesture-and-speech behaviors were associated with longer infant attention duration in comparison to the other parental

behavior types across both language groups, the predicted advantaged of gesture-and-speech over speech-only was evident only among monolingual infants.

This finding aligns with previous research demonstrating that multimodal parental behaviors are associated with infant attention during interactions in the United States (Chen et al., 2021; Suárez-Rivera et al., 2022; Schroer & Yu, 2022). Coordinating gesture with speech may make objects more salient by providing infants with multiple channels of information. However, the extent to which multimodal input is associated with infant attention may depend based on the linguistic context in which the interaction occurs. In bilingual environments, infants may encounter greater variability in the linguistic forms caregivers use to refer to objects and actions. This variability may influence how infants process and respond to speech during interactions, potentially reducing the difference in attention between speech-only and gesture-and-speech behaviors.

The present findings extend previous work by highlighting that the association between gesture-and-speech behaviors and infant attention may differ across linguistic environments. Follow-up comparisons indicated that monolingual infants had longer attention bouts than bilingual infants during gesture-and-speech bouts; while the language groups did not differ significantly during gesture-only, no input, or speech-only bouts. Therefore, differences between bilingual and monolingual infants were most apparent when parents coordinated gesture with speech. These findings emphasize the importance of considering the language context in which multimodal parent-infant interactions occur when examining infant attention.

Most research examining caregivers' gesture and speech behaviors have treated speech as a binary variable (i.e., present vs. absent) rather than considering the specific language in which parents communicate (Chen et al., 2021; Schroer & Yu, 2022; Suárez-Rivera et al., 2022). Consequently, relatively little is known about how bilingual parents' language use is associated with their behaviors during interactions with infants. This question is particularly important because bilingual caregivers may use more than one language during everyday interactions, creating opportunities to examine whether

infants' attention varies depending on the language used by their caregivers. Prior work has shown that bilingual caregivers adapt characteristics of infant-directed speech across languages (Ramirez Barajas et al., 2025), suggesting that language choice may influence not only acoustic properties of speech but also how parents coordinate speech with gestures during interactions.

We tested whether parents use gestures differently with English versus Spanish during interactions with infants. Bilingual parents produced more Spanish than English bouts independently of infant attention. This pattern was consistent with parents' self-reported language use, as parents reported speaking Spanish to their infants more frequently than English. However, the likelihood of producing gesture-and-speech rather than speech-only behaviors did not differ between Spanish- and English-language interactions. Therefore, although bilingual parents differed in the amount of speech they produced across languages, their likelihood of coordinating gesture with speech did not vary according to the language being used. These findings suggest that bilingual parents' language use was associated with the amount of speech produced during the interaction but was not associated with whether parents combined gesture with speech. Instead, parents' coordination of gesture and speech appears relatively consistent across Spanish- and English-language interactions.

Furthermore, we examined Spanish-English bilingual infants' attention during gesture-and-speech and speech-only behaviors as a function of the language used by the parent. Overall, infant attention duration was longer during Spanish-language bouts than English-language bouts. The interaction between parent language use and behavior type was not significant, indicating that the association between parental language use and infant attention duration did not differ between gesture-and-speech and speech-only behaviors. Follow-up comparisons indicated that Spanish gesture-and-speech bouts were associated with longer infant attention duration than English speech-only bouts, and Spanish speech-only bouts were also associated with longer attention duration than English speech-only bouts. However, Spanish and English gesture-and-speech bouts did not differ significantly. These findings provide evidence for an

overall association between parental language use and infant attention, but not evidence that this association differed depending on whether parents used speech alone or coordinated speech with gesture.

These findings extend previous research demonstrating that gesture and speech are associated with infants' attention (Chen et al., 2021; Schroer & Yu, 2022; Suárez-Rivera et al., 2022) by showing that, within bilingual interactions, the language used by parents may also be associated with infants' moment-to-moment attention. This finding is particular important because existing research has examined caregiver speech as present or absent, without considering the specific language used by bilingual parents. By examining language use directly, the present study identifies language context as an additional feature of bilingual parent-infant interactions that may relate to infants' attention. Although bilingual infants showed longer estimated attention durations during Spanish-language bouts than English-language bouts overall, the nonsignificant interaction between language use and behavior bout type indicates that this association did not depend on whether parents used gesture-and-speech or speech-only behaviors.

In addition, variation in the proportion of Spanish exposure reported at home did not explain differences in infant attention duration. The proportion of Spanish exposure at home was not significantly associated with infant attention duration, suggesting that the observed association between parents' language use and infant attention may reflect features of the immediate interaction rather than broader differences in infants' everyday language exposure. This distinction is important because infants' reported language exposure at home and the language use during a particular interaction represent different aspects of their linguistic experiences.

Previous research has emphasized the salience of coordinated gesture and speech behaviors for engaging infants (e.g., Suárez-Rivera et al., 2022; Yu & Smith, 2016). The present findings build on this work by suggesting that the linguistic context in which these multimodal behaviors occur may also be relevant to infant attention. In bilingual contexts, the specific language used by the parents may contribute to the attentional context in which infants experience and interpret social interactions. Thus, parent

language background should not be viewed solely as a demographic characteristic; it also reflects differences in the linguistic environments in which parent-infant interactions unfold.

Notably, the longer attention durations observed during Spanish-language bouts among bilingual infants may reflect the sociolinguistic context in which these interactions occurred. In Northern California, both English and Spanish widely use in many communities, and bilingual infants may therefore encounter Spanish regulatory language utterances in their everyday interactions. Repeated exposure to Spanish may contribute to infants' familiarity with the language, contributing to infants having greater attention episodes when parents use Spanish during play. This interpretation is consistent with previous research showing that bilingual infants' preferences can be shaped by their language experience (Byers-Heinlein & Werker, 2009). Future research should examine how infants' language experience, familiarity with each language, and caregivers' language choices contribute to infants' attention during bilingual interactions.

**Limitations**

Several limitations of the current study should be considered when interpreting these findings and provide directions for future research. First, the present study was not designed to assess infant attention using head-mounted eye-tracking technology. Recent research has examined infants' attention in relation to parents' multimodal cues using head-mounted eye tracking devices (Chen et al., 2020; Chen et al., 2021) and has demonstrated that parental behaviors can influence infants' visual attention. In the current study, infant attention was measured using head orientation, an observational measure that has been widely used in developmental research to assess infants' attention with objects and in social settings (Bakeman & Adamson, 1984; Bornstein & Tamis-LeMonda, 1990). Although head orientation provides a reliable measure of infants' attention at a broader level, future research using more precise measures of visual attention, such as eye-tracking, may provide additional insight into how infants allocate attention to specific objects, gestures, and cues.

Second, although infant age was included as a predictor in the analyses and was not significantly associated with attention duration, the current sample may have been limited to detect developmental changes across the 8-to-20-month age range. Previous research examining caregiver multimodal cues has identified age-related differences in infant attention within overlapping developmental periods (Suárez-Rivera et al., 2022). Future studies with longitudinal samples may provide how infants' sensitivity to parents' speech and gesture changes across development. In addition, examining caregiver age and infant age together may provide insight into whether caregivers' verbal and nonverbal behaviors vary with infants' developmental stage.

Finally, bilingual and monolingual groups differed in their sociocultural backgrounds, including their racial and ethnic composition. All bilingual participants identified as Hispanic, with many reporting Mexican heritage, whereas most monolingual participants identified as White and not Hispanic. Therefore, differences between bilingual and monolingual groups cannot be attributed solely to differences in language background and may also reflect broader differences in cultural, social, or experimental contexts. This limitation is important when interpreting the differences observed between groups in relation between parental behavior and infant attention. Future research should include comparison groups that more closely match

**Conclusion**

In conclusion, the present study examined Spanish-English bilingual and English-speaking monolingual parents' speech and gesture behaviors during play interactions with their 8- to 20- month old infants and how these behaviors were associated with infant attention. Across both language groups, speech-only behaviors occurred more frequently than gesture-and-speech and gesture-only behaviors. Infant attention duration varied as a function of parental behavior type, and this pattern differed between bilingual and monolingual infants. Among monolingual infants, attention duration was longer during gesture-and-speech bouts in comparison to speech-only bouts. In contrast, among bilingual infants, attention duration during gesture-and-speech and speech-only bouts did not differ significantly. These

findings highlight the relation between parents' multimodal behaviors and infant attention and suggest that this relation may vary across linguistic environments.

When examining bilingual dyads, parents produced more Spanish- than English-language bouts, consistent with their reported greater use of Spanish with their infants. However, the likelihood of producing gesture-and-speech rather than speech-only behaviors did not differ between Spanish- and English-language interactions. Bilingual infants also showed longer attention durations during Spanish-language bouts than during English-language bouts overall. Nevertheless, the interaction between parent language use and parental behavior type was not significant, indicating that the association between parental language use and infant attention did not differ between gesture-and-speech and speech-only behaviors. These findings highlight the importance of examining both the behaviors parents use and the language in which parents communicate with their infants in relation to infant attention. More broadly, the findings suggest that the relation between parental speech and gestures and infant attention may depend on the linguistic context in which these behaviors are produced, while also emphasizing that the specific language used by bilingual parents may be associated with infants' moment-to-moment attention.

# CHAPTER 3

# STUDY 2: EXAMINING UTTERANCE FUNCTIONS AMONG MEXICAN AMERICAN MOTHER-INFANT DYADS IN RELATION TO MATERNAL ACCULTURATION

Decades of research on parent-child interactions have demonstrated that early social interactions are foundational to infants' cognitive, social, and language development (Ainsworth et al., 1978; Baumrind, 1966; Bowlby, 1969, 1982; Bornstein, 2002; Hoff, 2006; Tamis-LeMonda et al., 2001; Tomasello, 2003). During these interactions, caregivers provide infants with rich linguistic input that not only supports language learning and conveys information about objects, actions, and social interactions. The functions of caregivers' infant-directed speech, such as directing infants' attention (Fernald, 1992), labeling objects (Goldfield, 2000), and guiding behavior (Hoff-Ginsberg, 1991), illustrate ways in which parents support early communication and learning. Examining variation in infant-directed utterances can therefore provide insight into how caregiver' cultural and linguistic experiences are associated with differences in early language environments.

Among Latine families in the United States, children of Mexican heritage represent the largest subgroup (Chen & Guzman, 2021). Mexican American mothers often navigate both Mexican and U.S. cultural contexts, and these bicultural experiences may influence their parenting beliefs and communicative practices (Berry & Sam, 1997; Krogstad & Noe-Bustamante, 2021). In the present study, we examined the functions of infant-directed utterances produced by Mexican American mothers from Northern California during play interactions with their infants. Specifically, we investigated whether mothers' acculturation and language use (i.e., Spanish, English, and Language Mixing) were associated with differences in the functions of their utterances.

Infant-directed speech (IDS) is characterized by distinctive acoustic, lexical, and pragmatic features that support early communication (Saint-Georges et al., 2013; Soderstrom, 2007). One proposed function of IDS is to capture and maintain infants' attention to speech (Liu et al., 2003; Nencheva & Lew-

Williams, 2022; Räsänen et al., 2018), thereby promoting social engagement and attention to people and speech. Caregiver speech also supports infants' emerging language and cognitive development by providing input that is responsive to their developing communication abilities (Hoff, 2006; Rowe, 2012). Cross-linguistic research demonstrates that, although the specific characteristics of IDS differ across languages, caregivers across cultural contexts modify their speech in ways that support infants' attention and language learning (e.g., Broesch & Bryant, 2015; Fernald et al., 1989; Kitamura et al., 2001). For example, Ramirez Barajas et al. (2025) found that Spanish-English bilingual parents adjusted their pitch in both languages during IDS but produced greater pitch elevations in English than in Spanish (see also Kalashnikova & Naranjo, 2022). Together, these findings suggest that caregivers flexibly adapt their speech across linguistic contexts, including when communicating with children at different developmental levels and when using different languages.

Beyond the acoustic properties of IDS, examining the functions of caregivers' utterances provides insight into how caregivers may guide infants' attention, behavior, and learning. Tamis-LeMonda et al. (2012) investigated Dominican, Mexican, and African American mother-infant dyads and found that mothers across the cultural groups were highly responsive to infants' vocalizations, although their linguistic styles differed. African American mothers used more referential language, whereas Dominican and Mexican mothers used more regulatory language. Referential language involves labeling and describing objects and the environment (e.g., *That's a ball*), whereas regulatory language is used to guide children's behavior or actions (e.g., *Come here, don't touch that*). Similarly, Kuchirko et al. (2020) examined the functional organization of Mexican, Dominican, and African American mothers' speech to infants and found that mothers' use of referential, regulatory, and vocalization-promoting language varied across sociocultural contexts, including maternal ethnicity, education, and years in the United States. For example, Mexican and Dominican mothers used more regulatory language, particularly attention directives, than African American mothers. In addition, African American mothers used more vocalization prompts than Latine mothers. These findings suggest that mothers' use of different utterance functions

may reflect how caregivers structure infants' learning experiences and guide their participation in social interactions.

Among regulatory utterances, directives represent an important category because they can be used to guide infants' attention and actions. Directives are defined as attempts to influence or control children's behavior and attention (Akhtar et al., 1991; Mahoney & Neville-Smith, 1996). The association between maternal directive use and children's language development remains unclear, with research demonstrating negative (Tomasello & Farrar, 1986), positive (Akhtar et al., 1991; Barnes et al., 1983), and null associations (Hoff & Naigles, 2002; Tomasello & Todd, 1983) between directive use and children's language outcomes. One explanation for these mixed findings is that directives may differ in their function and interactional context. For example, intrusive directives may restrict children's exploration and opportunities for language learning, whereas supportive directives may scaffold children's attention toward relevant aspects of the environment and facilitate learning (Akhtar et al., 1991; Bruner, 1975; Hoff, 2006; Tomasello, 2003; Yu & Smith, 2012). Thus, the relation between directive use and children's development may depend on how and when directives are used within the interaction.

Prior research examining cultural variation in caregivers' use of directives has shown that regulatory language varies across cultural communities and serves important functions in organizing and guiding infants' attention (Bornstein et al., 2015; Kuchirko et al., 2020; Tamis-LeMonda et al., 2012). For example, Mexican and Dominican American mothers have been found to produce more regulatory language than African American mothers. Mexican mothers have also been found to produce more prohibitions than Dominican and American mothers when interacting with 24-month-old infants (Kuchirko et al., 2020). Rather than functioning solely to control children's behavior, regulatory utterances in these studies often included attention and action directives that guide infants' attention to objects and ongoing activities, highlighting their role in supporting joint attention and learning (Yu & Smith, 2012; Masek et al., 2021).

Prior work has similarly found that Mexican and Latine parents frequently use directives during parent-child interactions (Tamis-LeMonda et al., 2012; Peredo et al., 2020). Peredo et al. (2020) found that Spanish-speaking Latine parents produced more directives than non-Latine English-speaking parents. Similarly, Domenech Rodríguez et al. (2009) characterized first-generation Latine parents as "protective parents" who used more behavior-regulating directives while maintaining high levels of warmth and responsiveness. These findings suggest that directive use may reflect culturally shaped parenting goals rather than a lack of sensitivity. Indeed, cultural values and beliefs are socialized across generations in Mexican American families (Knight et al., 2011), and mothers may adapt their interactions with children in ways that align with these values (Hernández & Bámaca-Colbert, 2016). However, less is known about how Mexican American mothers use directives across languages or how cultural factors may be associated with the types of regulatory utterances they use.

Acculturation refers to the process through which individuals modifying their beliefs, behaviors, and values through interactions with people from different cultural backgrounds (Berry & Sam, 1997; Cabrera et al., 2006). Within the framework used in the present study, lower acculturation scores reflect a stronger orientation toward the heritage culture, whereas higher scores reflect greater orientation toward the dominant U.S. cultural context (Cuellar et al., 1995). Prior research suggests that acculturation is associated with differences in how parents interact with and respond to their children. For example, lower levels of acculturation have been associated with more authoritarian parenting practices among Asian American and Latine parents. Authoritarian parenting is characterized by a greater emphasis on obedience, parental authority, and behavioral control and these practices may reflect stronger adherence to traditional cultural values (Calzada et al., 2012; Chun & Akutsu, 2003). Acculturation may be associated with differences in parenting practices and, potentially, in how caregivers use language to guide and respond to their children during interactions.

Research examining Mexican American and other Latine families further demonstrates that acculturation is associated with differences in how parents engage with their children during interactions.

Calzada et al. (2012) found that acculturation was associated with mothers' cultural socialization practices, which were in turn related to parenting styles. Differences in parenting behaviors may have implications for children's social and behavioral development. For example, Ispa et al. (2004) found that maternal intrusiveness predicted an increase in children's negativity across ethnic groups and was associated with lower child engagement among more acculturated Mexican American families. Parke et al. (2004) similarly found that greater maternal acculturation was associated with lower levels of hostile parenting, although associations between acculturation and parenting behaviors differed across ethnic groups. More broadly, Fuller and Garcia Coll (2010) argued that variation in Latine children's developmental contexts and family practices reflects differences in culturally shaped developmental niches.

Although this literature demonstrates that acculturation is associated with variation in parenting beliefs and behaviors, less is known about whether acculturation is also associated with how parents use language during interactions with their children. Examining utterance functions may provide a more fine-grained understanding of how cultural experiences are reflected in mothers' moment-to-moment interactions with their infants. This may be important for Mexican American mothers, whose language use and utterance functions may reflect both the linguistic context of the interaction and their broader cultural experience.

**Current Study**

An emerging literature on Mexican American mother-child interactions has highlighted the role of cultural experiences in shaping parenting and parent-child interactions (Ispa et al., 2004; Livas-Dlott et al., 2010; Tamis-LeMonda et al., 2020). However, less is known about whether acculturation is associated with the functions of mothers' speech when communicating with infants. The present study examined whether mothers' acculturation levels were associated with the functions of their utterances. Research with Mexican American families has shown that parents' levels of acculturation are associated with how

they interact with their infants, with potential implications for children's behavioral outcomes (Ispa et al., 2004). Prior work suggests that mothers with lower levels of acculturation may more strongly endorse heritage-based cultural beliefs than more acculturated mothers (Cabrera et al., 2006), which may be associated with culturally specific interaction patterns. Recent research has shown that among Latine families, mothers who more strongly endorse their cultural values such as *respeto,* which emphasizes children's respect and obedience toward parents and other authority figures, tend to engage in more directive parenting with their toddlers (Kuhns & Cabrera, 2020). Mexican mothers have also been found to use more regulatory (i.e., directive) than referential (i.e., descriptive) language when interacting with their infants (Tamis-LeMonda et al., 2012). These findings suggest that cultural experiences and values may be associated with how mothers use language to guide and engage their children during interactions.

In addition to cultural experiences, bilingual mothers' language use may provide another context in which utterance functions vary, Research on bilingual infant-directed speech indicated that Spanish-English bilingual parents differentiate IDS from adult-directed speech to a great extend in English than in Spanish, as reflected in pitch variation (Ramirez Barajas et al., 2025). This finding suggests that bilingual parents systematically modulate linguistic features across communicative contexts and languages, raining the possibility that they may also vary their use of utterance functions across languages they use with their infants. Examining the functions of bilingual mothers' utterances may therefore provide insight into how language and cultural experiences are reflected in their moment-to-moment interactions with infants.

To better understand how bilingual mothers structure their interactions with infants, the present study examined two broad utterance functions: regulatory utterances, which includes directives that guide infants' attention or behavior, and referential utterances, which include labels and descriptions of objects and events. Prior research has demonstrated that Mexican American and other Latine mothers frequently use regulatory language during interactions with their infants (Kuchirko et al., 2020; Tamis-LeMonda et al., 2012). However, little is known about how bilingual mothers distribute these utterance functions across the languages they use with their infants or whether these patterns vary with acculturation. We

predicted that mothers' language use and utterance functions would vary systematically across language and acculturation level. First, we predicted that language use would differ as a function of utterance function. Specifically, regulatory utterances were expected to be more likely to occur in Spanish and Language Mixing than in English, whereas referential utterances were expected to be relatively more likely to occur in English.

This prediction is consistent with cultural models of language socialization, which suggest that caregivers' language use may reflect culturally shaped socialization goals (Kuchirko et al., 2020; Tamis-LeMonda et al., 2012). Because Spanish may be an important context for maintaining heritage-cultural practices, mothers may be more likely to use Spanish or combine Spanish and English when guiding infants' attention and behavior. In contrast, referential utterances, such as labeling and describing objects, may occur relatively more often in English, consistent with the broader sociolinguistic context in which English is the dominant language in the United States. Thus, English may be more relatively more common for referential utterances, whereas Spanish and Language Mixing may be relatively more common for regulatory utterances.

Second, we predicted that mothers' acculturation levels would be associated with differences in the distribution of utterance functions. Specifically, lower maternal acculturation scored were expected to be associated with a greater likelihood of regulatory relative to referential utterances, whereas higher acculturation scored were expected to be associated with a greater likelihood of referential relative to regulatory utterances. This prediction was based on prior research demonstrating that acculturation is associated with variation in parenting beliefs and interactions among Mexican American and other Latine families (Calzada et al., 2012; Ispa et al., 2004). Mothers with lower acculturation scores may place greater emphasis on interactional practices that involve parental guidance and behavioral regulation, which may be reflected in greater use of regulatory utterances that direct infants' attention and actions. In contrast, higher levels of acculturation have been associated with parenting approaches that emphasize cognitive stimulation (Baker, 2018), which may be reflected in greater use of referential utterances that

label, describe, and provide information about objects and events (Kuchirko et al., 2020; Tamis-LeMonda et al., 2012).

The present study also examined the specific types of regulatory utterances mothers produced, focusing on behavioral and attentional directives in relation to mothers' language use. We predicted that mothers would produce more attentional directives than behavioral directives overall, reflecting the importance of directing infants' attention during interactions. Attentional directives represent a type of regulatory directive used to direct infants' attention towards people, objects, and ongoing activities (Kuchirko et al., 2020; Tamis-LeMonda et al., 2012). Distinguishing between types of directives is important because caregivers frequently organize infants' attention to objects and activities through the use of language and other cues (Kuchirko et al., 2020).

We further predicted that attentional directives would occur more frequently in Spanish and Language Mixing than in English. This prediction was based on prior research showing that the use of regulatory language varies across sociocultural contexts (Tamis-LeMonda et al., 2020). In Mexican immigrant families, for example, cultural values such as *respeto,* which emphasizes appropriate behavior and interpersonal respect, have been associated with mothers' language use and discourse during mother-infant interactions (Tamis-LeMonda et al., 2020). In addition, mothers' language functions vary across everyday activities and routines, suggesting that the function of an utterance may be closely related to the interactional context in which it occurs (Tamis-LeMonda et al., 2019). These findings suggest that mothers' use of attentional directives may vary across languages and interactional contexts.

To address these topics, Mexican American mothers and their infants participated in an at-home free-play interaction. Mothers also completed questionnaires assessing their acculturation. Mothers' speech during the play session was transcribed and coded for referential and regulatory utterances toward their infants. Regulatory utterances were further classified as attentional or behavioral directives. Maternal acculturation was examined using both continuous acculturation scores and generation status.

## Method

### Participants

Participants were recruited from the California Babies Project, a longitudinal study of Mexican American families in the greater Sacramento, California area (California Families Project, n.d.). For the present study, mothers were eligible if they identified as Mexican or Mexican American and had an infant of the same ethnic background. The final sample included 49 mothers who participated with their 18-month-old infants. Mothers ranged in age from 20 to 42 years ($M$ = 26.75, $SD$ = 5.57), and infants ranged in age from 16 to 22 months ($M$ = 18.66, $SD$ = 1.64). All mothers were bilingual in English and Spanish. Mothers were interviewed in their primary language, with 51% ($n$ = 25) interviewed in Spanish and 49% ($n$ = 24) interviewed in English.

Family income ranged from less than $5,000 to $95,000, with a modal income was $40,000–$45,000. All mothers identified as Hispanic/Latine, and mothers varied in generation status. Of the 49 mothers, 21 had completed a high school diploma or GED, 8 had completed some college education but had not obtained a degree, 6 had completed a bachelor's degree (BA), 5 had completed grades 9–11, 4 had completed a technical school program, 3 had completed an associate degree (AA/AS), 1 had completed grades 1–8, and 1 had completed a graduate or professional degree.

### Procedure

Data for the present study were collected as part of the larger California Babies Project, directed by Dr. Leah Hibel. Additional information about the project is available at https://hibellab.weebly.com/the-california-babies-project.html (see also Hernandez et al., 2026). Mothers and infants were invited to participate in the longitudinal study following confirmation of eligibility. During approximately 2-hour home visits, mothers completed interviews and assessments in their preferred language (Spanish or English). Interviewers were native Spanish-English bilingual speakers, many of whom shared a Mexican American cultural background with participating families.

As part of the home visit, mothers and infants completed a 15-minute free-play interaction followed by a 5-minute clean-up task. For the present study, analyses focused exclusively on the 15-minute free-play period. These interactions were audio- and video-recorded for subsequent coding. During the free-play task, mothers were provided with toys and instructed to play with their infants as they normally would. Mothers received $100 in compensation for their participation.

**Acculturation**

Maternal acculturation was assessed using the Brief Acculturation Scale for Mexican Americans-II (ARSMA-II-Brief; Cuellar et al., 1995). The shortened version of the full Acculturation Scale for Mexican Americans-II (ARSMA-II) consists of 12 items: six items assessing Mexican cultural orientation (MOS) and six items assessing Anglo-American cultural orientation (AOS). Items were rated on a 5-point Likert scale ranging from 1 (*Not at all*) to 5 (*Almost always)*. Maternal acculturation scores were calculated by averaging responses across items within each subscale to obtain mean MOS and AOS scores. A directional acculturation score was then calculated by subtracting the mean MOS score from the mean AOS score (AOS − MOS), with higher scores indicating greater orientation toward Anglo-American culture relative to Mexican culture.

Based on the brief ARSMA-II scoring guidelines, acculturation scores can be categorized into five levels: Level 1, Very Mexican Oriented ($< -1.33$); Level 2, Mexican Oriented to Balanced Bicultural ($\geq -1.33$ to $\leq -0.07$); Level 3, Slightly Anglo Oriented Bicultural ($> -0.07$ to $< 1.19$); Level 4, Strongly Anglo Oriented ($\geq 1.19$ to $< 2.45$); and Level 5, Very Assimilated ($> 2.45$). Based on these classification guidelines, five mothers were categorized as Very Mexican Oriented, 19 as Mexican Oriented to Balanced Bicultural, 17 as Slightly Anglo-Oriented Bicultural, five as Strongly Anglo Oriented, and three as Very Assimilated. Mothers' acculturation scores averaged $M = -0.096$ ($SD = 1.38$), with scores ranging from −3.33 to 3.33.

The questionnaire also included items assessing mothers' generation status, with categories ranging from first generation (mother born in Mexico) to fifth generation (mother born in the United States, with great-great-grandparents born in Mexico). Specifically, first-generation mothers were born in Mexico; second-generation mothers were born in the United States and had parents who were born in Mexico; third-generation mothers were born in the United States and had parents born in the United States and grandparents born in Mexico; fourth-generation mothers were born in the United States and had parents and grandparents born in the United States and great-grandparents born in Mexico; and fifth-generation mothers were born in the United States and had parents, grandparents, and great-grandparents born in the United States and great-great-grandparents born in Mexico. Twenty-three mothers were classified as first generation Mexican American, 21 mothers as second generation, four mothers as third generation, and one mother as fourth generation.

**Stimuli**

Stimuli consisted of three sets of toy objects used during the free-play session: a car race set (i.e., cars, and a racetrack), a tea set (i.e., spoons, cups, and a sugar bowl), and a set of building blocks with labels, along with a short book. All three toy sets and the book were included in the play session.

**Data Preparation**

Audio recordings were first transcribed using Amazon Web Services (AWS) Transcribe, an automated speech recognition program for English and Spanish speech. An R script (Cohn, 2025) subsequently converted the AWS output into Praat (Boersma & Weenink, 2023) TextGrid files. Native Spanish–English bilingual research assistants reviewed and corrected the TextGrids using Praat. Utterances containing both Spanish and English, which AWS often failed to transcribe accurately, were corrected by research assistants.

Utterances were coded following the utterance coding scheme developed by Suárez-Rivera et al. (2019). No minimum utterance duration was required. Speech separated by less than 400 ms of silence

was coded as a single utterance, whereas a pause of at least 400 ms marked the beginning of a new utterance (Yu et al., 2016; Pereira et al., 2014; Yu & Smith, 2012). Utterances were also categorized by language as Spanish, English, or Language Mixing. Language mixing utterances were further classified as intra-sentential and inter-sentential. Intra-sentential language mixing occurred when an utterance consisted primarily of one language but included one or a few words from the other language (e.g., *Mira the red truck*). Inter-sentential language mixing occurred when the speaker alternated languages across consecutive sentences (e.g., *You like the red truck! Esta te gusta a ti.*).

After all transcripts were corrected, native Spanish–English bilingual coders categorized each utterance as either regulatory or referential. Table 3.1 presents the function categories and examples. The categories of referential and regulatory utterances were adapted from Flynn and Masur (2007) and Tamis-LeMonda et al. (2001). Referential utterances provided information about objects, actions, or events, and included descriptions that provided additional information about or elaborate on the characteristics of an object, action, or event (e.g., *The baby is crying*). Regulatory utterances were used to control and guide infants' attention and behavior and included attentional and behavioral directives. Attentional directives oriented infants toward objects and events (e.g., *Look! Mira!*), whereas behavioral directives guided infants' actions (e.g., *Put it down! Put it here!*). Coders also identified other utterance types (i.e., questions, praise, and responses) that were not directly relevant to the current research questions. Therefore, these utterance types were excluded from the present analyses.

To establish coding reliability, each session was coded by two coders: a first coder (an experienced coder who trained other research assistants) and a second coder (the first author). Across all sessions, average percent agreement between the first and second coders was 90% (range = 85%–94%).

**Table 3.1**

*Utterance function categorization (Regulatory and referential utterances)*

| **Utterance Type** | **Broad level category** | **Basic level Utterance category** | **Definition** | **Examples** |
|---|---|---|---|---|
| Regulatory | Directive | | Instructions given to child about behavior | All of the examples in the examples below are subtypes of directives |
| | | Attentional Directives | Attract, direct, or direct the child's attention | "Look, see the bunny"<br>"Look what I have"<br>Infant name or nickname (Mami, Papi, Princess) |
| | | | When the caregiver directs the attention of the child towards an item the child is not already attending to. | "Look at the baby dog" (When the child is looking at something else) (requires audio & video) |
| | | Behavioral/Action Directives | Direct behavior by commanding requesting, suggesting, or encouraging the child to do or to stop doing something. | "Give me the ball"<br>"Let's play with the duck"<br>"Sit down now"<br>"Can you please sit down"<br>"Close the door [please]"<br>"Could you not grab that [please]"<br>"I'm going to take the toy away if you keep doing that"<br>"I want the toy now"<br>Can you clap?<br>Can you show me?<br>Give that one to me, okay? |
| | | | Requesting or suggesting specific actions from a child while they handle or attend to a specific object. Parent is supporting more play or more elaborate | "You can put baby bear to sleep"<br>(requires audio & video) |

| | | | | |
|---|---|---|---|---|
| | | | play or attention to the item, not trying to chance the child's direction. | |
| | | | When the caregiver directs the behavior of the child towards another object, something the child wasn't attending to or interacting with. | "Take this baby doll" (When the child is holding something else) (requires audio & video) |
| Referential | Label | General label | Utterances used to label objects, action, or event | "This is a cup" "That's called a dog" |
| | | Label with description | Utterances that label an object, action, or event and include descriptive or elaborative information. | "This car is blue" "That is a big red boat" "That is a fast horse" |
| Referential | Descriptions | General object, action, event Descriptions | Utterances that describe or elaborate on aspects of an object, action, or event. Some instances will include the name of a target item, but the focus is on description or elaboration. | |
| | | | Utterances that describe or elaborate on aspects of an object. | "It's round" "That's a big one" |
| | | | Utterances that describe or elaborate an action or event. | "You are squeezing the duck to make it go quack!" |
| | | Emotion, state, mental state language | Utterances that describe infants' external or internal states, emotions, or thoughts, or others' external or internal | "This duck is sad" "You look so happy" "The baby is crying" "You are feeling happy like the dog" "You like that one, |

| | | | | |
|---|---|---|---|---|
| | | | states. Utterances that focus on emotion or mental state. | huh? You know this one” |

**Statistical Analyses**

Statistical analyses were conducted in R (R Core Team, 2025). Descriptive statistics were first calculated to examine the distribution of utterance functions, regulatory utterance subtypes, and language use. Inferential analyses used mixed-effects regression models to account for repeated observations within mothers. Four analyses were conducted to examine associations among language use, utterance function, regulatory utterance subtype, maternal acculturation, and maternal age. Bayesian multinomial mixed-effects models were fitted using the *brms* package (Bürkner, 2017) for Bayesian multinomial mixed-effects model and generalized linear mixed-effects model were fitted using the *lme4* package (Bates et al., 2015).

***Language use as a function of utterance function and maternal age***

We conducted a Bayesian multinomial mixed-effects model to examine whether mothers' language use (Spanish, English, or Language Mixing) varied as a function of utterance function (regulatory vs. referential), while accounting for the potential age-related variation in maternal language use. Maternal age was included as a continuous covariate because of the broad age range of mothers in the sample. The analysis was restricted to regulatory and referential utterances.

English was specified as the reference category for language use and referential utterances were specified as the reference category for utterance function. Maternal age was centered and included as a covariate. The model was fitted using the *brms* package (Bürkner, 2017), with a categorical family appropriate for multinomial outcomes. To account for repeated observations within mothers, a random intercept for participant was included. No post-hoc comparisons were conducted because the multinomial

mixed-effects model directly estimated the planned language contrasts within levels of utterance function. The retained model structure was as follows:

*Language ~ Utterance Function + Maternal Age (centered) + (1 | Participant)*

***Maternal acculturation and utterance function***

We then conducted a binomial generalized linear mixed-effects model (GLMM) to examine the association between maternal acculturation and mothers' use of regulatory versus referential utterances. The model was fitted using the *glmer* function from the *lme4* package (Bates et al., 2015), with a binomial distribution with a logit link. Utterance function was modeled as a binary outcome variable, with referential utterances specified as the reference category. Maternal acculturation and maternal age (centered) were included as fixed effects. To account for repeated observations within mothers, a random intercept for participant was included. The model structure was as follows:

*Utterance Function ~ Maternal Acculturation + Maternal Age (centered) + (1 | Participant)*

In a separate exploratory binomial generalized linear mixed-effects model (GLMM), generation status was examined as a predictor of utterance function, with maternal age (centered) included as a covariate and participant included as a random intercept. Referential utterances were specified as the reference category. No pairwise comparisons were conducted because the analyses focused on the overall associations of maternal acculturation and generation status with utterance function rather than differences between specific generation groups.

***Mothers' use of attentional and behavioral regulatory directives***

A binomial generalized linear mixed-effects model (GLMM) was fitted to examine whether mothers differed in their likelihood of producing attentional versus behavioral directives. The model was fitted using the *glmer* function from the *lme4* package (Bates et al., 2015), with a binomial distribution and a logit link. The analysis was restricted to regulatory utterances, excluding referential utterances.

Directive subtype was modeled as a binary outcome with two levels: attentional and behavioral directives. A random intercept for participant was included to account for repeated observations within mothers. No post-hoc comparisons were conducted because the model directly tested the difference between the two directive subtypes. The model structure was as follows:

$$Directive\ Subtype \sim 1 + (1 \mid Participant)$$

***Language use and regulatory utterance subtype***

Lastly, we conducted a binomial generalized linear mixed-effects model (GLMM) to examine the association between language use and mothers' regulatory utterance subtype. The model was fitted using the *glmer* function from the *lme4* package (Bates et al., 2015), with a binomial distribution and a logit link. The analysis was restricted to regulatory utterances, which included behavioral and attentional directives. Behavioral directives were specified as the reference category. Language use was included as a fixed effect, with English specified as the reference category. Maternal age (centered) was included as a covariate. To account for repeated observations within mothers, a random intercept for participant was included. The model structure was as follows:

$$Regulatory\ Utterance\ Subtype \sim Language\ Use + Maternal\ Age\ (centered) + (1 \mid Participant)$$

**Results**

The present analyses examined regulatory and referential utterance functions across English, Spanish, and Language Mixing categories and assessed whether maternal acculturation was associated with these utterance functions. Mothers produced a total of 5,665 infant-directed utterances during the 15-minute free-play session, including 3,484 regulatory utterances, and 696 referential utterances. Across language categories, mothers produced 2,479 English utterances, 2,784 Spanish utterances, and 402 Language Mixing utterances. Table 3.2 presents the frequencies of utterance functions and language use.

**Table 3.2**

*Distribution of regulatory and referential utterance functions across language use*

| Category | English | Spanish | Language Mixing |
|---|---|---|---|
| Regulatory | 1438 | 1763 | 283 |
| Referential | 310 | 347 | 39 |

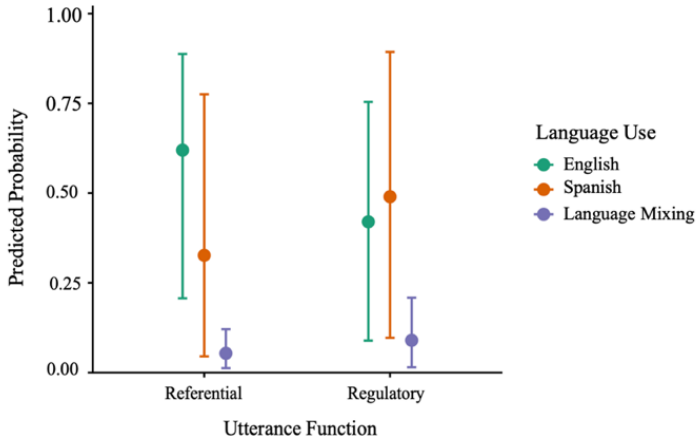
***Language use as a function of utterance function and maternal age***

The multinomial mixed-effects model revealed that utterance function was associated with mothers' language use. English was specified as the reference language category, and referential utterances specified as the reference utterance function. Regulatory utterances were associated with higher log-odds of Spanish relative to English, $\beta = 0.95$, 95% *CrI* [0.64, 1.26], and higher log-odds of Language Mixing relative to English, $\beta = 0.92$, 95% *CrI* [0.52, 1.34]. Maternal age was negatively associated with Spanish relative to English, $\beta = -0.94$, 95% *CrI* [−1.24, −0.68], such that older mothers were less likely to use Spanish relative to English. In contrast, maternal age was not clearly associated with Language Mixing relative to English, $\beta = -0.07$, 95% *CrI* [−0.23, 0.07].

These findings indicate that the distribution of language use differed across utterance functions. Specifically, regulatory utterances had higher relative use of Spanish and Language Mixing than referential utterances, relative to English. Figure 3.1 illustrates predicted probabilities of language use across utterance functions.

**Figure 3.1**

*Predicted probabilities of English, Spanish, and Language Mixing across maternal utterance functions.*



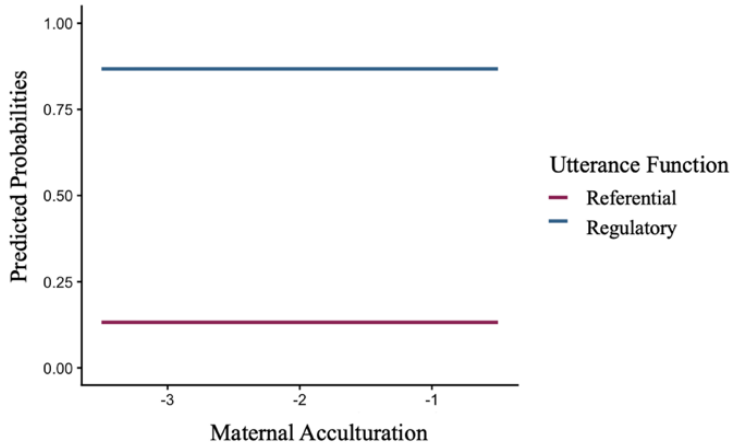

***Maternal acculturation and utterance function***

A binomial generalized linear mixed-effects model (GLMM) revealed that maternal acculturation was not associated with mothers' likelihood of producing regulatory versus referential utterances, $\beta$ = 0.00, *SE* = 0.11, $p$ = .998. Maternal age also was not significantly associated with utterance functions, $\beta$ = 0.04, *SE* = 0.03, $p$ = .172 (see Figure 3.2).

In an exploratory analysis, we examined whether generation status was associated with mothers' use of regulatory versus referential utterances. Generation status was not significantly associated with utterance function, $\beta = -0.17$, *SE* = 0.19, $p$ = .353. Maternal age was also not significantly associated with utterance function in this model, $\beta$ = 0.04, *SE* = 0.03, $p$ = .143. Overall, neither maternal acculturation nor generation status was significantly associated with mothers' use of regulatory versus referential utterances.

**Figure 3.2**

*Predicted probabilities of referential and regulatory utterances across maternal acculturation levels.*




***Mothers' use of attentional and behavioral regulatory directives***

The third analysis focused exclusively on regulatory utterances. Mothers produced a total of 3,484 regulatory utterances, including 1,814 attentional directives and 1,670 behavioral directives. The model did not indicate a significant difference in mothers' likelihood of producing attentional directives and behavioral directives, $\beta = 0.04$, $SE = 0.12$, $p = .726$. Thus, mothers produced attentional and behavioral directives at comparable rates. Table 3.3 provides descriptive counts and proportions for the two regulatory directive subtypes.

**Table 3.3**

*Distribution of regulatory directive subtypes*

| **Directive Subtype** | **Count** | **Proportion** |
|---|---|---|
| Behavioral | 1670 | 47.9% |
| Attentional | 1814 | 52.1% |

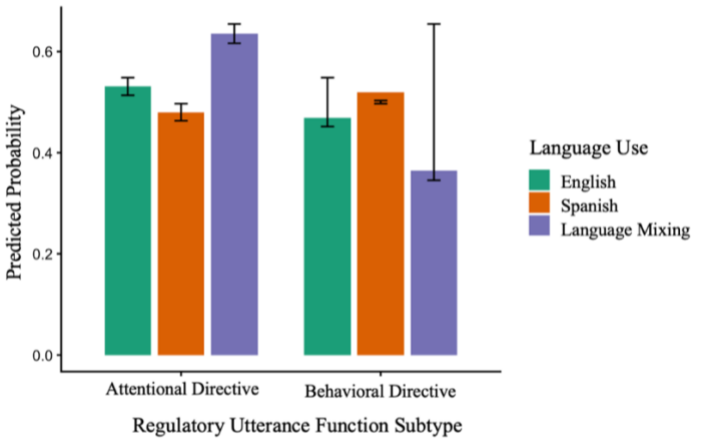
### *Language use and regulatory utterance subtype*

The binomial generalized linear mixed-effects model revealed that language use was associated with mothers' regulatory utterance subtype use. English was used as the reference language, and behavioral directives were specified as the reference subtype. Language Mixing was associated with higher log-odds of attentional directive relative to behavioral directives, $\beta = 0.43$, $SE = 0.15$, $p = .005$, whereas Spanish was not clearly associated with attentional relative to behavioral directives, $\beta = -0.20$, $SE = 0.12$, $p = .090$ (see Figure 3.3). Maternal age was not significantly associated with regulatory utterance subtype, $\beta = 0.03$, $SE = 0.02$, $p = .244$

These findings indicate that the distribution of regulatory utterance subtypes differed across language use. Mothers had a higher probability of producing attentional rather than behavioral directives when using Language mixing compared with English. Estimated marginal probabilities indicated that attentional directives account for 53.1% of English utterances, 48.0% of Spanish utterances, and 63.6% of Language Mixing utterances. Pairwise comparisons further indicated that the odds of producing attentional relative to behavioral directives were higher for Language Mixing than for English ($p = .014$), and higher for Language Mixing than for Spanish ($p < .001$). English and Spanish did not significantly differ in the odds of producing attentional relative to behavioral directives ($p = .207$).

**Figure 3.3**

*Predicted probabilities of regulatory directive subtypes by language use*




Note. Error bars represent 95% confidence intervals.

**General Discussion**

The present study examined Mexican American mothers' infant-directed utterance functions in relation to their levels of acculturation in the United States and the language they use to produce difference utterance types. The goal of the study was to further understand how mothers use different types of speech during play interactions with their infants and to examine the role of cultural experiences and bilingual language practices in early caregiver–infant interactions. Overall, the findings provided evidence that language use was associated with mothers' utterance functions, whereas acculturation and generation status was not.

The first prediction examined the relationship between mothers' utterance functions and language use. We found that regulatory utterances were more likely to occur in Spanish and Language Mixing relative to English when compared with referential utterances. Referential utterances were relatively more likely to occur in English than in Spanish or Language Mixing. This pattern suggests that mothers' language use varied according to the function of the utterances during interactions with their infants. In

particular, Spanish and Language Mixing were relatively more common for regulatory than referential utterances, suggesting that mothers may draw on their languages differently depending on the communicative function of their speech. One possible explanation for this pattern is that Spanish use may be connected to mothers' Mexican cultural affiliation to cultural values such as *respeto*. Spanish can serve as an important marker of cultural identity and connection to Mexican heritage. Mothers may therefore draw more heavily on Spanish, including Language Mixing, when engaging in regulatory utterances.

However, the present study did not examine mothers' reasons for choosing a particular language or directly assess cultural practices associated with language use. Thus, the findings do not establish that cultural preferences or experiences cause mothers to use Spanish or Language Mixing for particular communicative functions. Rather, they indicate that language use and utterance function were associated during mother-infant play interactions.

The second prediction was that mothers' acculturation would be associated with differences in their use of regulatory versus referential utterances. Contrary to this prediction, maternal acculturation was not associated with utterance function. This finding remained consistent regardless of whether acculturation was conceptualized as a continuous measure or as a categorical variable (i.e., generation status). Thus, the prediction that mothers' level of acculturation would be related to their use of different utterance functions was not supported.

One possible explanation for this null finding is the restricted variability in acculturation within the present example. Most mothers were classified within bicultural or moderately oriented acculturation categories using the Brief Acculturation Scale for Mexican Americans-II (Cuellar et al., 1995). Limited representation across the full range of acculturation experiences may have reduced the variability necessary to detect an association between maternal acculturation and utterance functions. Accordingly, the absence of an association should not necessary be interpreted as evidence that cultural adaptation is unrelated to mother-infant communication.

It is also possible that global measures of acculturation do not fully capture the aspects of cultural experience that are most relevant to everyday mother-infant interactions. Acculturation is increasingly conceptualized as multidimensional and context-dependent process that can vary across domains such as language use, identity, values, and practices (Berry & Sam, 1997; Schwartz et al., 2010). Consequently, mothers with similar overall acculturation scores may nevertheless differ in the languages they use with their infants. For example, mothers may differ in their use of Spanish at home or in the extent to which they engage their infants in heritage-cultural practices. Examining specific domains of cultural adaptation may therefore provide a more sensitive approach to understanding variation in maternal speech.

Given the finding that regulatory utterances were more likely to occur in Spanish and Language Mixing than in English, we further examined whether different types of regulatory utterances varied by language use. We investigated whether behavioral and attentional directives were differentially produced in English, Spanish, and Language Mixing. Previous research has established that behavioral directives are used to instruct or redirect infants' behavior (Akhtar et al., 1991; Carpenter et al., 1998), whereas attentional directives are intended to direct the infants' attention toward objects (Tamis-LeMonda et al., 2001). Contrary to our prediction, attentional directives were not more frequent than behavioral directives. Instead, mothers produced attentional and behavioral directives at comparable rates overall. This finding suggests that mothers used directives for multiple regulatory purposes during play, including both directing infants' attention and guiding their behavior.

Although attentional and behavioral directives occurred at similar rates overall, their use varied somewhat by language. Specifically, Language Mixing was associated with higher odds of attentional rather than behavioral directives compared with English, whereas Spanish did not significantly differ from English. This finding suggests that the relationship between language use and regulatory function may depend on the specific type of regulatory directive being expressed. In addition, mothers' use of Language Mixing may have been more closely associated with directing infants' attention than with regulating their behavior.

The prediction concerning language use was partially supported. Language Mixing utterances had higher log-odds of functioning as attentional rather than behavioral directives relative to English, whereas Spanish utterances did not significantly differ from English. The pattern was specific to Language Mixing rather than Spanish more generally. This finding suggest that Language Mixing may be particularly relevant to mothers' use of attentional directives during play. However, the present study did not examine the conversational circumstances surrounding Language Mixing; therefore, the mechanisms underlying this pattern remains unclear. Future research should examine when and why mothers use Language Mixing within interactions and whether Language Mixing is systematically related to particular communicative goals. This can be examined by coding language use at the utterance or conversational-turn level and examining whether Language Mixing occurs in association with directing infants' attention or regulating their behavior.

Together, these findings highlight the importance considering both cultural and linguistic experiences when examining mother-infant interactions. Although maternal acculturation was not associated with differences in mothers' utterance functions, language use was related to how mothers used their speech during interactions with their infants.

**Limitations**

Several limitations should be considered when interpreting these findings. First, although maternal acculturation was measured using a validated multidimensional instrument, acculturation is widely conceptualized as a context-dependent process that may not be fully captured by global measures (Schwartz et al., 2010). Contemporary acculturation frameworks emphasize that cultural adaptation occurs across multiple domains, including language use, identity, values, and practices, and may vary across contexts and relational settings rather than forming a single unified construct (Berry & Sam, 1997; Schwartz et al., 2010). Future research should examine specific domains of cultural adaptation to better understand how different aspects of acculturation may be related to caregiver-infant interactions.

Second, the study focused on two specific categories of utterance function: regulatory and referential utterances. Regulatory utterances included only directives, whereas referential utterances included labels and descriptions. Maternal speech encompasses a broader range of utterances that were not examined in the present study, including questions, praise, and emotion-related utterances. These types of speech serve distinct roles in children's linguistic, cognitive, and socioemotional development (Hoff, 2006; Rowe, 2012; Ruffman et al., 2002). For example, questions can scaffold infants' participation in interactions and support language development, whereas praise and feedback may support motivation and social engagement. Examining these additional utterance types may provide a more comprehensive understanding of how maternal speech varies in relation to acculturation and language use.

Future research would benefit from incorporating a more comprehensive taxonomy of maternal speech to capture the range of utterance functions used during mother-infant interactions. Doing so would provide for a more fine-grained understanding of how different types of maternal utterances may support infants' linguistic and socio-cognitive development across cultural and linguistic contexts.

Lastly, the study focused primarily on mothers' utterance functions and language use and did not examine infants' attention in relation to specific utterance functions. Prior literature has established that regulatory utterances, particularly directives, can guide and modify infants' attention and behavior during interactions with caregivers (Flynn & Masur, 2007). However, it remains unclear whether different types of regulatory directives are differentially related to infants' attention. Future research should therefore investigate how regulatory utterances subtypes, such as behavioral and attentional directives, are associated with infants' attention during mother-infant interactions. Examining these associations may provide a more nuanced understanding of how mothers use different types of utterances to support and guide infants' attention.

## Conclusion

The present study examined Mexican American mothers' utterance functions and acculturation levels during naturalistic free-play interactions with their 18-month-old infants. Contrary to our prediction, mothers' acculturation levels were not associated with differences in their use of regulatory versus referential utterances. In contrast, language use was associated with utterance function: regulatory utterances had higher relative use of Spanish and Language Mixing than referential utterances, relative to English. In addition, referential utterances had higher relative use of English than regulatory utterances.

When examining regulatory utterances subtypes, Language Mixing was associated with greater odds of attentional rather than behavioral directives relative to English, whereas Spanish did not significantly differ from English. Together, these findings suggest that language use may be relevant to how Mexican American mothers structure different types of speech during interactions with their infants. Examining mother-infant interactions through both cultural and linguistic perspectives may therefore provide a more nuanced understanding of bilingual communication in early development.

# CHAPTER 4

## STUDY 3: EXPLORING CAREGIVER-INFANT EARLY INTERACTIONS: THE ROLES OF TOUCH, SPEECH, AND ACCULTURATION

Caregivers respond to their infants through coordinated social behaviors, including touch and speech. These behaviors provide infants with meaningful information about their environment and support early learning. Touch is one of the earliest sensory modalities to develop and provides an important way for caregivers to regulate infants' emotional states, guide their actions, and support interactions (Feldman et al., 2002; Stack & Muir, 1992). Caregiver speech also serves important regulatory and communicative functions and provides infants with opportunities to develop language and learn about their environment (e.g., Gogate et al., 2000; O'Neill et al., 2005). Importantly, these behaviors rarely occur in isolation. Rather, touch and speech are frequently coordinated, creating multimodal interactions that provide infants with integrated sources of information (e.g., Abu-Zhaya et al., 2017; Deák et al., 2014; Tincoff et al., 2019).

Although caregiver touch and speech play important roles in infant development, the ways in which these behaviors are used and coordinated may vary across cultural contexts. Cultural beliefs and caregiving practices influence how caregivers interpret infants' needs, structure interactions, and select forms of communication during everyday exchanges (Bornstein, 2012; Harkness & Super, 1996; Keller, 2007). Examining how cultural experiences shape caregivers' behaviors can provide insight into variation in caregiver-infant interactions. The present study examined Mexican American mothers and their 18-month-old infants during play interactions at home. Specifically, we investigated mothers' use of touch and speech directed toward their infants and examined whether these behaviors varied as a function of mothers' acculturation.

Touch is one of the earliest sensory modalities to develop and plays a fundamental role in social development (e.g., Feldman et al., 2002; Stack & Muir, 1992). Caregiver touch serves multiple functions,

including regulating infants' emotions and physiological states (Field, 2010; Jean et al., 2009), guiding their actions (Soska et al., 2010; Tamis-LeMonda & Lockman, 2020), communicating affection (Hertenstein, 2002), supporting play (Mantis et al., 2019; Mercuri et al., 2023), and meeting everyday caregiving needs such as positioning, feeding, and dressing (Ainsworth et al., 1978; Hertenstein, 2002). For example, Tamis-LeMonda and Lockman (2020) highlighted how caregivers actively scaffold infants' object exploration by positioning objects and supporting infants' manual actions. Similarly, Mercuri et al. (2023) demonstrated that maternal touch varies across developmental and interactional contexts. They found that mothers' patterns of touch including stroking, caressing, massaging, and rubbing varied according to infant age, interaction context, and the intended function of the touch, including soothing and emotion regulation. Thus, caregiver touch can serve multiple functions during interactions and may shape infants' experiences in a variety of ways.

Touch has also been identified as an important contributor to early learning, particularly by supporting infants' ability to extract and interpret information from their environment (e.g., Seidl et al., 2015; Tincoff et al., 2019). Seidl et al. (2015) investigated 4- to 6-month-old infants' ability to discriminate word boundaries and whether touch could facilitate speech segmentation by providing temporally aligned cross-modal cues. During an artificial-language task, the experimenter delivered touches that were temporally aligned with target words embedded within a continuous speech stream. Infants who received tactile cues were better able to identify word boundaries, suggesting that touch can enhance infants' ability to detect and process linguistic information within continuous speech.

Extending this work, Tincoff et al. (2019) demonstrated that parents naturally coordinated touch with speech when labeling infants' body parts. Infants showed greater responsiveness when tactile and linguistic cues were aligned than when they received touch or speech alone. These findings suggest that touch can provide an additional source of information that strengthens infants' ability to establish connections between sensory experiences and linguistic representations. Consistent with this view, tactile cues that accompany spoken words may support word–referent mapping by reinforcing associations

between labels and their corresponding objects or events (Gogate et al., 2000). In addition, Abu-Zhaya et al. (2017) found that American mothers produced more exaggerated tactile and vocal cues when these behaviors occurred simultaneously than when speech or touch occurred alone. Caregiver touch may be particularly relevant to infants' learning because tactile cues can highlight objects, actions, or other information within an interaction.

Caregiver touch has also been studied across cultural contexts. Wang et al. (2025) examined cultural patterns of parental guidance of infants during hands-on experience tasks. Parents and their 9-month-old infants from Taipei, Taiwan, and Santa Cruz, California, United States engaged in tasks that involved culturally distinctive approaches to attention management and action coordination. Chinese-heritage mothers in Taipei demonstrated greater use of directive guidance than European-heritage mothers in Santa Cruz. This difference was particularly evident in the use of hand-holding, in which mothers guided infants' hands or arms to support the completion of actions, such as covering an object, while infants remained receptive to this assistance. In contrast, hand-holding was rarely observed among European-heritage dyads in Santa Cruz. Therefore, the findings suggest that caregiver touch is not used uniformly across cultural contexts and may be shaped cultural practices. Touch may therefore serve as one means through which caregivers guide infants' attention, actions, and learning experiences.

Cultural variation has also been documented in caregivers' use of physical contact and proximity. Cultural communities such as the Aka of Central Africa and the Nso farming community in Cameroon emphasize proximal caregiving practices characterized by frequent physical contact and carrying (Hewlett et al., 2011; Keller et al., 2007). In contrast, caregiving practices in cultural groups from Germany, Greece, and the United States involve less continuous physical contact (Keller et al., 2011).

These differences in caregiving practices may shape infants' experiences and opportunities for exploration. For example, Karasik et al. (2023) examined motor development among infants in Tajikistan who experienced extended periods of restricted movement due to placement in the traditional "gahvora" cradle. They found that these infants demonstrated later onset of motor milestones relative to World

Health Organization standards. However, by four to five years of age, children's motor abilities were comparable to U.S. norms, suggesting that culturally specific early experiences may influence the timing of developmental milestones without necessarily resulting in lasting developmental differences. These findings highlight the importance of examining culturally patterned caregiving practices within specific cultural groups.

Research with Latine families has also shown differences in caregivers' use of touch during interactions with their infants. Franco et al. (1997) examined Hispanic and Anglo mothers' use of touch, including close and affectionate touch, during free-play sessions and collected questionnaire data on mothers' perceptions of the importance and frequency of touch with their infants. Questionnaire data indicated that Hispanic and Anglo mothers reported similar rates of touch directed toward their infants. However, observations from the free-play sessions revealed that Hispanic mothers used more affectionate touch, whereas Anglo mothers used more distal touch, such as touching infant with a toy. These findings suggest that cultural differences may be reflected not only in the frequency of caregiver touch but also in how touch is expressed during parent-infant interactions.

Parenting practices among Mexican-origin families have been described as reflecting cultural beliefs and values that emphasize family interdependence and respect for others. Research has shown that Mexican American and other Latine caregivers often balance sensitivity and emotional support with behavioral expectations (Benito-Gomez, 2022; Domenech Rodríguez et al., 2009), although the expression of these behaviors may vary across families and levels of acculturation. Acculturation refers to the process through which individuals adapt their beliefs, behaviors, and values when interacting with other individuals from different cultural backgrounds (Berry & Sam, 1997; Cabrera et al., 2006). Examining acculturation may therefore provide insight into how caregivers' cultural experiences are related to their use of touch and speech during parent-infant interactions.

Ispa et al. (2004) examined maternal intrusiveness and warmth during play among European American, African American, and Mexican American families with their 15-month-old infants. They

found that maternal intrusiveness was associated with an increase in children's negativity across cultural groups. This association was moderated by maternal warmth with African American families. In addition, greater maternal intrusiveness was associated with a decline in infants' engagement with their mothers among European American families. These findings suggest that the associations between parenting behaviors and infants' responses may vary across cultural groups and that parenting practices should be considered with a broader cultural context of families. Similarly, Cabrera et al. (2006) investigated variation in mother-infant interactions and father engagement as a function of country of origin, socioeconomic status, and English language proficiency with Latine dyads, including Mexican American, Puerto Rican, Central American, and Dominican families. They found that Mexican American infants had lower mother-infant interaction scores and experienced less father physical play than infants the other Latine groups. These differences were associated with parents' English proficiency, such that lower English proficiency was associated with lower levels of mother-infant interactions and father physical play among Mexican American families. This finding suggesting that acculturation may contribute to the existing variation in parenting practices and parent-infant interactions within Latine families.

Further evidence suggests that cultural experiences may also be reflected how parents engage with infants during interactions. Although research examining Mexican American caregiver-infant interactions remains limited, studies of related Mexican-origin and Latine populations provide insight into patterns of interaction that may inform our understanding of Mexican American caregivers. Luo and Tamis-LeMonda (2016**)** examined African American, Dominican immigrant, and Mexican immigrant mothers interacting with their children at 14, 24, and 36 months and coded the verbal and physical strategies mothers used during play. They found that Mexican immigrant mothers used more nonverbal strategies, including gestures and hands-on guidance, than African American and Dominican immigrant mothers. In contrast, African American and Dominican mothers relied more on verbal strategies to engage their infants with toys. These findings suggest that Mexican immigrant mothers may place greater emphasis on physical and nonverbal strategies during interactions.

Prior work with Latine and Mexican-origin families further suggests that caregiver-infant interactions involve forms of communication beyond spoken language. Caregivers use combinations of touch, gestures, speech, and other embodied behaviors to engage infants and support early learning. Cote et al. (2008) found that Latine immigrant mothers spent more time engaging in person-directed interactions than European American mothers, emphasizing physical contact and face-to-face engagement. The authors suggested that these interaction patterns reflected cultural values related to interpersonal closeness and social connectedness during infancy. Similarly, broader reviews of cultural variation in early caregiving highlight the use of gestures, touch, and other nonverbal cues among Mexican-origin caregivers (Cote et al., 2008; Fletcher et al., 2020; Kuchirko et al., 2020). These findings suggest that caregiver-infant communication among Latine and Mexican-origin families extends beyond speech to include interconnected forms of interaction.

Evidence from Mexican American families further emphasizes the developmental significance of tactile interactions. Bierce et al. (2025) examined maternal affectionate touch among Mexican American mother–infant dyads and found that differences in maternal touch were associated with infants' physiological regulation. Specifically, infants who experienced higher levels of affectionate touch demonstrated more adaptive physiological regulation, suggesting that tactile interactions are significant in supporting regulatory processes.

Research with other populations has similarly demonstrated that caregivers integrate multiple forms of communication with their infants. Kosie and Lew-Williams (2024) examined infant-directed communication, including speech, gesture, touch, and emotional expressions, among predominantly White, middle-class, English-speaking families in the United States with 18- to 24-month-old infants. They found that caregivers frequently coordinated multiple behaviors during interactions and increased their use of touch and speech when interacting with infants who had smaller vocabularies. Furthermore, the use of touch also appears to change across development. Jean et al. (2009) reported age-related changes in both the types and quantity of maternal touch. More specifically, caregivers of 1-month-old

infants used touch to soothe and regulate infants' emotions, whereas mothers of 9-month-old infants used more complex forms of tactile engagement, such as grasping and poking.

In addition, the coordination of touch with speech may change across development. Ko et al. (2023) examined Korean mother-infant dyads across three infant age groups (8, 14, and 27 months) to investigate the temporal coordination between mothers' touch and speech. They found that mothers of 8-month-old infants produced the highest frequency of co-occurring touch and speech compared with mothers of 14- and 27-month-old infants, suggesting that coordination of touch and speech may vary with infants' developmental level. Similarly, Gogate et al. (2000) demonstrated that Hispanic American mothers synchronized speech with object movement and occasional touch when introducing novel words, adapting these cues to infants' developmental level. When teaching infants novel words, mothers produced a higher proportion of synchronous naming and object-motion events, and touch and speech events, with 5- to- 8-month-old infants to 9- to- 17-month-old infants.

**Current Study**

Research with Mexican American mothers suggests that acculturation is associated with variation in mother–infant interactions (Cabrera et al., 2006; Ispa et al., 2004), and studies of Mexican-origin and Latine families have examined the use of physical and nonverbal behaviors during caregiver-infant interactions (Cote et al., 2008; Luo & Tamis-LeMonda, 2016). However, relatively little is known about whether within-group differences in acculturation are associated with Mexican American mothers' use of touch and speech. Building on prior work, the present study addressed this gap by examining the frequency and coordination of maternal touch and speech during naturalistic interactions between Mexican American mothers and their 18-month-old infants. Specifically, we examined whether mothers' use of touch and speech varied as a function of their level of acculturation.

We predicted that Mexican American mothers would produce speech and touch behaviors more frequently and for longer durations than speech-only and touch-only behaviors during interactions with

their infants. In addition, we examined whether within-group variation in mothers' levels of acculturation was associated with differences in the frequency and duration of maternal touch-only, speech-only, and speech-and-touch behaviors. Specifically, we predicted that mothers with stronger Mexican cultural orientation (i.e., lower acculturation scores) would produce higher rates of touch-based behaviors and longer touch-based behavior durations than mothers with stronger Anglo-American cultural orientation (i.e., higher acculturation scores). This prediction was based on cultural models that emphasize relational closeness and interpersonal connections (Calzada, 2010; Keller, 2007; Valdés, 1996).

To test these predictions, Mexican American mothers and their 18-month-old infants participated in an at-home naturalistic play session. Mothers also completed questionnaires assessing their cultural acculturation. From the play sessions, we coded maternal speech and touch behaviors and examined the frequency and duration of touch-only, speech-only, and speech-and-touch behaviors.

## Method

### Participants

This study used the same sample as described in Chapter 3. Participants were 49 Mexican American mothers and their 18-month-old infants recruited from Northern California. Detailed information regarding participant recruitment, eligibility criteria, and demographic characteristics is provided in Chapter 3. The full sample was used to examine mothers' acculturation and its association with their use of touch and speech during mother–infant interactions.

### Acculturation

Maternal acculturation was assessed using the Brief Acculturation Scale for Mexican Americans-II (ARSMA-II-Brief; Cuellar et al., 1995), as described in Chapter 3. Mothers completed items assessing their cultural practices, preferences, and identity across Mexican and Anglo-American acculturation levels. Based on established ARSMA-II-Brief classification guidelines. Five mothers were classified as

Very Mexican Oriented, 19 as Mexican Oriented to Balanced Bicultural, 17 as Slightly Anglo-Oriented Bicultural, 5 as Strongly Anglo-Oriented, and 3 as Very Assimilated. Overall acculturation scores ranged from −3.33 to 3.33, representing a range from Very Mexican-Oriented to Very Assimilated (Anglo-oriented; $M = -.10$, $SD = 1.38$). Twenty-three mothers were first generation Mexican American, 21 were second-generation, 4 were third-generation, and 1 was fourth-generation.

**Stimuli**

Stimuli consisted of three sets of toy objects: a car race set (i.e., cars and a racetrack), a tea set (i.e., spoons, cups, and a sugar bowl), and a set of building blocks, as well as a short book.

**Data Preparation**

*Mother Speech Coding*. Audio recordings were transcribed using Amazon Web Services (AWS) Transcribe, an automated speech recognition program for English and Spanish speech. An R script (Cohn, 2025) subsequently converted the AWS output into Praat TextGrid files for utterance coding. Native Spanish–English bilingual research assistants reviewed and corrected the TextGrid files using Praat software (Boersma & Weenink, 2023). Mothers' speech was segmented into utterances following procedures established in previous research (Schroer & Yu, 2022; Suárez-Rivera et al., 2019). No minimum utterance duration was required; however, speech separated by less than 400 ms of silence was coded as a single utterance (Yu et al., 2016; Pereira et al., 2014; Yu & Smith, 2012). A pause of at least 400 ms marked the beginning of a new utterance. Across the 49 sessions, mothers produced 5,665 utterances ($M = 115.61$, $SD = 43.24$), with individual mothers producing between 20 and 192 utterances.

*Touch Coding*. Trained native Spanish-English bilingual research assistants coded mothers' touch using Datavyu (Datavyu Team, 2014), behavioral coding software that allows video recordings to be coded frame by frame at approximately 30 frames per second. Touch was defined as any touch that a mother deliberately directed toward her infant on any part of her infant's body (Abu-Zhaya et al., 2017; Ko et al., 2023). Examples included a mother grabbing the infant's hand to guide the infant toward a toy

or repositioning the infant's hand. Unintentional touch, such as accidentally touching the infant's back while attempting to grab the infant's leg, was not coded.

Video recordings were 15 min in duration, and bilingual research assistants coded the full video without sound, independently of the mothers' speech coding. Touch was not coded when the infant was out of camera view. Intercoder reliability for touch between the primary and secondary coders ranged from 90% to 98% across the 49 sessions.

To examine the coordination of mothers' speech and touch, utterance-level speech coding and touch coding were synchronized using R scripts (Cohn, 2025) and Datavyu Ruby scripts. Following procedures used in previous research examining caregivers' vocal and tactile behaviors (Abu-Zhaya et al., 2017), the synchronized speech and touch behaviors were then organized into behavioral bouts.

**Bouts Preparation**

Mothers' speech and touch behaviors were segmented into behavioral bouts based on the temporal continuity. A bout was defined as a period of successive video frames (~33 ms per frame; 30 frames per second) during which maternal speech and/or touch was directed toward the infant. Behavioral events separated by less than 200 ms (6 frames) were combined into a single bout, whereas events separated by at least 200 ms were coded as separate bouts. The final dataset included 9,923 behavioral bouts across 49 participants. Each bout was classified into one of three categories based on the behaviors occurring during the bout: (1) speech-only bouts, in which speech occurred without touch ($n$ = 2,838); (2) touch-only bouts, in which touch occurred without speech ($n$ = 3,544), and (3) speech-and-touch bouts, in which speech and touch co-occurred ($n$ = 3,541).

**Statistical Analyses**

Statistical analyses were conducted in R (R Core Team, 2025). Four analyses were conducted to examine behavioral bout type, duration, and frequency. First, a Bayesian multinomial mixed-effects model was used to examine differences in the relative probability of speech-and-touch, speech-only, and

touch-only bouts. Second, a linear mixed-effects model was used to examine differences in bout duration across behavioral bout types. Third, a zero-inflated negative-binomial mixed-effects model was conducted to examine whether behavioral bout frequency varied as a function of behavioral bout type and maternal acculturation. Fourth, a linear mixed-effects model was used to examine the association between behavioral bout duration as a function of maternal acculturation.

***Differences in behavioral bout types***

A Bayesian multinomial mixed-effects model was fitted to examine the relative probability of speech-and-touch, speech-only, and touch-only bouts. Behavioral bout type was treated as a categorical outcome with three levels. A random intercept for participant was included to account for the repeated observations contributed by each mother. Speech-and-touch bouts were specified as the reference category. The model was estimated using four Makov chain Monte Carlo (MCMC) chains, with 4,000 iterations per chain and 2,000 warm-up iterations per chain. The model was specified as follows:

$$Behavioral\ Bout\ Type \sim 1 + (1 \mid Participant)$$

Posterior pairwise contrasts were subsequently conducted to directly compare all three behavioral bout types, using the *brms* package (Bürkner, 2017).

***Differences in behavioral bout duration***

We next conducted a linear mixed-effects model (LMM) to examine whether behavioral bout duration differed across speech-and-touch, speech-only, and touch-only bouts. Bout duration was measured in seconds and was positively skewed; therefore, it was log transformed to improve the distribution of the outcome. Residual diagnostics were examined for both the untransformed and the log-transformed models. The residuals from the untransformed model showed substantial deviations from normality, whereas the log transformation substantially improved the normality of the residuals. Therefore, the log-transformed duration measure was retained for the analysis. Speech-and-touch bouts

were specified as the reference category. Behavioral bout type was included as a fixed effect, and a random intercept for participant was included to account for the repeated observations within mothers.

The model was estimated using the *lme4* package (Bates et al., 2015), with degrees of freedom and inferential tests obtained using *lmerTest* (Kuznetsova et al.,2017). Estimated marginal means and Tukey-adjusted comparisons were conducted using *emmean*s package (Lenth, 2025). Because the model was estimated on the log-transformed scale, back-transformed estimated marginal means were reported as geometric means. Differences between conditions were interpreted as relative rather than absolute differences in bout duration. The retained model structure was:

$$log\ (Bout\ duration) \sim Behavioral\ bout\ type + (1 \mid Participant)$$

***Differences in maternal behavioral bout type frequency and acculturation***

Subsequently, a zero-inflated negative-binomial generalized linear mixed-effects model (GLMM) was conducted to examine variation in the frequency of behavioral bouts as a function of behavioral bout type, maternal acculturation, and their interaction. Because the outcome consisted of counts of maternal behavioral bouts and showed evidence of overdispersion relative to a Poisson distribution, a negative-binomial distribution was considered. Model diagnostics were used to evaluate dispersion, residual uniformity, and zero inflation. The negative-binomial model showed evidence of excess zeros; therefore, a zero-inflated negative-binomial model was used for the analysis.

The model was estimated using the *glmmTMB* package (Brooks et al., 2017), with model diagnostics conducted using *DHARMa* (Hartig, 2022). Behavioral bout type and maternal acculturation were included as fixed effects, along with their interaction, and a random intercept for participant was included to account for repeated observations within mothers. Speech-and-touch bouts were specified as the reference category for behavioral bout type. The zero-inflation component included an intercept only. Estimated marginal means and Tukey-adjusted pairwise comparisons were obtained using the *emmeans* package (Lenth, 2025) to evaluate differences among behavioral bout types. Because the model used the

negative-binomial distribution with a log link, estimated marginal means were interpreted on the original count scale, The retained model structure was:

*Frequency of bouts ~ Behavior bout type x Maternal acculturation + (1| Participant)*

*Zero-inflation: ~ 1*

As an exploratory analysis, a separate zero-inflated negative-binomial generalized linear mixed-effects model was conducted to examine whether behavioral bout frequency varied as a function of generation status and behavioral bout type. Generation status and behavioral bout type were included as fixed effects, along with their interactions, and random intercept for participant was included to account for repeated observations within mothers. Speech-and-touch bouts were specified as the reference category for behavioral bout type. The zero-inflation component included an intercept only. Estimated marginal means and Tukey-adjusted pairwise comparisons were used to evaluate differences among behavioral bout types using the *emmeans* package (Lenth, 2025). Because this model also used a negative-binomial distribution with a log link, estimated marginal means were interpreted on the original count scale.

***Differences in maternal behavioral bout duration and acculturation***

Lastly, we conducted a linear mixed-effects model (LMM) to examine behavioral bout duration as a function of behavioral bout type, maternal acculturation, and their interaction. Bout duration was measured in seconds and was positively skewed; therefore, it was log transformed to improve the distribution of the outcome variable. Residual diagnostics were examined for both the untransformed and the log-transformed models. The residuals from the untransformed model showed substantial deviations from normality, whereas the log transformation substantially improved the normality of the residuals. Therefore, the log-transformed duration measure was retained for the analysis. Behavioral bout type, maternal acculturation, and the interaction between behavioral bout type and maternal acculturation were included as fixed effects, and participant was included as a random intercept to account for repeated

observations within mothers. Speech-and-touch bouts were specified as the reference category for behavior bout type.

The model was fitted using the *lme4* package (Bates et al., 2015), with inferential tests conducted using the *lmerTest* package (Kuznetsova et al., 2017). Estimated marginal means and Tukey-adjusted pairwise comparisons were used to evaluate differences among behavioral bout types using the *emmeans* package (Lenth, 2025). Because the model was estimated on the log-transformed scale, back-transformed estimated marginal means were reported as geometric means, and differences between conditions were interpreted as relative rather than absolute differences in bout duration. The retained model structure was:

*Log (Duration of bout ~ Behavioral bout type x Maternal acculturation + (1| Participant)*

In a separate linear mixed-effects model (LMM), we examined behavioral bout duration as a function of behavioral bout type, generation status, and their interaction. The same log-transformation procedure, residual-diagnostic procedures, and model estimation procedures were used. Behavioral bout type, generation status, and their interaction were included as fixed effects, and participant was included as a random intercept. Speech-and-touch bouts were specified as the reference category for behavioral bout type. Estimated marginal means and Tukey- adjusted pairwise comparisons used to evaluate differences among behavioral bout types using the *emmeans* package (Lenth, 2025). The interaction between behavioral bout type and generation status was included to examine whether differences in bout duration across behavioral bout types varied as a function of generation status.

## Results

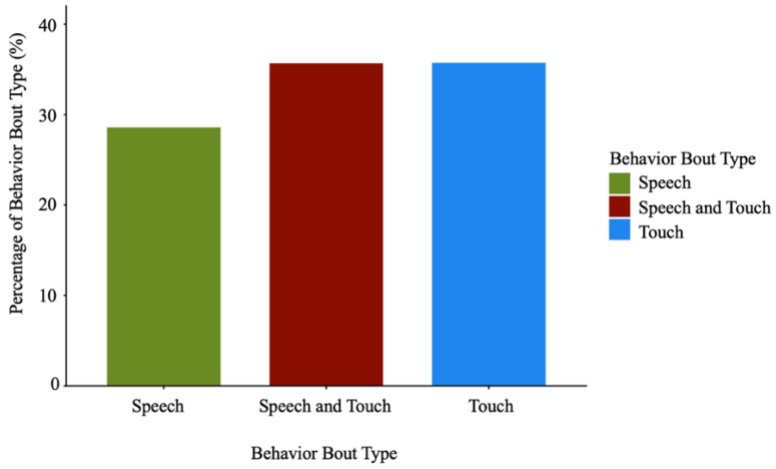
### *Differences in behavioral bout type*

Mexican American mothers produced a total of 9,923 behavioral bouts. Of these, 3,541 (35.7%) were speech-and-touch bouts, 2,838 (28.6%) were speech-only bouts, and 3,544 (35.7%) were touch-only bouts. The Bayesian multinomial mixed-effects model revealed differences in the relative probability of behavioral bout types. Relative to speech-and-touch bouts, mothers were less likely to produce speech-

only bouts, $\beta$ = - 0.31, 95% *CrI* [-0.50, -0.12]. In contrast, the relative probability of touch-only bouts did not differ from that of speech-and-touch bouts, $\beta$ = 0.03, 95% *CrI* [-0.05, 0.13]. A posterior pairwise contrast further indicated that speech-only bouts were less likely than touch-only bouts, $\beta$ = - 0.34, 95% *CrI* [-0.54, -0.14]. Thus, mothers produced speech-and-touch and touch-only bouts at similar relative probabilities, and both bout types were more likely than speech-only bouts (see Figure 4.1).

**Figure 4.1**

*Distribution of maternal behavioral bout types..*




Note. *Bars represent the percentage of speech-only, touch-only, and speech-and-touch bouts produced across Mexican American mothers.*

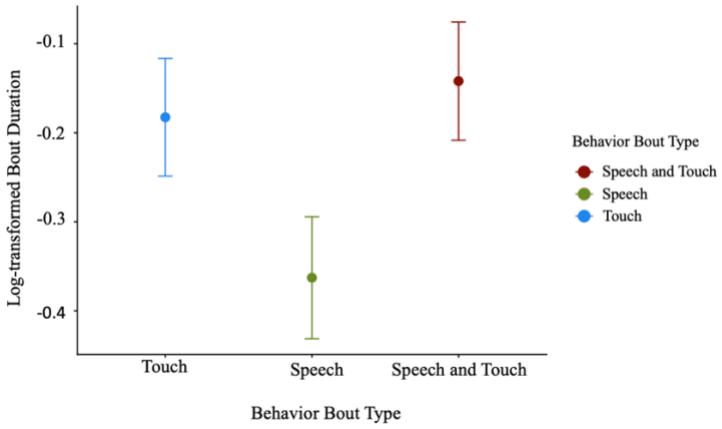
***Differences in behavioral bout duration***

A linear mixed-effects model revealed a significant overall effect of behavioral bout type on log-transformed bout duration, $F$ (2, 9912.7) = 44.97, $p$ < .001. Tukey-adjusted pairwise comparisons on the log-transformed scale indicated that speech-and-touch bouts were significantly longer than speech-only bouts, $\beta$ = 0.22, $SE$ = 0.02, $z$ = 9.09, $p$ < .001. In addition, touch-only bouts were significantly longer than speech-only bouts, $\beta$= 0.18, $SE$ = 0.02, $z$ = 7.41, $p$ < .001. In contrast, speech-and-touch and touch-only bouts did not significantly differ in duration, $\beta$= 0.04, $SE$ = 0.02, $z$ = 1.81, $p$ = .168 (see Figure 4.2).

Back-transformed estimated marginal means indicated that speech-and-touch bouts has the longest geometric mean duration (0.87 s, 95% CI [0.81, 0.93]), followed by touch-only bouts 0.83 s, 95% CI [0.78, 0.89]), and speech-only bouts 0.70 s, 95% CI [0.65, 0.74]). Because the bout duration was log transformed, these values represent geometric rather than arithmetic means, and comparisons between conditions reflect relative differences in bout duration. Overall, bout duration differed by behavioral bout type, with speech-and-touch and touch-only bouts having longer durations than speech-only bouts, whereas speech-and-touch and touch-only bouts did not significantly differ in duration.

**Figure 4.2**

*Log-Transformed Bout Duration by Behavior Type*




***Differences in maternal behavioral bout type frequency and acculturation***

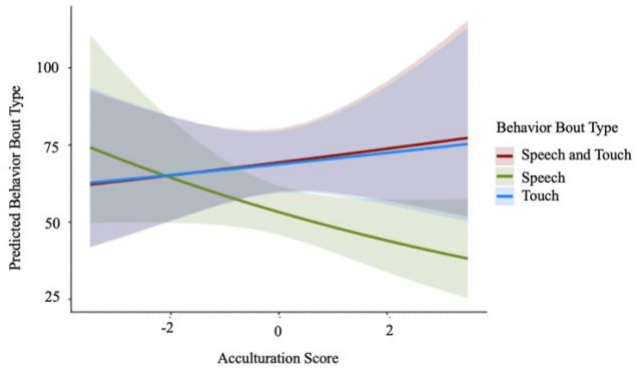
The model revealed that the main effect of maternal acculturation was not significantly, $\beta = -0.012$, $SE = 0.046$, $z = -0.26$, $p = .791$. In contrast, behavioral bout type was associated with bout frequency. Relative to speech-and-touch bouts, mothers produced fewer speech-only bouts, $\beta = -0.26$, $SE = 0.07$, $z = -3.75$, $p < .001$, and touch-only bouts did not differ significantly from speech-and-touch bouts, $\beta = -0.01$, $SE = 0.07$, $z = -0.12$, $p = .904$ (see Figure 4.3).

The interaction between behavioral bout type and maternal acculturation was significant for speech-only bouts relative to speech-and-touch bouts, $\beta = -0.13$, $SE = 0.05$, $z = -2.46$, $p = .014$. However, the interaction between touch-only bouts and maternal acculturation was not significant, $\beta = -0.005$, $SE = 0.05$, $z = -0.10$, $p = .923$. Follow up comparisons indicated that maternal acculturation was not significantly associated with the frequency of speech-and-touch bouts, $\beta = 0.03$, $SE = 0.05$, 95% CI [−0.08, 0.14], speech-only bouts, $\beta = -0.10$, $SE = 0.05$, 95% CI [−0.20, 0.01], or touch-only bouts, $\beta = 0.03$, $SE = 0.05$, 95% CI [−0.08, 0.13]. However, the acculturation slope for speech-only bouts was significantly lower than the slope for speech-and-touch bouts, $\beta = 0.13$, $SE = 0.05$, $z = 2.46$, $p = .037$. The acculturation slopes did not differ between speech-and-touch and touch-only bouts, $p = .995$, or between speech-only and touch-only bouts, $p = .052$.

Estimated marginal means indicated that mothers produced 69.6 speech-and-touch bouts, 95% CI [60.0, 80.7], 68.9 touch-only bouts, 95% CI [59.6, 79.7], and 53.9 speech-only bouts, 95% CI [46.4, 62.5] per 15-minute observation. Tukey-adjusted pairwise comparisons indicated that mothers produced more speech-and-touch bouts than speech-only bouts ($p = .001$) and more touch-only bouts than speech-only bouts ($p = .002$). Speech-and-touch and touch-only bouts did not differ significantly ($p = .990$). Thus, mothers produced speech-and-touch and touch-only bouts at similar frequencies, and both occurred more frequently than speech-only bouts. Although maternal acculturation was not independently associated the frequency or any behavioral bout type, the significant interaction indicated that the association between acculturation and bout frequency differed between speech-only and speech-and-touch bouts.

**Figure 4.3**

*Predicted maternal behavioral bout frequency across maternal acculturation*




In a follow-up exploratory analysis, we examined whether generation status was associated with behavioral bout frequency and whether the association between behavioral bout type and bout frequency varied as a function of generation status. Generation status was not significantly associated with bout frequency, $\beta = -0.007$, $SE = 0.100$, $z = -0.07$, $p = .943$. In addition, the interaction between generation status and speech-only bouts was not significant, $\beta = -0.089$, $SE = 0.102$, $z = -0.87$, $p = .382$, nor the interaction between generation status and touch-only bouts, $\beta = -0.002$, $SE = 0.095$, $z = -0.02$, $p = .986$. The pattern of behavioral bout frequency did not differ as a function of generation status and was consistent with the findings from the acculturation analysis.

***Differences in maternal behavioral bout duration and acculturation***

A linear mixed-effect model revealed that maternal acculturation was not significantly associated with behavioral bout duration, $\beta = 0.001$, $SE = 0.025$, $t$ (60.75) = 0.06, $p = .955$ (see Figure 4.4). Behavioral bout type was associated with bout duration. Relative to speech-and-touch bouts, speech-only bouts were significantly shorter, $\beta = -0.23$, $SE = 0.024$, $t$ (9917) = -9.41, $p < .001$. However, touch-only bouts did not significantly differ from speech-and-touch bouts, $\beta = -0.04$, $SE = 0.022$, $t$ (9907) = - 1.81, $p = .070$.

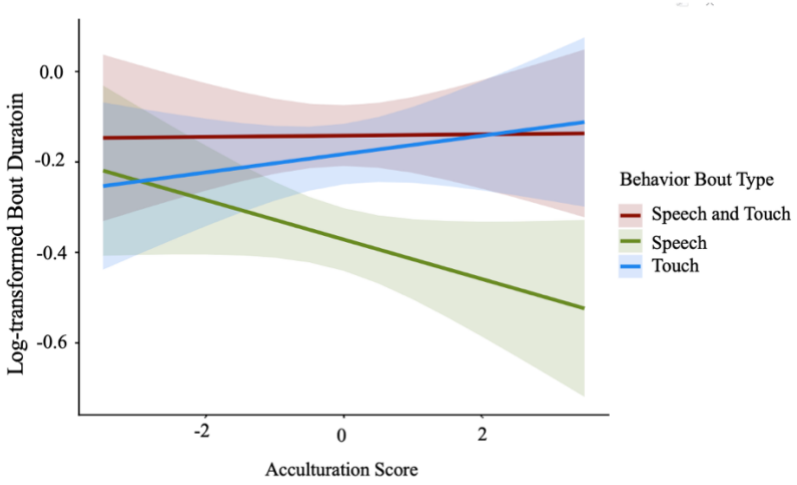
There was a significant interaction between behavioral bout type and maternal acculturation for speech-only bouts relative to speech-and-touch bouts, $\beta = -0.045$, $SE = 0.018$, $t\ (9910) = -2.52$, $p = .012$. The interaction between touch-only bouts and maternal acculturation was not significant, $\beta = 0.019$, $SE = 0.016$, $t\ (9891) = 1.15$, $p = .251$. Follow-up tests of the simple slopes showed that maternal acculturation was not significantly associated with duration for speech-and-touch bouts, $\beta = 0.001$, $SE = 0.025$, 95% CI [−0.048, 0.051], speech-only bouts, $\beta = -0.044$, $SE = 0.026$, 95% CI [−0.095, 0.008], or touch-only bouts, $\beta = 0.020$, $SE = 0.025$, 95% CI [−0.029, 0.070]. In contrast, Tukey-adjusted comparisons indicated that the acculturation slope for speech-only bouts was significantly more negative than the slopes for speech-and-touch bouts ($p = .031$) and touch-only bouts ($p = .001$), whereas the slopes for speech-and-touch and touch-only bouts did not significantly differ ($p = .484$).

Tukey-adjusted pairwise comparisons of behavioral bout types indicated that speech-and-touch bouts were significantly longer than speech-only bouts ($p < .001$), whereas speech-and-touch and touch-only bouts did not significantly differ ($p = .167$). Touch-only bouts were also significantly longer than speech-only bouts ($p < .001$). Back-transformed estimated marginal means indicated that speech-and-touch bouts have a geometric mean duration of 0.87 s (95% CI [0.81, 0.93]), touch-only bouts had a geometric mean duration of 0.83 s (95% CI [0.78, 0.89]), and speech-only bouts had a geometric mean duration of 0.70 s (95% CI [0.65, 0.75]). Because the outcome as log-transformed, these values represent geometric rather than arithmetic means, and comparisons between conditions reflect relative differences in bout duration.

The findings suggest that maternal acculturation was not independently associated with behavioral bout duration. However, the significant interaction suggests that the association between acculturation and bout duration differed across behavioral bout types. The acculturation slope for speech-only bouts was significantly more negative than those slopes for speech-and-touch and touch-only bouts. Independent of maternal acculturation, speech-and-touch and touch-only bouts were longer than speech-only bouts.

***Figure 4.4***

*Association between maternal acculturation and log-transformed bout duration by behavioral bout type*




In a follow-up exploratory analysis, we examined whether behavioral bout duration varied as a function of generation status and whether differences across behavioral bout types varied by generation status. The linear mixed-effects model revealed no significant main effect of generation status on bout duration. Relative to first-generation mothers, second generation mothers did not significantly differ in bout duration, β = −0.028, SE = 0.073, *t* (60.94) = −0.38, p = .706; third-generation mothers did not significantly differ, β = 0.000, SE = 0.112, *t* (64.95) = 0.00, p = .998; and fourth-generation mothers did not significantly differ, β = 0.219, SE = 0.241, *t* (59.62) = 0.91, p = .369.

The model revealed significant interactions between generation status and behavioral bout type for speech-only bouts relative to speech-and-touch bouts among second generation mothers, $\beta = 0.148$, $SE = 0.052$, $t$ (9911) = 2.85, $p = .004$, and third generation mothers, $\beta = 0.157$, $SE = 0.080$, $t$ (9911) = 1.97, $p = .049$. The interaction between speech-only bouts and fourth generation mothers was not significant, $\beta = -0.505$, $SE = 0.676$, $t$ (9867) = −0.75, $p = .455$. Interactions between touch-only bouts and generation status were significant for second-generation mothers, $\beta = 0.097$, $SE = 0.048$, $t$ (9905) = 2.02, $p = .044$,

and third-generation mothers, $\beta = -0.163$, $SE = 0.076$, $t\ (9896) = -2.15$, $p = .032$, but not for fourth generation mothers, $\beta = 0.029$, $SE = 0.177$, $t\ (9870) = 1.65$, $p = .099$.

Back-transformed estimated marginal means indicated that geometric mean bout duration varied across generation status and behavioral bout type. Among first generation mothers, geometric mean durations were 0.88 s for speech-and-touch bouts (95% CI [0.79, 0.97]), 0.64 s for speech-only bouts (95% CI [0.58, 0.72]), and 0.82 s for touch-only bouts (95% CI [0.74, 0.90]). Among second generation mothers, geometric mean durations were 0.85 s for speech-and-touch bouts, (95% CI [0.77, 0.94]), 0.73 s for speech-only bouts (95% CI [0.65, 0.80]), and 0.87 s for touch-only bouts (95% CI [0.79, 0.97]). Among third generation mothers, geometric mean durations were 0.88 s for speech-and-touch bouts (95% CI [0.72, 1.06]), 0.75 s for speech-only bouts (95% CI [0.62, 0.92]), and 0.69 s for touch-only bouts (95% CI [0.57, 0.84]). Among fourth generation mothers, geometric mean durations were 1.09 s for speech-and-touch bouts (95% CI [0.69, 1.73]), 0.48 s for speech-only bouts (95% CI [0.12, 1.89]), and 1.36 s for touch-only bouts (95% CI [0.84, 2.20]). Because bout duration was analyzed on the log-transformed scale, these back-transformed estimated marginal means represent geometric rather than arithmetic means and on the original scale of measurement.

Tukey-adjusted pairwise comparisons suggested that among first generation mothers, speech-and-touch bouts were significantly longer than speech-only bouts ($p < .001$), whereas speech-and-touch and touch-only bouts did not significantly differ ($p = .101$). Touch-only bouts were also significantly longer than speech-only bouts ($p < .001$). Among second generation mothers, speech-and-touch bouts were significantly longer than speech-only bouts ($p < .001$), whereas speech-and-touch and touch-only bouts did not differ significantly ($p = .722$). Touch-only bouts were also significantly longer than speech-only bouts ($p < .001$). Among third generation mothers, speech-and-touch bouts were significantly longer than touch-only bouts ($p =. 001$), whereas speech-and-touch and speech-only bouts ($p =. 077$) and speech-only and touch-only bouts ($p =. 467$) did not significantly differ. None of the pairwise comparisons among fourth generation mothers were significant (all $ps >. 279$).

Overall, generation status was not associated with an overall difference in behavioral bout duration. However, the significant interactions indicated that differences in bout duration across behavioral bout types varied by generation status.

**General Discussion**

The present study examined how Mexican American mothers' speech and touch co-occurred during naturalistic interactions with their 18-month-old infants and whether mothers' acculturation was associated with variations in these behaviors. Building on previous research on caregivers' multimodal behaviors, this work characterized how mothers coordinated touch and speech during everyday interactions and examined whether these interactional patterns varied as a function of maternal acculturation. Across the analyses, speech-and-touch and touch-only bouts occurred at similar frequencies and both occurred more frequently than speech-only bouts. Maternal acculturation was not associated with behavioral bout frequency or duration. Nevertheless, in follow-up generation status analysis, generation status moderated the association between behavioral bout type and bout duration, suggesting that the pattern of duration across behavioral bout types differed across generations.

Consistent with our first hypothesis, Mexican American mothers frequently coordinated touch and speech during interactions with their infants. Speech-and-touch bouts occurred more frequently than speech-only bouts, suggesting that mothers commonly combined tactile and verbal cues during mother-infant interactions. However, contrary to our prediction, speech-and-touch bouts and touch-only bouts occurred at similar frequencies, with both occurring more frequently than speech-only bouts. These findings suggest that touch is a prominent component of mother-infant interactions, when presented with speech or when used independently. These findings suggest that touch was a prominent component of mothers' interactions with their infants, both when combined with speech and when used independently of speech in the present sample. This pattern is consistent with previous research demonstrating that caregivers coordinate multiple behavioral modalities during interactions (Abu-Zhaya et al., 2017; Deák et

al., 2014; Kosie & Lew-Williams, 2024), while also highlighting the role of touch in caregiver-infant interactions.

For the second hypothesis, we found that speech-and-touch bouts were significantly longer than speech-only bouts, and touch-only bouts were also significantly longer than speech-only bouts. However, speech-and-touch bouts and touch-only bouts did not differ significantly in duration. Because bout duration was positively skewed, duration was log transformed for analysis: therefore, the model estimates reflect relative differences in bout duration. Overall, bouts involving touch, whether accompanied by speech or occurring independently, were sustained for longer periods than speech-only bouts. This pattern suggests that touch may contribute to the organization of mothers' interactions with their infants. Previous research suggests that touch can support infants' attention, emotion regulation, and exploration by providing tactile information and helping caregivers guide infants' actions (Tamis-LeMonda & Lockman, 2020). Although the present study did not directly examine these functions, the longer duration of bouts involving touch is consistent with the possibility that touch serves functions within caregiver-infant interactions. More broadly, these findings contribute to research demonstrating that caregivers coordinate multiple behavioral modalities during interactions, providing infants with multiple forms of information that may support engagement and learning.

For the third hypothesis, maternal acculturation was not significantly associated with the frequency and duration of touch-only, speech-only, and speech-and-touch behavioral bouts. Although the interactions between behavioral bout type and maternal acculturation was significantly, follow-up comparisons indicated that acculturation was not significantly associated with the frequency of any individual bout type. Rather, the association between acculturation and bout frequency differed between speech-only and speech-and-touch bouts. Maternal acculturation was also not significantly associated with the relative behavioral bout duration. Thus, contrary to our prediction, mothers with stronger Mexican cultural orientation (i.e. lower acculturation levels) did not produce more touch-based behaviors than mothers with stronger Anglo cultural orientation (i.e. higher acculturation levels). Overall, these

findings suggest that within-group differences in maternal acculturation were not simply associated with how frequently or how long mothers used touch and speech during naturalistic play session.

In the exploratory analysis of generation status, generation was not significantly associated with overall bout duration or frequency, However, generation status moderated the association between behavioral bout type and bout duration, indicating that differences in duration across speech-only, touch-only and speech-and-touch bouts varied across generations. These findings should be interpreted cautiously given the small number of mothers in the third and fourth generation groups.

This finding does not suggest that maternal acculturation is irrelevant to caregivers' behaviors; rather, it suggests that variation in acculturation may not be expressed through differences in the overall frequency of touch and speech within this particular Mexican American sample and naturalistic play context. Prior work has demonstrated cultural differences in caregivers' use of verbal, tactile, and nonverbal behaviors (Bornstein, 2012; Cote et al., 2008; Luo & Tamis-LeMonda, 2016). For example, Mexican-origin caregivers have been found to use physical and nonverbal behaviors during interactions, which suggests that touch may be an important factor of mother-infant communication. Nevertheless, the majority of the research has compared families from different cultural or ethnic groups. The present study examined variation within a group of Mexican American mothers. The absence of an association between acculturation and behavioral frequency or relative bout duration may indicate that mothers in this sample showed similar overall patterns of touch and speech use despite differences in their levels of acculturation.

In addition, the present findings suggest that frequency alone may not fully capture how acculturation is expressed in mother-infant interactions. While acculturation was not significantly associated with the frequency of any individual behavioral bout type, behavioral bout type was strongly associated with frequency. Mothers produced speech-and-touch and touch-only bouts at similar frequencies, and both occurred more frequently than speech-only bouts. This pattern was consistent across levels of acculturation and suggests that touch continues to be a prominent component of maternal

interaction. It is possible that cultural variation is expressed less in whether mothers use touch and speech and more in how the behaviors are used and coordinated. For example, mothers may differ in the functions, timing, or social meanings of touch while producing similar overall numbers of touch bouts. Examining these qualitive and functional aspects of maternal behavior may therefore provide a more sensitive way to understand how cultural experiences are reflected in mother-infant interactions.

Another interpretation of the present findings is that the naturalistic context of the present study may have contributed to the lack of an association with acculturation. Mothers interacted with their 18-month old infants during play at home, where mothers' behaviors were likely influenced by immediate interactional demands. At this age, infants are able to move independently and actively participate in interactions; therefore, mothers may adjust their use of touch and speech in response to infants' attention and actions. Thus, immediate characteristics of the interaction may be more closely related to mothers' behavioral choices than differences in acculturation. The present study focused on the frequency and duration of maternal behavioral bouts rather than their specific functions, which limits our ability to assess whether acculturation may be related to how mothers use touch and speech for different interactional purposes.

Although generation status was not associated with an overall difference in bout duration, the follow-up analysis revealed that generation status moderated the relationship between behavioral bout type and duration. More importantly, the relationship between generation status and duration differed for speech-only and touch-only bouts relative to speech-and-touch bouts. Among second generation mothers, the relative durations of speech-only and touch-only bouts compared with speech-and-touch bouts differed from those observed among first-generation mothers. Similarly, third generation mothers demonstrated the same patterns, although the direction of the interaction for touch-only bouts differed from that observed for the second generation mothers. These findings suggest that generation status may be related to differences in the relative duration of behavioral bout types rather than to an overall increase or decrease in bout duration.

Moreover, the generation-status findings should be distinguished from the maternal acculturation findings. Acculturation was not significantly associated with either behavioral bout frequency or relative bout duration, whereas generation status interacted with behavioral bout type in predicting duration. Hence, generation status and acculturation did not show identical patterns of association with maternal behavior. Generation status may capture aspects of mothers' cultural experiences that are not fully represented by individual acculturation scores. In addition, the present findings cannot establish that generational differences reflect cultural transmission, as generational status may also be associated with other social or contextual factors. Future research should therefore move beyond behavioral frequency and duration to examine the functions of touch and speech and how these behaviors are coordinated with infants' attention and actions. Examining multiple dimensions of cultural experience, including acculturation, generation status, and other aspects of cultural context may provide a more complete understanding of how acculturation is associated with mother-infant interactions.

**Limitations**

There are several limitations to the current study that provide directions for future research. First, the study focused on a specific form of maternal touch. This approach allowed us to examine how mothers' use of touch directed toward their infants, but it did not capture the broader range of tactile behaviors that may occur during mother-infant interactions. Much of the existing research examining Mexican American and Latine families has focused on affectional touch and proximal caregiving practices as culturally meaningful forms of interaction. Therefore, it remains unclear whether the patterns observed in the present study reflect broader cultural patterns of maternal touch. Future research should examine multiple forms of touch, including affectional and regulatory touch, to better understand how different forms of tactile behavior function during mother-infant interactions and whether their use varies across cultural contexts.

Second, the present study focused primarily on maternal behavior and did not examine how maternal touch and speech were associated with infants' concurrent behaviors and responses. This is an

important limitation because caregiver–infant interactions are reciprocal, and infants' behaviors may influence the timing and form of maternal input. Prior research has demonstrated associations between caregivers' multimodal behaviors and infants' attention, suggesting that maternal touch and speech may provide infants with multiple cues that support attention (Suárez-Rivera et al., 2022; Chen et al., 2021). Future research should examine how mothers' touch, speech, and coordinated behaviors are associated with infants' attention to objects. For example, researchers could examine whether infants are more likely to orient toward, maintain attention to, or shift their attention toward an object when mothers touch the infant, touch the object, speak about the object, or coordinate speech and touch. Such analyses would provide greater insight into whether the behavioral patterns identified in the present study serve distinct functions.

Future research should also consider infant affect during play. Infants' emotional states may influence mothers' use of touch and speech, while mothers' tactile and verbal behaviors may, in turn, be associated with infants' emotional regulation. For example, mothers may increase physical contact or modify their speech when infants become frustrated or distressed, whereas positive infant affect may be associated with more socially orienteered or playful forms of interactions. Examining infant affect alongside maternal touch and speech would therefore provide greater insight into whether these behaviors are associated with attention and learning from those that serve emotional regulation. Future research could whether mothers' use of touch and speech varies as a function of infants' affective states and whether particularly combinations of touch and speech are associated with changes in infant affect over the course of an interaction. Such analyses would provide a more complete understanding of how maternal behaviors and infant affect are related over the course of mother-infant interactions.

**Conclusion**

Taken together, the findings demonstrate that Mexican American mothers frequently incorporated touch into their interactions with their 18-month-old infants. Speech-and-touch and touch-only bouts occurred at similar frequencies, and both occurred more frequently than speech-only bouts. In addition,

speech-and-touch and touch-only bouts were longer in duration than speech-only bouts. Maternal acculturation was not associated with overall differences in behavioral bout frequency or relative bout duration. Similarly, generation status was not associated with overall differences in bout frequency or duration. However, generation status interacted with behavioral bout type in predicting bout duration, suggesting that differences in duration across behavioral bout types varied by generation status. These findings highlight the essential role of touch in Mexican American mother-infant interactions while providing limited evidence that maternal acculturation was associated with the overall frequency or duration of mothers' touch and speech behaviors.

# CHAPTER 5

## GENERAL CONCLUSION

The present dissertation begins to address gaps in developmental psychology by examining caregiver-infant interactions as multimodal, culturally and linguistically embedded processes. Across the three studies, the dissertation examined how caregivers coordinated speech, gesture, and touch during interactions with their infants and whether variability in caregiver behavior was associated with infant attention, linguistic context, and maternal acculturation. The findings provide evidence that caregiver-infant interactions are multimodal, with caregivers coordinating multiple forms of communication during everyday interactions. At the same time, variability in caregiver behavior was more clearly associated with features of the behavioral and linguistic context than the broad measures of maternal acculturation.

In Study 1, the relation between caregiver behavior and infant attention varied across bilingual and monolingual language groups. Among bilingual parents, language use was associated with infant attention. Study 2 demonstrated that maternal language use was associated with utterance function, whereas maternal acculturation was not associated with utterance function. Similarly, Study 3 found that maternal acculturation was not associated with the overall frequency or duration of touch and speech. However, generation status moderated the relation between behavioral bout type and bout duration. These findings suggest that understanding caregiver-infant interactions requires attention to the behaviors caregivers use, the linguistic context in which those behaviors occur, and the specific characteristics of the interaction, rather than broad measures of acculturation.

A central contribution of the present dissertation is highlighting that caregiver communication during infancy is not limited to individual behavioral modalities. Across Studies 1 and 3, caregivers frequently coordinated multiple forms of communication, including speech with gesture and speech with touch. These findings are consistent with theoretical perspectives that conceptualize caregiver-infant interactions as involving the coordination of multiple behavior components (Thelen & Smith, 1994).

Rather than interpreting speech, gesture, and touch as independent sources of input, examining their co-occurrence provides a more comprehensive account of how caregivers communicate with infants.

The findings of Study 1 are consistent with research demonstrating that caregivers coordinate speech and nonverbal behaviors to support infants' attention and engagement (Chen et al., 2021; Schroer & Yu, 2022; Suárez-Rivera et al., 2022). At the same time, the present findings suggest that the relation between multimodal caregiver behavior and infant attention may depend on the linguistic context in which those behaviors occur. Because the present study was observational, these findings cannot establish that gesture-and-speech combinations caused infants to sustain attention for longer periods. Caregiver behavior may also be responsive to infants' existing attention states. The findings are consistent with a perspective in which caregiver behavior and infant attention are embedded with an ongoing interactional system.

Study 3 further demonstrated the importance of examining caregiver communication across modalities. The findings indicate that touch was a prominent component of the maternal interactions examined in the present study. In addition, this pattern of touch was observed across mothers with different levels of acculturation, suggesting that the prominence of touch in these interactions was not explained by differences in broad measures of acculturation. Together, Studies 1 and 3 demonstrate that caregivers frequently coordinate multiple behavioral modalities during interactions with infants. However, these studies also suggest that the meaning and potential relevance of these behaviors cannot be determined only from their frequency alone. The same behavioral pattern may occur in different interactional contexts and serve different functions.

In addition to demonstrating the multimodal nature of caregiver communication, the present dissertation highlights the importance of linguistic context in caregiver-infant interactions. Across Studies 1 and 2, language use was associated with both infant attention and the organization of caregiver speech. These findings suggest that the language caregivers use during interactions with their infant may represent an important feature of their environment, beyond simply whether a caregiver is monolingual or bilingual.

Study 1 provided evidence that bilingual parents produced more Spanish than English bouts, consistent with their reported patterns of language. Additionally, infants demonstrated longer attention during Spanish than English overall. However, language use did not interact with the type of behavior parents used, suggesting that the association between language and infant attention did not differ depending on whether parents provided gesture and speech together or speech only. Although multimodal behaviors were associated with infant attention, the specific language used by bilingual parents was also associated with infants' attention. This finding suggests that the linguistic context in which caregiver behaviors occur may be relevant to infants' moment-to-moment engagement.

Similarity, Study 2 demonstrated an association between linguistic context and caregiver communication. Mothers' regulatory utterances were more likely to occur in Spanish and Language Mixing than in English, whereas referential utterances were more likely to occur in English. Furthermore, Language Mixing was more likely to be an attentional directive than a behavioral directive relative to English. These findings suggest that bilingual mothers may organize their speech differently depending on the language being used during interactions. However, these findings do not establish why mothers selected a particular language or whether language choice was associated to a specific communicative goal. Rather, the study demonstrated that language use and utterance functions were associated within mother-infant interactions.

Studies 1 and 2 provide an insight to parent-child interactions in relation to infant attention and linguistic context. In Study 1, linguistic context was associated with infant attention, whereas in Study 2, linguistic context was associated with maternal utterance function. Together, these findings suggest that language may be an important feature of bilingual caregiver-infant interactions. Language use occurs within specific social and interactional contexts, and these contexts may contribute to the patterns observed in the present studies.

In contrast to the findings involving language use, the present dissertation did not provide evidence that broad measures of maternal acculturation predicted the caregiver behaviors examined in

Studies 2 and 3. Study 2 demonstrated that maternal acculturation was not associated with the use of regulatory versus referential utterances. Study 3 similarly found that maternal acculturation was not associated with the frequency or relative duration of touch and speech behaviors. Thus, although the dissertation examined mothers' acculturation levels as an important component of mother-infant interactions, the findings do not support the conclusion that mothers' acculturation levels directly predicted how they communicate with their infants.

More importantly, the distinction between language use and acculturation is important. Language use represented an immediate feature of the interaction and was associated with maternal utterance function and infant attention, whereas maternal acculturation did not significantly predict caregivers' behaviors that were examined in the studies. This pattern suggests that acculturation may not capture specific experiences or practices that are relevant to caregiver-infant communication. Acculturation is a multidimensional and context-dependent process that can encompass language, identity, values, and practices (Berry & Sam, 1997; Schwartz et al., 2010). Mothers with similar acculturation scores may therefore differ in their everyday language practices or interactional experiences.

The findings from Study 3 further illustrate the importance of distinguishing acculturation from other indicators of caregivers' experiences. Although maternal acculturation was not associated with mothers' speech and touch behaviors, generation status moderated the relation between mothers' behaviors and duration of the behaviors. These findings suggest that the organization of caregiver behaviors may vary across generations. However, generation status should not be interpreted as a direct measure of acculturation, and the present findings cannot establish that the differences found resulted from acculturation. The findings therefore suggest that different dimensions of caregivers' backgrounds may capture different forms of variability in caregiver-infant interactions. The findings from Studies 2 and 3 further suggest that within-group variability in caregiver communication may not be fully captured by a single measure of acculturation. Instead, examining specific linguistic practices, behavioral contexts,

and dimensions of caregivers' experiences may provide a more sensitive understanding of caregiver-infant interactions.

Taken together, the findings are consistent with a perspective in which caregiver–infant interactions involve the coordination of multiple behavioral and environmental components (Thelen & Smith, 1994). Across the three studies, caregiver behaviors were not isolated from the broader interactional context. Instead, variation was observed according to behavioral modality, linguistic context, infant attention, and, in Study 3, generation status. These findings highlight the importance of examining caregiver behavior as part of an ongoing system rather than as a stable characteristic of caregivers.

The present studies provide an initial step toward integrating multimodal caregiver behavior, infant attention, and linguistic context within developmental research. However, a stronger test of processes that unfold over time will require research that examines caregiver and infant behaviors continuously over time. In particular, future studies should investigate whether changes in infant attention, affect, or actions precede changes in caregiver speech, gesture, and touch, and whether caregiver behaviors subsequently influence infants' attention and engagement. Such approaches would more directly test the dynamic systems perspectives and provide greater insight into how caregiver–infant interactions unfold moment by moment.

Taken together, the three studies herein demonstrate that caregiver-infant interactions are multimodal and are consistent with a dynamic-systems perspective. Across the studies, caregivers coordinated multiple forms of communication, including speech, gesture, and touch, while variation in caregiver behavior and infant attention was more clearly associated with features of the immediate interaction and linguistic context than with broad measures of maternal acculturation. Findings from this dissertation begin to address the existing gaps in the developmental literature by integrating infant attention with multiple forms of caregiver communication, including speech, gesture, and touch (Masek et al., 2021; Yu & Smith, 2012), while examining variability in caregivers' linguistic and cultural experiences. This dissertation provides a more nuanced understanding of the diverse ways caregivers may

communicate with and support infants' attention during everyday interactions. These findings further emphasize the importance of moving beyond universal assumptions about caregiver-infant interactions and considering how caregivers' cultural and linguistic experiences may shape patterns of communication (Bornstein et al., 2012; Cote et al., 2008; Yu et al., 2016). Overall, this dissertation contributes to a growing body of literature underscoring the context-dependent nature of caregiver-infant interactions. This work also provides a foundation for future research to examine how infants' attention, caregivers' multimodal behaviors, and cultural and linguistic experiences may relate to one another to support learning and development.

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