

Linguistic Environment of Persian-Learning Infants in Iran:
Quantity and Prosodic Characteristics of Caregiver Speech

by

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Abstract

The language environment of infants—particularly the characteristics of caregiver speech—plays a central role in early language development. Although infant-directed speech (IDS) has been extensively examined in WEIRD (Western, educated, industrialized, rich and democratic) contexts, its features in Middle Eastern (ME) settings remain understudied, limiting cross-cultural understanding. Existing ME studies mainly offer qualitative descriptions or examine limited IDS features using small samples, and quantitative acoustic analyses—especially those from naturalistic longform recordings—are almost absent. No prior research has investigated speech quantity, prosodic characteristics, or developmental changes in IDS among Persian infants. Addressing this gap, this dissertation investigates the linguistic input of infants in Iran, focusing on speech quantity and the prosodic characteristics of IDS in Persian mothers.

This study used the Language ENvironment Analysis (LENA) system, analyzing ~605 hours of home audio recordings from 50 infants (6–13 months) in Mashhad, Iran, supplemented by demographic questionnaires, automated and manual annotations, and acoustic analyses. Adult speech quantity and prosodic features of IDS were examined using multiple regressions, Wilcoxon signed-rank test, and linear mixed-effects models in R to evaluate: (1) associations between infant age, sex, and socioeconomic status (SES) and adult speech quantity; (2) gender differences in speech input; and (3) prosodic modifications in IDS and their developmental changes. Cross-linguistic comparisons situate Persian IDS within broader global patterns.

Key findings were: (1) Adult Word Count (AWC) was not significantly associated with infant age, sex, or caregiver SES. (2) Infants heard significantly more speech from female than male adult speakers, with a gender gap larger than those reported in many Western samples. (3)

Mothers tended to use higher mean pitch, greater pitch variability, and shorter utterances in IDS relative to adult-directed speech (ADS). (4) None of the prosodic features in Persian IDS showed strong evidence of developmental change across the 6–13-month age range. (5) Cross-linguistically, Persian IDS ranked among the highest for mean pitch and medium-to-high for pitch variability.

This dissertation provides the first large-scale, naturalistic evidence on the linguistic environment of Persian-learning infants in Iran and highlights the importance of including underrepresented ME contexts in early language development research.

Keywords: caregiver speech, infant-directed speech (IDS), Persian (Farsi), non-WEIRD Middle Eastern context, Adult Word Count (AWC), LENA system, manual annotation, acoustic analysis.

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Chapter 1: Introduction to Infant Language Development and Study Objectives

1.1 Background and Significance of the Study

Language development is a cornerstone of early childhood, with foundational processes occurring in infancy. During these early years of life, infants are immersed in a language environment, which influences various aspects of their development. One of the most impactful aspects of this environment is the linguistic input infants receive from their caregivers, particularly through the speech directed to them, infant-directed speech (IDS).

IDS is characterized by distinct prosodic and linguistic features—such as higher pitch and shorter utterances—that differentiate it from the speech directed to adults, adult-directed speech (ADS). IDS is recognized as a key input that supports various aspects of infant development. It captures and maintains infant attention, and supports infants' social and emotional development, as well as cognitive and linguistic development (e.g. Bosseler et al., 2016; Cooper & Aslin, 1990; Fernald, 1993; Goldstein et al., 2003; Kalashnikova et al., 2018; Soderstrom, 2007; Trainor et al., 2000; Werker & McLeod, 1989).

Research shows that caregivers across various languages and cultures modify their speech when addressing infants relative to adults, and while some prosodic features of IDS—such as higher pitch—are commonly observed (Cox et al., 2023; Hilton et al., 2022), cross-linguistic and cross-cultural research reveals variations. For instance, Quiche Mayan caregivers in a seminal study did not use higher pitch with infants, reserving it instead for those of higher social status (Ratner & Pye, 1984). The extent of prosodic modification also varies across languages and cultures, with Swedish and American English showing the highest mean pitch, while Kenyan and Fijian languages were among those with the lowest (Cox et al., 2023). In

addition to the variations in infant-directed vocalization behaviors, differences have also been documented in the quantity of speech directed to and overheard by infants, the primary speaker in the linguistic input of infants, and the types of input infants received from their language environment across diverse languages and cultures (e.g., Cristia et al., 2019; Cristia, 2023; Farran et al., 2016; Shneidman & Goldin-Meadow, 2012). Such findings underscore the importance of considering linguistic and cultural adaptations in infants' linguistic input, which may reflect the unique experience and variations infants may experience within specific contexts. Understanding these nuances is essential for developing comprehensive and inclusive theories of early language development.

Despite decades of research in infant language development, several key gaps remain—particularly regarding the linguistic environments of infants in Middle Eastern (ME) contexts. While IDS has been widely studied in Western contexts, evidence from ME populations remains limited and often methodologically constrained. Existing work has largely focused on qualitative descriptions (e.g., interviews, observational reports) or small-scale analyses, without quantitative measures of speech quantity or acoustically based prosodic analysis. No research to date has used naturalistic longform audio recordings in Iran to investigate the linguistic environment of Persian infants. This lack of large-scale, quantitative evidence restricts the generalizability of early language research theories—particularly IDS—which have been shaped predominantly by WEIRD (Western, educated, industrialized, rich and democratic) populations (Henrich et al., 2010), leaving limited insight into how cultural and linguistic variation shapes IDS and overall infant language input.

The present dissertation addresses these gaps by providing the first naturalistic, acoustic analysis of the linguistic environment of Persian-learning infants in Iran using extensive daylong recordings. Because little is known about the linguistic input received by Persian-learning infants—particularly regarding speech quantity, sources of input, demographic and socioeconomic influences, and prosodic features of caregiver speech—this work expands the empirical foundation needed to develop more inclusive and culturally generalizable theories of early language development.

In particular, the Persian cultural context may offer unique caregiving practices that may influence the linguistic environment of infants. For instance, families in Iran often emphasize collectivist values, with mothers having the majority of the responsibility for infant care, and the caregiving responsibilities shared among extended family or relatives, such as grandparents (Mazandarani & Bahramabadi, 2023). These sociocultural norms may affect the nature of speech input infants receive. Furthermore, research suggests that Persian caregivers differ not only in the amount of speech they direct to infants, but also in its form, which may reflect their collectivist cultural values. For instance, mothers tend to use more interrogatives and fewer imperatives, while fathers use more directive language, such as imperatives—reflecting traditional gender roles and authoritative paternal norms in Iranian culture (Abkarian et al., 2003; Rafatbakhsh et al., 2017). These patterns highlight how cultural norms and gender roles shape caregiver speech to infants.

Persian—a language with rich prosody and a long literary and cultural history—spoken in Iran, a Middle Eastern country with collectivist cultural values—may exhibit unique patterns in the linguistic input of infants. Cultural differences may shape both how linguistic input relates to

infant characteristics and caregiver sociodemographic factors, and how IDS manifests in this context. Examining infant linguistic input in such a setting can provide culturally grounded insights that could challenge assumptions derived from WEIRD samples and contribute to refining theories of infant language development.

1.2 Research Questions

This dissertation addresses these research gaps by exploring the language environment of Persian-learning infants in Iran. The study is guided by the following research questions:

1. Is there any relationship between the age and sex of the Persian infants and the quantity of speech they receive?
2. Is there any relationship between the Persian caregivers' socioeconomic status (SES)—including family income and maternal education—and the quantity of speech their infants receive?
3. Do Persian infants receive more speech from female or male adult speakers?
4. Do Persian caregivers modify the prosodic characteristics of their speech when addressing their infants relative to adults? If so, in what ways?
5. How do the prosodic characteristics of Persian caregivers' IDS vary when addressing infants aged 6 to 13 months?

1.3 Chapter Summary

This chapter briefly established the foundation for the dissertation by highlighting the significance of studying the language environment of Persian infants in Iran, identifying research gaps, and presenting the research questions and objectives. The subsequent chapters build on this

foundation to provide a comprehensive exploration of the language environment of Persian-learning infants in Iran and its implications for early development.

1.4 Overview of the Dissertation Structure

This dissertation is organized into seven chapters, each addressing a specific aspect of the study:

1. Introduction to Infant Language Development and Study Objectives:

This chapter briefly introduces the background, significance, research gaps, along with the research questions guiding the investigation.

2. The Language Environment of Infants: Quantity, Quality, Sources, and Influences:

This chapter reviews literature on language environment of infants, including the quantity and quality of speech input, its sources, and the role of demographic and socioeconomic factors.

3. Infant-Directed Speech Across Languages and Cultures:

This chapter provides a detailed literature review of IDS, focusing on its characteristics and importance, cross-linguistic and cross-cultural similarities and differences, with a focus on findings from Western and Middle Eastern contexts, the role of culture in caregiver-infant communications, and the methodological challenges involved in studying the language environment of infants, particularly in underexplored settings such as Middle Eastern contexts. Finally, it outlines how these issues were addressed in the present study.

4. Methodological Approach to Understanding the Language Environment of Persian Infants:

This chapter describes the methodological framework for the study, including participant recruitment, data collection, and analysis procedures. The use of the LENA (Language ENvironment Analysis) system for audio recordings and automated annotations as well as the manual annotation procedure is described. The chapter also discusses the acoustic analysis of caregiver utterances, statistical methods employed, and ethical considerations in conducting the research.

5. Demographic and Socioeconomic Influences on Linguistic Input of Persian Infants:

This chapter presents findings from the descriptive analyses of the data, and the inferential analyses on the first three research questions, including how infant and caregiver demographics shape the linguistic input of Persian-learning infants.

6. Prosodic Patterns and Developmental Changes in Persian Infant-Directed Speech:

This chapter presents the findings of the last two research questions, on prosodic differences between Persian primary caregivers' IDS and ADS utterances, with comparisons to other linguistic and cultural contexts, as well as developmental changes in IDS prosodic characteristics from 6 to 13 months of age.

7. Study Contributions and Future Directions:

The final chapter synthesizes the study's findings, discusses their theoretical and practical implications, addresses limitations, and offers recommendations for future research.

Chapter 2: The Language Environment of Infants: Quantity, Quality, Sources, and Influences

The linguistic environment of infants plays a crucial role in their language development, encompassing the quantity and quality of speech they receive, the sources of this speech input, and the factors that shape it. One of the most widely studied aspects of input quality is infant-directed speech (IDS)—a specialized register characterized by exaggerated prosody and simplified linguistic forms. Given its central role, IDS is examined in greater detail in Chapter 3. Together, the quantity and quality of speech, its sources, and the contextual factors provide a comprehensive perspective on how infants’ environments shape early developmental outcomes.

2.1 Quantity and Quality of Linguistic Input

The quantity and quality of linguistic input that infants receive are foundational characteristics of early language development. Both elements have been widely studied, with researchers emphasizing the need to understand how these dimensions interact within different socioeconomic and cultural contexts.

Although research on the characteristics of IDS dates back to the mid-20th century, Hart and Risley’s (1995) influential study brought widespread attention to the role of input quantity, estimating that by age four, children from high-income families had heard approximately 30 million more words than children from low-income families. This so-called “30-million-word gap” was linked to disparities in vocabulary growth and long-term educational outcomes, and it inspired research and policy aimed at increasing verbal engagement in early childhood. However, this research was criticized and highlighted to have several methodological and

conceptual limitations, including their small, demographically narrow sample and their exclusive focus on infant-directed speech in nuclear family settings. These critiques argue that such measures may inadequately capture the full linguistic environment of children, especially in diverse or non-Western cultural contexts.

Central to the criticisms is the debate between Sperry, Sperry, and Miller (2019a, 2019b) and Golinkoff et al. (2019). Sperry and colleagues questioned the universality of the word gap by demonstrating that when ambient speech and input from multiple caregivers or community members were included, disparities in word counts between high- and low-SES households largely disappeared. They argued that models of input measurement often exclude meaningful forms of communication—such as overheard speech or community speech—that are prevalent in many communities. In response, Golinkoff and colleagues emphasized the distinct role of speech directed to infants, mentioning that IDS, especially when responsive and contingent, plays a uniquely facilitative role in infants’ language processing and vocabulary growth. They warned that ignoring differences in IDS could risk intervention efforts aimed at promoting language development among underserved populations.

While this debate underscores the complexity of defining and measuring quantity, it also draws attention to the role of quality in early linguistic environments. Here, the term quality is used to refer to the characteristics of linguistic input that go beyond its amount, and is not intended as a value judgment about caregivers’ speech. Rather, it distinguishes aspects of input that differ from quantity, such as its richness and responsiveness. High-quality input typically includes diverse vocabulary, varied syntactic structures, and contingent or sensitive, timely responses to the infant’s cues. For example, lexical diversity and the use of decontextualized

language in caregiver speech has been found to predict children's later language outcomes (Rowe, 2012). Additionally, Weisleder and Fernald (2013) found that greater quantity of speech directed to children, but not adult-directed speech, predicted infants' efficiency in language processing and their later vocabulary growth. This finding underscores that it is not merely the volume of linguistic input that matters, but the type and quality of input that best supports development.

The interplay between quantity and quality is now widely recognized as critical for language development. A higher quantity of speech provides infants with more opportunities to extract linguistic regularities, and these benefits are further amplified when the input is also high quality (Anderson et al., 2021; Gilkerson et al., 2018; Golinkoff et al., 2019; Montag et al., 2018; Rowe & Weisleder, 2020). Moreover, in contexts where speech quantity is limited—due to socioeconomic, structural, or cultural factors—greater responsiveness and linguistic richness may compensate, supporting more language outcomes (Hirsh-Pasek et al., 2015; Reynolds et al., 2019).

Finally, both the quantity and quality of linguistic input are influenced by broader contextual factors such as socioeconomic status and cultural norms. For instance, caregivers from higher SES backgrounds often engage in more frequent and varied verbal interactions, with greater responsiveness and richer vocabulary (Romeo et al., 2018; Rowe, 2008). At the same time, cultural norms may shape what is considered appropriate or effective input. In some non-Western communities, infants may receive less direct speech but still benefit from high-quality, socially embedded forms of communication (Shneidman & Goldin-Meadow, 2012). Importantly, even within these contexts, directed speech continues to be a strong predictor of language

outcomes—a paradox, since cultural practices emphasize indirect or overheard input while empirical findings underscore the unique benefits of direct IDS. Together, these findings underscore the need for context-sensitive approaches and caution against applying WEIRD-centric benchmarks universally, while also recognizing that the role of direct versus ambient input remains an open and complex question.

2.2 Sources of Linguistic Input

Infants acquire language not in isolation, but through immersion in rich and complex social environments that expose them to speech from a variety of sources. These include primary caregivers or parents, extended family members or other relatives, siblings and other children, and indirect input and overheard speech. Each of these sources contributes uniquely to the infant's linguistic environment, shaping both the quantity and quality of input available to support language development. Understanding the relative contributions of these sources across different cultural and socioeconomic contexts offers a more comprehensive view of early language development and highlights the diversity of infant development.

2.2.1 Primary Caregivers

In many cultural contexts, mothers serve as the primary source of infants' speech input, although in other settings this role may be filled by fathers, siblings, or extended family members. Maternal speech is often rich in prosodic features, such as exaggerated intonation and slower tempo, and characterized by responsive interactional patterns that support infants' attention, word segmentation, and language learning (Saint-Georges et al., 2013; Soderstrom, 2007; Theissen et al., 2005). Across diverse linguistic and cultural settings, research has consistently shown that mothers provide the majority of early verbal input. For example, in

North American context, infants were found to receive more speech from their mothers (Bergelson et al., 2019; Pancsofar & Vernon-Feagans, 2006). Taken together, these studies underscore the predominant role of mothers in early language input, while also highlighting variation in who provides speech to infants.

Fathers also contribute to the infant's linguistic environment, though typically at lower rates than mothers. Despite this difference in quantity, paternal input introduces valuable variability in vocabulary, syntactic structures, and interactional styles, enriching the infant's exposure to diverse forms of language (Pancsofar & Vernon-Feagans, 2010). The developmental significance of paternal speech is gaining recognition, particularly in families and cultural contexts where caregiving responsibilities are more evenly distributed. Recent work underscores the importance of including fathers in studies of early language development (Pancsofar, 2020; Tamis-LeMonda et al., 2014). Emerging empirical findings further highlight the nuanced role of fathers. For instance, a recent study found that although Latinx infants heard less speech overall from fathers than from mothers (50.4% less), the rate of infant-directed speech was similar between parents when adjusted for speech quantity. This finding provides evidence that fathers also contribute to the infants linguistic input and also challenges the stereotype that fathers are less likely to modify their speech for infants (Ferjan Ramírez et al., 2022). Moreover, in families where maternal input may be compromised, fathers' speech can play a particularly important role; for example, Kaplan, Danko, and Diaz (2010) found that paternal IDS had a privileged status in infants of depressed mothers, underscoring the importance of father involvement. Nonetheless, maternal contributions remain far more extensively studied, especially during the infant's first two years of life when mothers are typically the primary caregivers in many cultural contexts.

2.2.2 Extended Family and Other Adults

Beyond parents, other adults—including grandparents, aunts, uncles, and childcare providers—contribute to infants’ language input. These interactions, although often less frequent, offer exposure to different conversational styles and sociolinguistic norms. For instance, caregiving by grandmothers is widespread in many African societies and other collectivist cultures (Thupayagale-Tshweneagae, 2008). In Iran, similar patterns are observed in extended family systems, where multiple adults may participate in caregiving and communicative exchanges with the infant. Research indicates that the majority of the parents in Iran were reported receiving assistance from their extended family or other relatives. The maternal grandparents (64.1%) were the most supportive, then, the paternal grandparents (25.1%), and then other relatives. In contrast, Iranian parents rarely used daycare or babysitter services (Mazandarani & Bahramabadi, 2023). Shared caregiving models, common mostly in traditional and non-Western communities, offer infants access to a broader range of adult speakers. These models contrast with the more individualized caregiving common in WEIRD societies and challenge assumptions of nuclear family structures.

2.2.3 Siblings and Other Children

Siblings also play a critical role in shaping infants’ linguistic environments, especially in households with multiple children. Older siblings often engage in playful and emotionally expressive interactions that complement the more structured input provided by adults. While sibling speech may lack the linguistic complexity of adult speech, it still provides valuable opportunities for learning turn-taking, pragmatic skills, and peer-like communication (Bridges & Hoff, 2014).

Importantly, in many cultural settings, other children—not adults—are the primary source of child-directed speech. Seminal research from diverse cultures, including Luo, Koya, and Samoan families, have shown that mothers were not the primary source of input (Snow & Ferguson, 1979). Loukatou et al. (2022) found that while mothers were the main contributors to French-learning toddlers' input in France, other children provided the majority of input for Sesotho-learning toddlers in South Africa. Similarly, in Yucatec Mayan communities, children heard more speech from other children than from adults by 24 months of age (Shneidman & Goldin-Meadow, 2012). In Indigenous Australian Yakanarra communities, child-aged interlocutors also contributed significantly more input to infants than adults did (Loakes et al., 2013). These findings suggest that sibling and peer input can be a normative and meaningful part of the learning environment, particularly in settings where communal caregiving is practiced.

2.2.4 Indirect Input: Overheard Speech

Research in infant language environment is often limited to IDS in their measures (e.g., Hart & Risley, 1995; Rowe, 2012; Weisleder & Fernald, 2013). However, infants hear speech from a variety of sources. Overheard speech refers to a type of language input that is not directly addressed to the infant but occurs in their auditory environment (i.e., speech between two speakers in the infant's auditory environment). Although this form of input lacks the interactive qualities of IDS, it remains a component of infants' linguistic surroundings. For example, it was reported that 53% of input to Yucatec Mayan infants was overheard speech (Shneidman & Goldin-Meadow, 2012). Overall, the prevalence and role of overheard speech vary across cultural contexts, underscoring the need for cross-cultural approaches to fully capture the diversity of infants' language environments.

Research indicates that infants can also learn from overheard speech. For instance, Akhtar et al. (2001) showed that 2-year-olds were able to learn novel words from overhearing adult conversations just as effectively as when addressed directly, underscoring the active role of toddlers in monitoring and extracting information from their social environment. Extending this work to younger infants, Floor and Akhtar (2006) demonstrated that even 18-month-olds can learn novel object labels through overhearing when task demands like memory requirements are not too high. Together, these findings suggest that overheard speech can support vocabulary learning and that infants are observers who not only learn from the speech addressed directly to them, but also from the verbal interactions around and overheard by them. However, evidence indicates that verbal engagement during child-directed speech—but not overheard speech—has been linked to children's later outcomes (Weisleder & Fernald, 2013), and that overheard speech is less effective as a language-learning tool during the earliest stages of development (e.g., Golinkoff et al., 2019).

2.3 Demographic Influences on Linguistic Input

2.3.1 Infant Age

Infant age is a key factor influencing the linguistic input, including the quantity and the quality of the speech infants receive. As infants develop and become more communicatively competent, caregivers tend to respond more frequently and meaningfully to their behaviors. For example, older infants produce more vocalizations and gestures, which in turn elicit more responsive verbal engagement from caregivers. Classic research demonstrated that maternal responsiveness increases with infant age primarily because older infants initiate more communicative acts (Tamis-LeMonda et al., 2001). More recent cross-cultural evidence supports

a reciprocal pattern: Bergelson et al. (2023) showed that children's speech production increases with age and is strongly predicted by the amount of adult talk they hear, with the association between adult and child speech strengthening over time. Together, these findings underscore the bi-directional nature of input, where infants' developmental capacities both elicit and are scaffolded by caregiver responsiveness.

Beyond sheer quantity, the quality of linguistic input also evolves with infant age. A longitudinal study demonstrated that as infants age, caregivers gradually shift toward using more sophisticated language (Rowe, 2012). Specifically, parents increasingly used rare words and decontextualized utterances—forms of talk that go beyond the immediate context—into their speech as children grow older. Importantly, the relative importance of quantity and quality also varies developmentally: during the second year of life, the quantity of input is a strong predictor of language outcomes; however, lexical diversity and syntactic complexity become more influential in the third year (Rowe, 2012).

Consistent with this pattern, a meta-analysis by Anderson et al. (2021) found that both quantity and quality of parental input are associated with children's language development, but that the strength of these associations increases with child age. Notably, input quality was more strongly associated with child language outcomes than input quantity, especially as children grew older. This suggests that developmental changes in input are not only about frequency but also about the richness and appropriateness of language used.

The structure of speech input also shifts with infant age. Several studies have documented age-related shifts in IDS characteristics, which interact in complex ways with linguistic content and conversational context (e.g., Johnson et al., 2014; Stern et al., 1983). An analysis of North

American infants showed that the proportion of IDS increases across the first two years of life, largely due to a decrease in the proportion of ADS (Bergelson et al., 2019). This suggests that as infants mature, caregivers maintain a relatively stable amount of IDS while reducing their use of ADS, thereby increasing the relative share of speech directed to infants.

In sum, infant age plays a role in shaping linguistic environments. As infants grow, they both elicit and receive more sophisticated and complex forms of language input. These developmental changes underscore the importance of considering age-related variation in both the quantity and quality of input when assessing early language environments and their impact on developmental outcomes.

2.3.2 Infant Sex

The relationship between an infant's sex and the quantity and quality of speech input they receive has been a topic of research, yielding mixed and conflicting findings. These studies highlight both the potential for sex-based differences in linguistic input and the complexity of separating these effects from other contributing factors, such as infant language ability.

Much of this literature, conducted primarily in North America, suggests that caregivers may adjust their speech and verbal input based on an infant's sex. Research from the United States and Canada indicates that parents often talk more to female infants than male infants during infancy and toddlerhood. For example, mothers interacting with 24-month-old girls during play used more questions, explanations, and repetition, than with boys (Cherry & Lewis, 1976). Similarly, mothers of 6-month-old infants were more likely to ask questions of girls but used more directives and attention-getters with boys (Clearfield & Nelson, 2006). Johnson et al.

(2014) further observed that mothers—but not fathers—were more responsive to female infants, potentially providing them with richer linguistic environments. A meta-analysis drawing largely from North American samples found that mothers talked more and used more supportive language with daughters compared to sons, although these gender differences decreased over time, potentially reflecting evolving societal norms (Leaper et al., 1998). In contrast, other studies from similar Western contexts have reported a reversed pattern, with boys receiving more speech input than girls in specific contexts (e.g., Ahl et al., 2013; Weitzman et al., 1985).

At the same time, several longitudinal studies conducted in the United States have found no evidence of sex-based differences in speech input. A longitudinal analysis of speech directed at 1- to 2-year-olds, found no significant differences in parental speech directed to boys versus girls (Huttenlocher et al., 1991). More recently, Dailey and Bergelson (2023) examined longitudinal home recordings and found no significant sex differences in speech input. Their findings indicated that caregivers talked more to infants who had begun to produce speech, regardless of the infant's sex. This suggests that an infant's language ability, rather than their sex, may play a more prominent role in influencing linguistic input.

Most studies on sex differences in linguistic input are based on Western, middle-class populations, limiting generalizability to non-Western contexts. This highlights the importance of exploring cultural norms across other non-Western cultures and if they may shape caregiver-infant interactions, particularly the linguistic input as an infant sex factor.

In conclusion, the relationship between infant sex and linguistic input is complex and context-dependent. While some evidence suggests that female infants may receive more speech input, other studies report no significant differences or even higher input for male infants.

Methodological differences and the interplay between infant sex and age, language ability, and cultural norms further complicate the interpretation of these findings. Future research should aim to disentangle these factors and explore how gendered linguistic environments vary across diverse cultural and socioeconomic contexts.

2.3.3 Socioeconomic Status

Socioeconomic status (SES) is one of the most influential factors in shaping infants' linguistic environments, affecting both the quantity and quality of speech input that infants receive. SES is a broad concept encompassing income, education, and occupation, which together reflect the social as well as economic standing of a family (Duncan & Magnuson, 2001). These dimensions have effects on children's lives, including parenting behaviors, cognitive and behavioral development, and health outcomes (e.g., Halle et al., 2009; Hoff & Laursen, 2002).

SES affects language abilities of infants and children. For example, research shows that low-SES children, on average, have smaller vocabularies (Arriaga et al., 1998; Huttenlocher et al., 2010), less phonological awareness (Bowey, 1995; Hecht et al., 2000), and weaker reading readiness compared to their high-SES peers (West et al., 2000). These early differences in language skills have long-term implications for school readiness and academic achievement (Lee & Burkam, 2002; Walker et al., 1994).

One of the most well-known studies on SES and language development is Hart and Risley's (1995) seminal work, which introduced the concept of the "30-million-word gap." As discussed earlier, their finding underscored the impact of SES on early language experiences and motivated research and policy initiatives aimed at improving early language outcomes. However,

Hart and Risley's study has faced considerable critique, including its deficit-focused framework, and methodological limitations (e.g., Dudley-Marling & Lucas, 2009; Gilkerson et al., 2017; Sperry et al., 2019a, 2019b). Despite these criticisms, Hart and Risley's work has had a profound influence, inspiring a vast body of research aimed at addressing disparities in early language development. While Hart and Risley's findings drew attention to the role of quantity in early language exposure and linking SES disparities to vocabulary and language development gaps, subsequent research refined these findings. Newer studies have employed diverse samples and advanced methodologies, which have provided more nuanced perspectives on the word gap. For instance, Gilkerson et al. (2017) found smaller estimates of the gap, while Sperry et al. (2019a, 2019b) emphasized the role of overheard speech and speech from multiple speakers. These findings highlight the importance of methodological variability in shaping our understanding of SES-related language disparities and underscore the need for inclusive and culturally sensitive research.

More recently, in a meta-analysis of 19 studies, Dailey and Bergelson (2022) found that young children from low-SES homes heard less child-directed speech than those from mid- to high-SES homes, though this difference was smaller than Hart and Risley's original "30-Million-Word Gap." Importantly, they showed that SES effects were moderated by the way language input was measured: studies counting only child-directed speech showed large SES differences, while those including all ambient speech found no SES effect. Extending this line of work, Bergelson et al. (2023) analyzed over 40,000 hours of recordings from 1,001 children across six continents and found that age and adult talk were robust predictors of children's speech production, whereas SES was not a significant predictor. Together, these findings underscore the

importance of methodological and cultural context in shaping estimates of SES-related differences in language input.

In summary, SES has often been framed as a profound influence on the linguistic environments of infants, shaping both the quantity and quality of speech input they receive. Studies in Western contexts have shown that higher-SES families typically engage in more frequent and varied verbal interactions, fostering stronger language outcomes, whereas lower-SES families may face structural barriers such as time constraints and limited resources that reduce opportunities for high-quality interactions. Importantly, SES disparities in early language abilities have been linked to differences in school readiness and later academic achievement (Durham et al., 2007; Lee & Burkam, 2002). However, emerging evidence complicates this picture, highlighting that SES effects may be context-dependent. These findings underscore the need for culturally sensitive approaches that respect diverse caregiving practices rather than assuming uniform SES effects across all populations.

2.4 Chapter Summary

The linguistic environment plays a pivotal role in infant language development, encompassing the quantity and quality of speech input, the sources of this input, and the demographic factors shaping it. Both the quantity and quality of speech input are integral to language acquisition. While the quantity of speech exposure provides the foundation for developing linguistic skills, the quality of input enriches this foundation, particularly through features like IDS.

Speech input comes from various sources, with primary caregivers contributing the majority of speech. Additional input from siblings and other adults introduces variability and diversity, complementing caregiver interactions. Demographic factors, such as infant age, sex, and SES, including family income and caregiver education, further shape the linguistic environment. Caregivers naturally adjust the quantity and quality of their speech as infants grow, tailoring their interactions to developmental needs. Evidence regarding sex-based differences in speech input is mixed, with contextual factors influencing these patterns. SES is often linked to differences in the richness and frequency of caregiver input and linguistic outcomes, but large-scale cross-cultural work shows a more complex picture, underscoring the need to address socioeconomic disparities while recognizing that SES effects are context-dependent and shaped by cultural variation.

Chapter 3: Infant-Directed Speech Across Languages and Cultures

Infant-directed speech (IDS) is a specialized speech register widely believed to play a crucial role in infant development. However, IDS research has been predominantly WEIRD and English-centric, limiting our understanding of how its features and functions vary across linguistic and cultural contexts. Although IDS is often assumed to be universal, cross-cultural evidence reveals both shared tendencies and significant variation. This review examines Middle Eastern (ME) IDS—an underexplored area in cross-cultural research—contrasting it with Western IDS to highlight both common and culture-specific modifications. Emphasizing the role of culture in shaping caregiver-infant interaction, this review shows that while IDS occurs in both Western and ME contexts, its specific features—such as lexical choices and interactional styles—are shaped by sociocultural values. The chapter also critically evaluates methodologies used in infant language research, particularly the LENA system. Although widely used, LENA was designed for WEIRD contexts and struggles to capture linguistic diversity in non-WEIRD, multi-speaker, and multi-generational environments typical of many ME contexts. This review calls for broadening infant language research beyond WEIRD populations to include ME contexts and develop a more inclusive framework for understanding early linguistic input. Future research should adopt multimodal methodologies, refine speech analysis tools, and integrate sociocultural perspectives to ensure that theories of infant language development are globally representative.

3.1 Beyond the WEIRD Lens: Infant-Directed Speech Across Middle Eastern Contexts

Caregiver-infant communication is crucial for early developmental outcomes, with the speech directed to infants, infant-directed speech (IDS) being one of the most widely studied

forms of this interaction. IDS is characterized by special features, which make it not only noticeably different from the speech directed to adults or adult-directed speech (ADS), but also preferred by infants (Cooper & Aslin, 1990; ManyBabies Consortium, 2020). Over the years, researchers have identified several distinctive features of IDS. Prosodically, IDS involves a higher pitch, wider pitch range, greater pitch variability, and a slower speech rate (Fernald, 1985; Fernald & Kuhl, 1987; Fernald et al., 1989; Kitamura & Burnham, 2003; Kuhl et al., 1997; Liu et al., 2009; Soderstrom, 2007). Some studies also suggest that IDS features clearer articulation (Kuhl et al., 1997; Uther et al., 2007), although this remains debated (Benders, 2013; Englund & Behne, 2005). Linguistically, IDS is marked by simplified vocabulary, shorter sentences, and frequent repetitions (Fernald & Simon, 1984; Grieser & Kuhl, 1988; Newport et al., 1977; Soderstrom, 2007). Affectively and interactively, IDS is characterized by an affectionate tone, frequent questions, and responsive feedback (Fernald, 1985; Newport et al., 1977; Papoušek et al., 1987; Soderstrom et al., 2008; Trehub et al., 1993). Collectively, there is evidence that some of these features contribute to the multifaceted role of IDS in capturing and enhancing infant attention, fostering social bonding, and supporting some aspects of early language development; I will elaborate more on these in the following sections.

3.2 The Research Gap and Contribution of This Review

Over the past decade, IDS research has broadened to include a wider range of languages and cultures. However, most studies remain focused on WEIRD societies, particularly English-speaking countries (Henrich et al., 2010). This bias has led to theoretical assumptions that Western-derived models of IDS are universally applicable. However, emerging cross-linguistic and cross-cultural studies challenge this notion, suggesting that IDS may be influenced by socio-

cultural norms, with some cultures placing less emphasis on direct verbal engagement (e.g., Casillas et al., 2020, 2021; Sperry et al., 2019a, 2019b).

Despite growing interest in cross-cultural variation, empirical studies of IDS in the Middle East remain scarce, leaving a critical gap in our understanding of how IDS manifests across these diverse linguistic and cultural contexts. For instance, Hilton et al. (2022) conducted a large-scale study of IDS and infant-directed singing across 21 societies on six continents, but Middle Eastern languages were notably absent from their sample. Similarly, in a meta-analysis, Cox et al. (2023) surveyed IDS prosodic and articulatory modifications across a wider variety of languages across the globe, yet did not include any Middle Eastern languages. This underrepresentation of the Middle East from these major cross-linguistic studies reflects a broader bias in developmental and psycholinguistic research, where most studies are conducted in WEIRD populations, and underscores the need to examine IDS in underrepresented regions.

Given the Middle East's linguistic diversity and distinct socio-cultural norms and caregiving traditions, this gap raises important questions about the universality and cultural specificity of IDS features. The present review aims to address these limitations by exploring whether the proposed core prosodic, linguistic, and interactive IDS features are consistent across Middle Eastern contexts and examining how cultural values and caregiving practices shape IDS in this region.

To address these gaps, this chapter: 1. Examines variation in IDS, comparing primarily Western and Middle Eastern languages and cultures. 2. Explores how sociocultural factors in individualist versus collectivist contexts may influence IDS features. 3. Examines how the

limitations of WEIRD-centric methodologies interact with and are exacerbated by cross-cultural variations in infants' linguistic input, focusing on Middle Eastern contexts.

In the following sections, I examine the importance of IDS in early development, discussing IDS universality and its features in WEIRD contexts by summarizing key findings from Western languages and cultures. It then shifts focus to IDS in Middle Eastern contexts, highlighting the region's unique features. Finally, the review critiques methodological limitations in infant language research across ME contexts. By integrating cross-linguistic and cross-cultural perspectives, this review aims to contribute to a more inclusive framework for understanding early language development, emphasizing the need for culturally sensitive research approaches.

3.3 The Importance of IDS

An extensive body of research has emphasized the pivotal role of IDS across multiple domains of infant development. Three main areas illustrate how IDS contributes to early development: attentional regulation, social and emotional benefits, and cognitive and linguistic growth.

A key function of IDS is to capture and sustain infant attention, laying the foundation for subsequent learning. The higher and more exaggerated pitch contours typical of IDS draw infants' attention to the speaker (Cooper & Aslin, 1990; ManyBabies Consortium, 2020; Werker & McLeod, 1989). Additionally, the rhythmic and repetitive structure of IDS maintains engagement, enhancing infants' ability to more efficiently process linguistic information (Thiessen, Hill, & Saffran, 2005; Trainor & Desjardins, 2002).

IDS also fosters infant's social and emotional development. It enhances social reciprocity and understanding through responsive interactions (Goldstein et al., 2003; Tamis-LeMonda et

al., 2001). Additionally, the rhythmic and comforting tones of IDS help infants regulate emotions and establish secure attachment relationships (Fernald, 1989; Trainor et al., 2000). In sum, IDS facilitates both social–emotional bonding and communicative development, underscoring its central role in early caregiving interactions.

IDS plays a crucial role in infants' cognitive development by eliciting specific cortical responses, demonstrating its foundational role in early speech processing and cognitive engagement (Kalashnikova et al., 2018; Zangl & Mills, 2007). The melodic nature and pitch contours of IDS enhance brain activity and facilitate memory retention, supporting infants in processing and recalling linguistic elements (Bosseler et al., 2016; Thiessen & Saffran, 2003). In terms of language development, IDS influences phonological, lexical, and syntactic learning. Phonologically, IDS is often characterized by exaggerated prosody and clear articulation, features that are thought to help infants distinguish speech sounds and support the acquisition of native phonemic contrasts (Kuhl et al., 1997; Liu et al., 2003). However, this remains debated, as some studies suggest that vowel hyperarticulation—a hallmark of clear articulation—does not reliably facilitate phonetic learning or is not consistently observed across languages (e.g., Englund & Behne, 2005). It should be noted that most studies do not provide independent evidence for the impact of lexical and syntactic simplification, separate from prosodic marking. Lexically, IDS facilitates word recognition through exaggerated intonation and slowed tempo. Additionally, IDS often involves a reduced and repetitive vocabulary, which in combination with context-rich interactions, enhances word-object mapping, and supports vocabulary growth (Ma et al., 2011; Newport, Gleitman, & Gleitman, 1977; Thiessen & Saffran, 2003; Thiessen, Hill, & Saffran, 2005). Syntactically, the prosodic features of IDS emphasize clause boundaries, and the simplified and repetitive syntactic structures reinforce grammatical patterns, aiding in the

development of syntactic comprehension as infant's linguistic abilities evolve (Fernald & Simon, 1984; Fernald, 1985; Grieser & Kuhl, 1988; Newport et al., 1977; Rowe, 2012).

IDS is more than just a linguistic tool or an affectionate way of speaking—it is a multifaceted communicative system that supports infants' attentional, social, emotional, cognitive, and linguistic development. However, its specific impact and the mechanisms through which it operates can vary across different linguistic and cultural contexts. For example, while elevated pitch is common across many languages (Cox et al., 2023; Fernald et al., 1989), one study reported that caregivers of Quiché Mayan infants did not use higher pitch with infants; instead, higher pitch was reserved for individuals of higher social status (Ratner & Pye, 1984). Such findings highlight that cultural adaptations are not merely stylistic variations, but essential tendencies tailored to local social structures and communicative norms. Understanding these differences is crucial for developing culturally sensitive theories of language development.

In the next section, I examine how IDS manifests across languages and cultures, exploring the interplay between universal tendencies and culturally specific adaptations.

3.4 IDS: Importance Versus Universality

The discourse on IDS involves two interconnected dimensions: its importance for early development, and more specifically, language development, and its universality across languages and cultures. While these aspects are intertwined, it is essential to recognize the nuances between them. While the importance of IDS is well-acknowledged, its universality remains debated, raising an important question: Can IDS be essential for early development while also being culturally variable?

While IDS can create a beneficial environment for language development, it is not the sole determinant. What constitutes “optimal” input is shaped by cultural norms and communicative practices; characteristics that are beneficial in one culture may hold different meanings or levels of importance in another. For instance, research shows that infants raised in environments with minimal directed speech exposure—but rich overheard input—still acquire language efficiently (e.g., Casillas et al, 2020; Ochs & Schieffelin, 1984). These findings challenge the assumption that IDS practices are universal. Societies adopt diverse approaches to socializing and communicating with infants, and IDS, while a powerful tool, represents just one of many culturally embedded practices. Some researchers have even suggested that its role may have been overemphasized in the developmental literature (Sperry et al., 2019a, 2019b).

Recognizing this distinction between importance and universality is crucial for avoiding a monolithic view of language development, and understanding and respecting cultural practices within their specific contexts. IDS should not be conceptualized as a binary phenomenon—either universally present or absent—but as a culturally situated communicative practice. Cross-linguistic and cross-cultural evidence reveals both commonalities (e.g., higher pitch) and variations in how caregivers adapt their speech to infants. These patterns underscore the need for a more nuanced understanding of IDS, one that acknowledges its dynamic nature and cultural specificity.

A key question emerging from this body of research concerns the extent and variability of IDS across cultures. IDS practices are shaped by a complex interplay of linguistic structure, sociocultural norms, and caregiving practices. To explore these dynamics, the following sections synthesize evidence from both Western and Middle Eastern contexts, examining how cultural landscapes influence the form, frequency, and function of IDS. By applying a cultural lens, this

review aims to deepen our understanding of IDS as a flexible and context-sensitive phenomenon, rather than a fixed universal.

3.5 The Role of Culture in Caregiver-Infant Communication

Culture can be broadly defined as a dynamic system of shared ideas, values, beliefs, and practices that shape behavior, social norms, and perceptions of reality. It is learned, transmitted across generations, and influences key aspects of life, including communication and caregiving (Kreuter & McClure, 2004; LeVine, 1984). Cultural frameworks shape caregivers' beliefs about infant development—what skills are essential, when milestones should occur, and which caregiving practices are appropriate (Bornstein, 2013; Chen et al., 2019; Harkness & Super, 2002). While some practices, such as providing emotional support, are widespread, their meaning and function can differ across societies. For instance, physical discipline may be interpreted as harsh and inappropriate in some cultural groups but as a normative initiation practice in others (Bornstein, 2012).

Sleeping arrangements offer a clear example of cultural variation in caregiving goals. In many Western individualist societies, solitary sleeping is encouraged to promote infant autonomy and self-regulation (Ball & Russell, 2014; Germon et al., 2007; Hooker et al., 2001). In contrast, bed-sharing and co-sleeping are normative and valued in many collectivist cultures, including Iran, where physical closeness and caregiver responsiveness are emphasized (Mazandarani & Bahramabadi, 2023; Mohsenian et al., 2014). In some East Asian societies, solitary sleeping is even perceived as neglectful or cruel due to strong beliefs in the caregiver's responsibility for continuous nighttime care (Chung & An, 2014; Shimizu et al., 2014). These differences reflect how cultural beliefs shape caregiving goals—whether fostering independence

or interdependence—and highlight the need for culturally sensitive interpretations of caregiving behaviors.

Family structures play a central role in transmitting cultural values to infants. Parental beliefs and goals are shaped by cultural orientations: caregivers in individualist societies typically prioritize independence and self-reliance, while those in collectivist societies emphasize social harmony and interdependence (Raj & Raval, 2012; Trommsdorff, Cole, & Heikamp, 2012). These orientations influence how caregivers interact with infants, the language they use, and their expectations for social and emotional development. Importantly, caregiving in many collectivist societies extends beyond the nuclear family. Grandparents, older siblings, and other relatives are often deeply involved in daily childcare. In many collectivist cultures, such as those in Sub-Saharan Africa, for example, older siblings commonly take on primary caregiving responsibilities (Weisner et al., 1997). In Middle Eastern contexts, including Iran, grandparents—especially grandmothers—play a significant role in infant care (Mazandarani & Bahramabadi, 2023). Such extended caregiving networks provide economic and emotional support (Abebe & Aase, 2007) while also exposing infants to diverse linguistic inputs, potentially affecting the prosodic, lexical, and interactional features of the speech they hear.

Given these cultural differences in caregiving structures, it is essential to examine how IDS manifests across different linguistic and cultural contexts. The structure, frequency, and function of IDS may vary depending on who is speaking to the infant and the norms governing caregiver-infant interactions. The following sections address three key questions: (1) Do the core features of IDS considered "universal" hold true in Middle Eastern languages and cultures? (2) How do IDS practices in Middle Eastern contexts compare to those in WEIRD societies? and (3) What cultural values, beliefs, or caregiving practices contribute to variation in IDS?

By exploring these questions, this review aims to illuminate both the shared and culturally specific dimensions of caregiver–infant communication.

3.6 IDS Modifications Across Western and Middle Eastern Contexts

3.6.1 Prosodic Modifications in IDS

3.6.1.1 Western Findings

A substantial body of research has shown that IDS in Western languages is characterized by systematic prosodic exaggerations, including higher pitch, wider pitch range, greater pitch variability, longer pauses, and slower speech rate (Broesch & Bryant, 2015; Cristia, 2010; Fernald & Simon, 1984; Fernald et al., 1989; Garnica, 1977; Han et al., 2020; Hilton et al., 2022; Jacobson et al., 1983; Kalashnikova & Burnham, 2018; Kondaurova et al., 2013; Lee et al., 2014; Martin et al., 2016; Raneri, 2015; Shute & Wheldall, 1989; Stern et al., 1983; Uther et al., 2007). These prosodic adjustments are thought to serve multiple functions, supporting early development.

A recent large-scale cross-linguistic study by Cox et al. 2023 confirmed these findings. Examining IDS across many languages, and primarily Western languages—including several English varieties (e.g., Australian, British, Canadian) and European languages (e.g., Danish, Dutch, French, German, Hungarian, Italian, Spanish)—they found consistently higher pitch, and in many languages, greater pitch variability and slower articulation rates, compared to adult-directed speech. However, the magnitude of these modifications varied across languages. Crucially, no Middle Eastern languages were included in this study, leaving an important gap in cross-cultural understandings of IDS prosody.

3.6.1.2 Middle Eastern Findings

Although less extensively studied, research suggests that prosodic modification is also a central feature of IDS in Middle Eastern languages. In Persian, mothers significantly raise their pitch, expand their pitch range, and lengthen pauses when addressing infants, compared to adults (Moradi et al., 2014), and fathers also use higher pitch when addressing infants (Asadi & Imani, 2023). In Hebrew, although direct acoustic analyses are limited, classification approaches indicate that IDS carries a distinctive emotional acoustic signature, consistent with prosodic patterns observed elsewhere (Parlato-Oliveira et al., 2020). In Arabic-speaking contexts, prosodic adaptations are also well documented. For instance, Palestinian maternal singing directed at infants is marked by greater pitch variability, increased amplitude, and resonance, with these features predicting children's sensorimotor and language outcomes (Punamäki et al., 2024). Similarly, Egyptian Arabic IDS (rural ilBasandi dialect) is described as employing high pitch and expressive intonation (Woidich, 2003).

3.6.2 *Phonological Modifications in IDS*

3.6.2.1 Western Findings

Phonological adjustments in Western IDS highlight how caregivers fine-tune segmental and sub-segmental features to enhance clarity and facilitate infants' speech perception. A key feature is vowel lengthening, which provides clearer segmentation cues and improves infants' ability to discriminate sounds (Ratner, 1984; Uther et al., 2007).

Another well-documented feature is vowel hyperarticulation, whereby caregivers produce point vowels in more extreme positions, leading to expanded vowel spaces that exaggerate contrasts and support phoneme category formation. However, the evidence is mixed. Expansion has been observed in several languages—including American and British English, Australian

English, Hungarian, and German (Gergely et al., 2017; Hartman et al., 2017; Kalashnikova & Burnham, 2018; Lovcevic et al., 2020; Uther et al., 2007; Weirich & Simpson, 2019; Wieland et al., 2015)—but not in others, such as Dutch and Norwegian (Benders, 2013; Englund & Behne, 2005).

Another important dimension of phonological modification involves Voice Onset Time (VOT) adjustments. Some studies report increased separation between voiced and voiceless stops in IDS, enhancing discriminability (Malsheen, 1980). Yet, findings are mixed: Sundberg and Lacerda (1999) found decreased VOT in IDS, while Englund (2005) observed increases for certain consonants. More recent work also points to variability across contexts (Rosslund et al., 2025).

3.6.2.2 Middle Eastern Findings

Phonological modifications in ME IDS are less studied than prosody, but available evidence points to a distinct pattern centered on simplification and reflections of cultural-linguistic traditions. In Turkish IDS, caregivers provide ample phonological and prosodic cues that distinguish grammatical categories, supporting infants' early sensitivity to functional distinctions in speech (Shi et al., 1998). In Omani Arabic, caregivers employ several phonological modifications such as segmental approximation, syllabic and segmental reduction, and reduplication (e.g., repeating syllables; *mama*, *dada*), all of which reduce articulatory complexity and enhance perceptual salience for infants (Jahdhami, 2023). Similarly, in Egyptian Arabic, caregivers use child-friendly forms and sound substitutions that facilitate comprehension and bonding (Woidich, 2003). In Persian, fathers elevated formant frequencies (F2, F3, F4), likely reflecting both affective expressiveness and vowel articulation adjustments (Asadi & Imani, 2023).

3.6.3. Lexical and Syntactic Modifications in IDS

3.6.3.1 Western Findings

In Western contexts, Lexical and syntactic simplification are hallmark features of IDS, serving to make speech more comprehensible and learnable for infants.

Lexically, caregivers exhibit several tendencies that reduce linguistic complexity. A common pattern is maintaining a low type/token ratio, limiting the diversity of word types and relying on frequent, familiar words. This reduction helps infants focus on recurring items, thereby facilitating comprehension and segmentation (Henning et al., 2005; Kaye, 1980; Phillips, 1973; Remick, 1976). Another characteristic of IDS is the frequent use of diminutives and onomatopoeia, which simplify morphological structures and provide predictable, child-friendly forms. In English and other Western languages, diminutives regularize stress patterns and may support word segmentation and early vocabulary acquisition, though their long-term developmental impact remains debated (Berko et al., 1994; Kempe et al., 2001; 2008).

Syntactically, Western IDS is characterized by shorter utterances and simpler structures compared to ADS. Caregivers reduce mean length of utterance (MLU), limit embedded clauses and abstract constructions, and foreground core syntactic information (Martin et al., 2016; Nelson, 1973; Phillips, 1973; Snow, 1977; Stern et al., 1983). These characteristics collectively decrease processing demands, making input more transparent and facilitating early grammatical learning.

3.6.3.2 Middle Eastern Findings

Lexical and syntactic modifications in Middle Eastern IDS likewise aim to reduce complexity and enhance communicative clarity, but their characteristics reflect local

sociolinguistic contexts—such as extended caregiving networks—and grammatical systems that include features like flexible syntax.

In Omani Arabic, caregivers simplify vocabulary, use onomatopoeic words and sound symbolism, and favor light verb constructions, reducing syntactic complexity (Jahdhami, 2023). In Kuwaiti Arabic, IDS features restricted, simpler vocabulary and frequent use of familiar words, while also incorporating foreign lexical items (e.g., Hindi borrowings), reflecting the sociolinguistic influence of foreign domestic workers on infant language input (Haggan, 2002).

Turkish IDS exhibits both lexical and syntactic adjustments: caregivers reduce verb use, focus on nouns and content words, and restructure questions with reference addition and reordering to scaffold comprehension (İlhan, 2019; İnci-Kavak & Kavak, 2021). Similarly, Hebrew IDS balances content words by using nouns and verbs equally while minimizing adjectives and adverbs to highlight core categories (Adi-Bensaid et al., 2015). In Egyptian Arabic, caregivers also produce shorter utterances to reduce cognitive load (Woidich, 2003). Meanwhile, in Saudi Arabic IDS, syntactic-morphological simplification is evident in the reduction of number distinctions: caregivers often fine-tune singular versus plural forms (Al-Akeel, 1998) or avoid dual/plural markers altogether (Alqahtani, 2016).

3.6.4. Pragmatic Modifications in IDS

3.6.4.1 Western Findings

Pragmatic adaptations in IDS play a crucial role in structuring interaction and scaffolding learning. In Western contexts, a central feature is the use of repetitions which reinforce linguistic forms and support infants' ability to generalize across word or unit classes (Cameron-Faulkner et al., 2003; Papoušek et al., 1987). Caregivers use variation sets—sequences of utterances that

repeat content with slight modifications—providing infants with multiple exemplars of the same structure and facilitating the recognition of word classes and construction patterns (Küntay et al., 1996; Lester et al., 2022). Additionally, caregivers frequently use questions in their speech to infants which functions not only to invite infant responses but also to maintain attention and encourage participation in interaction (Newport et al., 1977; Soderstrom et al., 2008).

Pragmatic differences also emerge by parent gender. In Western contexts, fathers tend to ask more questions than mothers, placing greater linguistic demands on their infants and encouraging them to assume more communicative responsibility (McLaughlin et al., 1983; Rowe et al., 2004). Findings are more mixed regarding directive speech. Several studies report that fathers use more commands and prohibitions than mothers (Brachfeld-Child et al., 1988; Goldberg et al., 2002; Leaper et al., 1998; Nandy et al., 2021), while others find no differences (Rowe et al., 2004). Overall, these studies suggest that mothers and fathers often pursue different goals in interaction, reflecting the complex contributions of parental gender to IDS in Western contexts.

3.6.4.2 Middle Eastern Findings

Pragmatic adaptations in Middle Eastern IDS reflects interactional style and cultural values, often prioritizing socialization, emotional bonding, and cultural transmission. As in Western contexts, ME caregivers frequently use repetitions and questions to scaffold interaction and simplify input, which has been documented in Kuwaiti and Egyptian Arabic (Haggan, 2002; Woidich, 2003). Gender differences also mirror broader cultural roles: Persian mothers use more interrogatives and fewer imperatives, while fathers rely more heavily on imperatives as a directive style (Abkarian et al., 2003; Rafatbakhsh et al., 2017). These differences reflect broader cultural expectations around parental roles and authority.

Scaffolding is also achieved through variation sets, observed in Hebrew (Tal & Arnon, 2018) and Turkish (İnci-Kavak & Kavak, 2021) IDS. Additionally, caregivers use pronoun shifts—such as in Egyptian Arabic, to model social roles, and in Kuwaiti Arabic, to elevate the infant’s agency (Haggan, 2002; Woidich, 2003)—illustrating culturally specific pragmatic devices.

Other pragmatic characteristics serve explicitly affective and cultural functions. In Iraqi Kurdish, IDS is used for endearment and easy communication, reinforcing closeness between caregiver and infant (Abdulaziz, 2016); in Turkish, caregivers embed politeness markers and respectful forms to socialize infants into cultural norms of deference (Altinkamis, 2017). Egyptian Arabic IDS includes culturally embedded practices like role and gender shifts as protective rituals against supernatural harm, addressing infants “as adults” to model behavior, and affectionate scolding as a playful bonding practice (Woidich, 2003).

Some evidence suggests that Middle Eastern caregivers use more IDS overall compared to Western norms, as shown in Lebanese families (Farran et al., 2016), reflecting collectivist orientations and family-centered interaction. Kurdish IDS provides a clear example of how context-specific vocabulary—for instance, terms used for warnings or references to physical appearance—can encode pragmatic functions and reflect broader cultural meanings (Abdulaziz, 2016).

Taken together, findings across prosodic, phonological, lexical/syntactic, and pragmatic domains reveal both shared tendencies and culturally specific patterns in IDS across Western and Middle Eastern contexts. In both regions, caregivers systematically modify their speech to support infants’ attention, engagement, and language learning. However, the form, magnitude, and function of these modifications are shaped by cultural values, interactional norms, and

sociolinguistic environments. Western IDS typically emphasizes individual-focused characteristics, such as exaggerated prosody, reflecting child-centered, individualistic interactional styles. By contrast, Middle Eastern IDS embeds speech modifications within collectivist, family-oriented frameworks, reflecting culturally grounded practices of socialization. For example, pragmatic characteristics in Middle Eastern contexts often emphasize social bonding, respect, and protection. These patterns underscore that IDS is a culturally situated communicative practice shaped by caregiving structures and cultural values within which it occurs.

3.7 Methodological Issues of Infant Language Research

Historically, infant language research relied on short, controlled recordings or live observations. These approaches, while foundational, often failed to capture the spontaneous, naturalistic interactions essential for understanding early language development. The advent of digital storage and recording technologies revolutionized this field, enabling longform audio recordings that provide more representative samples of infants' auditory environments. However, while these advances have deepened our understanding of early language experiences, they have also introduced methodological challenges, particularly in cross-linguistic and cross-cultural research.

This section explores the methodological advances and challenges in infant language research, emphasizing the role of naturalistic longform audio recordings, the limitations of automated tools like the Language ENvironment Analysis (LENA) System (Gilkerson & Richards, 2008), and the necessity of appropriately adapting WEIRD-centric tools to diverse contexts, particularly Middle Eastern collectivist communities. While research in other collectivist, non-WEIRD cultures highlighted the limitations of applying Western-centric

methodologies globally (e.g., Casillas et al., 2020, 2021), this review focuses specifically on Middle Eastern contexts. In this section, I aim to address these gaps by assessing how tools like LENA system can be appropriately adapted for culturally diverse environments and by proposing actionable recommendations for integrating hybrid methods and designing more inclusive research tools. These contributions seek to enhance the accuracy and validity of infant language research, ensuring its applicability to a broader range of linguistic and cultural contexts, such as Middle Eastern context.

3.7.1 Longform Audio Recordings

Longform audio recordings have revolutionized early language research by providing significant advantages, including capturing naturalistic data from infants' linguistic environments while minimizing observer influence and thereby reducing the Hawthorne Effect (McCarney et al., 2007; Xu et al., 2009) and enhancing inclusivity and generalizability of findings across diverse populations (Casillas et al., 2020, 2021; Cristia et al., 2019).

One widely used tool in this domain is the LENA system, introduced in 2008 to capture long hours of audio data and provide automated estimates of infants' language exposure, including adult word counts, child vocalizations, and conversational turns (Gilkerson & Richards, 2008). LENA has facilitated large-scale naturalistic studies, but it was developed in English contexts and its limitations in diverse sociocultural environments remain a concern (see Cristia et al., 2020, for review). The following section outlines these limitations in collectivist contexts and considers possible alternatives.

3.7.2 LENA System: Limits in Collectivist Contexts

The LENA system has notable limitations across technical and ethical dimensions in collectivist contexts that require critical attention.

3.7.2.1 Technical Challenges

Tools like the LENA system face several technical challenges that become especially problematic in collectivist and Middle Eastern contexts, where infants' language environments are shaped by multigenerational caregiving and frequent overlapping speech.

1. **Speaker Misclassification:** The LENA system makes classification and labeling errors, leading to inaccuracies in its automated metrics. Cristia et al. (2021) reported that precision for male adult and other children voices was as low as 43% and 27%, respectively, with recall rates for female adults, male adults, and other children all around 31%. Other misclassifications were also common, such as mislabelling female adult speech as male and other child. While concerning in any context, these errors are particularly problematic in collectivist contexts, such as Middle Eastern households, where fathers, grandparents, siblings, and other family members play integral roles in infants' linguistic input. In Iran, for instance, grandparents provide extensive caregiving support—64.1% of Iranian mothers receive help from maternal grandparents and 25.1% from paternal grandparents (Mazandarani & Bahramabadi, 2023), thus they contribute substantially to infant's linguistic input. Similar patterns are found in other non-WEIRD communities, where infants receive substantial input from men and other children, especially as they grow older (Casillas et al., 2021). Because LENA struggles to reliably detect and classify these voices, its automated outputs risk underrepresenting key sources of linguistic input in collectivist, multigenerational contexts.

2. Addressed vs. Overheard Speech: The LENA system does not distinguish between speech directed to infants and speech overhead by them, despite evidence that addressed speech (IDS) plays an important role in early language development (Weisleder & Fernald, 2013). The significance of this limitation is context-dependent. In Western settings, where addressed speech is typically the primary driver of language learning, conflating these registers can lead to misleading input estimates. In contrast, in some non-WEIRD contexts—including Middle Eastern households—overheard speech itself may constitute a meaningful source of input, potentially reducing the impact of this limitation. For example, in some non-WEIRD communities, infants hear substantially more overheard speech (approximately 21 and 36 vs. 7 min/hour) and about three times less IDS than North American infants (Bergelson et al., 2019; Casillas et al., 2020, 2021). In Middle Eastern households, where extended families often co-reside, multiple caregivers and relatives further increase the proportion of overheard input. While this means that LENA’s conflation may be less problematic in contexts where overheard input is developmentally meaningful, it still limits researchers’ ability to quantify and compare these distinct registers across cultural contexts, obscuring differences in the structure and function of infant language environments.

3. Overlapping Speech in Multi-Speaker Households: Overlapping speech and noisy environments pose major challenges for the accuracy of LENA’s automated measures (Bulgarelli & Bergelson, 2020). Because LENA was developed for nuclear family households in American English-speaking populations, its algorithms exhibit biases that limit performance in diverse linguistic and cultural settings. As a result, LENA often conflates overlapping speech from multiple speakers, leading to incomplete and distorted estimates of infants’ linguistic environments. This issue is particularly salient in non-WEIRD contexts, where households are

typically larger. For example, household size in some communities is nearly double that of North American homes (6.19 vs. 3.44; Casillas et al., 2021). Such overlap is characteristic of Middle Eastern collectivist households, where simultaneous talk across generations is routine. In these contexts, LENA’s misclassifications systematically underrepresent key contributors—such as fathers, grandparents, and siblings—thereby reducing the reliability of automated analyses.

Recognizing these challenges, researchers have developed alternative tools that may better capture infants’ linguistic environments in collectivist and multi-speaker households. Hardware such as *BabyLogger* (Cao et al., 2018), which integrates multiple microphones and a camera, provide improved precision and contextual information. Multimodal approaches—such as pairing stereo audio recorders with wearable fisheye-lens cameras—have also proven useful for identifying speakers and contexts in traditional communities (Casillas et al., 2021). Beyond hardware, open-source tools address some of LENA’s algorithmic biases. The ACLEW project’s Automatic LInguistic unit Count Estimator (ALICE; Räsänen et al., 2021) estimates phoneme, syllable, and word count across languages, while Voice Type Classifier (VTC; Lavechin et al., 2020) distinguishes overlapping speakers through multi-label classification. However, both were trained primarily on WEIRD datasets and lack representation from Middle Eastern languages. Consequently, features of Middle Eastern input—such as overlapping multigenerational talk—may still be misclassified. This underscores the need to retrain algorithms with regionally representative data and refine them to distinguish speakers not only by gender but also by age (and potentially accent, since grandparents often speak with more traditional pronunciations).

3.7.2.2 Ethical Challenges

Ethical concerns in infant language research are particularly pronounced when using longform audio recordings, these concerns are amplified in collectivist and more specifically Middle Eastern contexts where cultural norms, family structures, and legal frameworks differ from Western assumptions. Below, I discuss key ethical challenges and how they are exacerbated in these settings.

1. Privacy and Sensitivity: Naturalistic recordings capture private household conversations, which in Middle Eastern contexts may include religious, political, or family matters that carry social or legal risks. Researchers must be cautious in reassuring confidentiality and should explicitly advise families to avoid sensitive discussions during recordings, as breaches of privacy can have more serious consequences than in WEIRD settings.

2. Community and Family Consent: Unlike WEIRD contexts where consent is typically granted at the individual level, in collectivist societies, participation often requires approval from elders, religious leaders, or extended family. In the Middle East, legal guardianship further shapes participation—for example, in Iran, fathers (or if absent, paternal grandfathers) are considered infants' legal guardians (Raeesi, 2015). Such dynamics make Western consent protocols, based on individual autonomy, culturally inappropriate. Moreover, without culturally grounded consent processes, archiving or secondary use of recordings may be perceived as exploitative. Transparent verbal explanations, involvement of local collaborators, and ensuring tangible community benefits are therefore essential.

3. **Consent Form Adaptation:** Standard Western consent forms often fail to translate meaningfully into Middle Eastern contexts. Written forms may not be fully understood in lower-literacy households, while cultural conventions differ—for instance, in Iran, initials are not used in formal documents, and are typically used to anonymize individuals. Instead, individuals sign their last name with a graphical signature. Researchers should therefore adapt consent processes, prioritizing oral explanations delivered in the presence of trusted family members, and consult local community members to ensure linguistic and cultural relevance.

4. **Cultural and Religious Norms:** Researcher conduct must align with local expectations to build trust. In many Middle Eastern contexts, this may include following Islamic norms such as hijab regulations and requirements for female researchers and sensitivity to gendered interactional norms. Overlooking such expectations can undermine community trust and participant comfort, even if formal ethical approval has been obtained.

5. **Bias in Automated Tools:** Automated systems such as LENA raise unique ethical concerns in collectivist households. Optimized for nuclear-family, Western contexts, LENA systematically underrepresents speech from fathers, grandparents, siblings, and other caregivers who are central to infants' input in the Middle East. This misrepresentation risks reinforcing Western-centric assumptions and erasing the contributions of key caregivers, thereby producing skewed scientific conclusions about infant language environments.

6. **Researcher Well-being:** Finally, ethical challenges extend to research personnel. Longform recordings may expose researchers to sensitive or distressing material, including household conflict or politically charged conversations, which can be particularly common in regions experiencing socio-political instability. Teams working in Middle Eastern contexts

should therefore establish clear protocols for handling sensitive content and provide mental health support to protect research assistants and others involved.

3.8 Methodological Responses to LENA System Limitations

Although the LENA system presents several technical challenges—particularly in non-WEIRD, ME contexts—the present study addressed these limitations through careful methodological decisions. To mitigate these challenges, LENA estimates were used only for speech quantity measures (AWC), as AWC is one of the most reliable LENA outputs across a range of languages (Cristia et al., 2020; Cristia et al., 2021; Gilkerson et al., 2015). Furthermore, emerging evidence demonstrates that LENA yields valid estimates of the linguistic environment for Hebrew- and Arabic-learning infants, suggesting broader applicability within Middle Eastern languages (Levin-Asher et al., 2023). However, because the accuracy of LENA’s automated annotations has never been validated for Persian, the LENA estimates may still underrepresent the true amount of adult speech. Therefore, all fine-grained analyses—including identifying the primary caregiver’s or mother’s speech, identifying and distinguishing IDS/ADS utterances, and excluding low-quality utterances—were conducted through multi-stage manual annotation and acoustic verification, rather than relying on automated labels (more details on each stage is provided in the next chapter).

In addition to technical considerations, the study also addressed several ethical challenges associated with naturalistic, daylong audio recordings, particularly in Middle Eastern cultural settings. For instance, I translated and adapted the study materials, including consent form, into Persian to ensure linguistically and culturally appropriate explanations of the study. Additionally, I conducted the data collection in Iran, as a native Iranian Persian speaker, with continued

guidance from a committee member who served as the local expert and advised at every stage—from data collection to the various levels of analysis. Furthermore, data were stored securely, caregivers retained control over their data, and all interactions were guided by culturally sensitive researcher conduct that respected local norms and participant comfort (more details on every stage is provided in the next chapter). Together, these practices ensured that the study met ethical standards while remaining culturally responsive.

By integrating automated LENA estimates with rigorous manual-acoustic methods and culturally grounded ethical procedures, this work provides a feasible, sensitive, and methodologically robust model for conducting longform audio research in Iran and other non-WEIRD Middle Eastern settings.

3.9 Conclusion

This chapter highlights that IDS reflects both universal caregiver tendencies and culture-specific practices. While IDS plays a well-documented role in infants' early development, its specific features—prosodic, phonological, lexical/syntactic, and pragmatic—vary substantially across linguistic and cultural contexts. Western IDS typically reflects individualistic, child-centered interactional values, whereas Middle Eastern IDS embeds speech modifications within collectivist, family-oriented traditions. These differences illustrate how cultural norms, infant-rearing practices, and sociolinguistic structures shape caregiver-infant communication in ways often overlooked in Western-centric research, underscoring the need for cross-cultural approaches.

A key limitation of current IDS studies is its reliance on methodologies developed for WEIRD populations, which often fail to capture the multi-speaker and multi-generational ME

collectivist environments. Addressing these gaps requires culturally sensitive research designs, including manual coding, multimodal analysis, and community-based collaborations that more accurately reflect linguistic and cultural diversity. Extending IDS research to non-WEIRD populations—particularly underexplored Middle Eastern societies—will support the development of a more inclusive and ecologically valid framework for understanding early language development.

Although the LENA system presents methodological and ethical challenges in Middle Eastern contexts, my dissertation was designed to address these limitations directly through extensive manual annotations and cultural and ethical considerations that were incorporated into data-collection and analysis protocols. Together, these steps ensured that LENA could be used appropriately, ethically, and reliably within this study, while acknowledging its boundaries and adapting it to the cultural context.

Chapter 4: Methodological Approach to Understanding the Language Environment of Persian Infants

4.1 Introduction

This chapter outlines the methodological approach used to investigate the linguistic environment of Persian-learning infants in Iran. Although qualitative methods (e.g., ethnographic observations) can provide valuable contextual insight into caregiver–infant interactions, they are less suited to quantifying speech input or capturing prosodic patterns at scale. To address the aims of this dissertation—which required the measurement of speech quantity and acoustic features—a quantitative, acoustically based design was employed. This study integrates naturalistic longform audio recordings, automated analyses using the LENA system, and detailed manual annotation to examine both the quantity and prosodic quality of infants’ speech input.

LENA was selected for this study because it offers a validated and widely used method for capturing daylong, ecologically representative recordings of infants’ language input. Compared to laboratory observations or brief audio samples, LENA minimizes observer effects and allows researchers to document caregiver–infant interactions as they naturally occur in the home environment. The system provides reliable quantitative estimates, including AWC and CTC (Conversational Turn Count), which have demonstrated acceptable validity across diverse linguistic contexts. Given the goals of this dissertation, which required measuring overall speech quantity and examining prosodic features in naturalistic settings, LENA provided an optimal balance of scalability, ecological validity, and technological precision.

The study addressed five research questions concerning (1) the relationship between infants’ demographic characteristics and their speech input quantity, (2) the relationship between

caregiver socioeconomic status and speech input quantity, (3) differences in input quantity from female versus male adult speakers, and (4–5) whether and how Persian caregivers modify prosodic features in infant-directed speech, including developmental changes across 6 to 13 months. By creating the first large-scale naturalistic dataset of Persian infants' language environments, this research contributes to diversifying samples in developmental psychology and provides a resource for future investigations.

As outlined in Chapter 3, although the LENA system poses several technical and ethical challenges in Middle Eastern contexts, the present study incorporated safeguards—including extensive manual annotation, culturally adapted procedures, and ethical considerations—to ensure valid and culturally appropriate use of the technology in an Iranian context. The sections that follow describe the participants, materials, data collection procedures, annotation and acoustic analysis methods, and statistical approaches used in the study.

4.2 Method

4.2.1 Participants

A total of 50 infants ($f = 26$, $m = 24$) aged 6 to 13 months ($M = 9.21$ months, $SD = 1.81$) and their caregivers participated in this study. Families were recruited from urban areas of Mashhad, Iran, using a non-probability, convenience sampling approach, in which parents volunteered to participate after learning about the study through recruitment channels. All infants were typically developing, with the exception of one infant born prematurely (before 37 weeks of gestation), specifically at 1 month and 11 days before full-term gestation, and one twin (only one of the twins participated). None of the infants had any developmental disorders or hearing impairments. Also, they were all healthy and had no medical issues. All infants were exposed

primarily to Persian at home, though 14% of families reported the use of additional languages or dialects. The primary caregivers were mothers (M age = 32 years, range = 19–43), with fathers (M age = 37 years, range = 27–52) serving as secondary caregivers.

Caregiver demographics varied in educational background, employment, and household income (see Table 1 for full details). For instance, 40% of mothers held a high school diploma or less, 44% a bachelor's degree, and 16% a graduate degree. About one-third of families fell into the lowest income category, while the remainder were distributed across medium to high income brackets. Roughly half of families reported additional caregiving support (e.g., grandparents or aunts). Further information about infant birth order, siblings, household size, and caregiver characteristics is summarized in Table 1.

Table 1

Table 1: Demographic Characteristics of the Infant Participants and Their Caregivers

Characteristic	n	%	M	SD	Range
Infant Age (months;days)			9.21	1.81	6;5–13;11
Infant Sex					
Female	26	52			
Male	24	48			
Infant Birth Order					
1st	19	38			
2nd	22	44			
3rd	6	12			
4th+	3	6			
Siblings					
0	18	36			
1	22	44			
2+	10	20			

Household Size			3.92	0.91	3–7
Caregiver Age (years)					
Mother			32.0	5.19	19–43
Father			37.02	5.06	27–52
Mother's Education					
≤ High school	20	40			
Bachelor's	22	44			
Master's+	8	16			
Father's Education					
≤ High school	26	52			
Bachelor's	15	30			
Master's+	9	18			
Family Income (IRR/month)					
≤ 41,797,750	18	36			
41,797,750–100M	14	28			
100–150M	6	12			
≥ 150M	12	24			
Mother's Employment					
Housewife	36	72			
Other	14	28			
Father's Employment					
Self-employed	24	48.98			
Other	22	44			
Not provided	4	8.16			
Daycare Attendance					
Yes	3	6			
No	47	94			
Other Caregivers					
Yes	23	46			
No	26	52			
Primary Language at Home					
Persian	50	100			
Other Languages at Home	7	14			
Knowledge of Other Languages/Dialects					
Yes	18	36			

No	32	64
Caregiver Experience with Children		
Yes	38	76
No	12	24

Note. Father's information was not reported for one participant. Instead, an aunt's demographic information was provided as the secondary caregiver. The primary caregiver had mentioned in the demographic questionnaire that the infant's aunt had a secondary caregiving role, and no information was provided for the infant's father. However, I had spoken with the father during recruitment, and his voice was also present in the audio recording.

Twenty-one participants identified grandparents as caregivers, and two mentioned that both grandparents and aunts had caregiving roles.

The participants reported to have knowledge of other languages/dialects such as Lori, Turkish, English, French, Kurdish, Deutsch, and Arabic.

Overall, my sample reflects the socio-economic characteristics of urban Iranian families during the data collection period, including a mix of educational backgrounds, income levels, and household structures. While the distribution is somewhat skewed toward lower income levels, this pattern mirrors the broader economic conditions in Iran, especially during that time, which was marked by high national poverty rates of around 38% between 2021 and 2023 (MacroTrends, n.d.). As such, the sample can be considered broadly representative of the target population of urban families in Mashhad, Iran.

4.3 Materials

4.3.1 Recording Equipment and Data Processing Software

Data for this study was collected using LENA Digital Language Processor (DLP), a small wearable audio recording device specifically designed for capturing the longform natural sounds of the language environment of infants. The device can record up to 16 hours of audio in a single session, providing continuous, high-quality recordings of all the sounds the infant is exposed to throughout the day. The device was placed in a specially designed pocket in the infant's clothing, which ensured the device remained unobtrusive and in proximity to the infant's speech hearing and production area.

LENA Pro – Grad Version software (LENA Research Foundation, 2012) was purchased in Summer 2022 by Baby Language Lab and was installed in a laptop by the Psychology Department IT section. This study laptop was sent to me prior to data collection. This software automatically processes the longform audio data recorded on the LENA recorders, using built-in speech-identification algorithms to provide estimates of the infant's language environment. The main metrics produced by the LENA software included Adult Word Count (AWC), Child Vocalization Count (CVC), and Conversational Turn Count (CTC) (Cristia et al., 2021). These automated outputs provide a general estimate of the infant's language exposure and production and interaction patterns.

The Advanced Data Extractor (ADEX) software was further used to provide more detailed automated output from the audio data, including the total number of AWC in 5-minute segments.

4.3.2 Paper Forms

The forms used in this study included: consent form, demographic questionnaire, log sheet, LENA instruction (parent's guide), and study advertisement. These forms, in both English and Persian versions are attached in Appendix 2-11.

An informed consent form was used to provide the participants more details about the study and their rights including withdrawing from the study at any time. Moreover, it was used to obtain written consent from the caregivers to participate in this study, and using their data for this study, future studies in the lab, and sharing their data in scientific repositories.

Demographic information was collected using a demographic questionnaire designed to gather key details about the infants and both the primary and secondary caregivers. The questionnaire was divided into two sections:

1. **Infant Background:** In this section, caregivers provided details about the infant, including their sex, date of birth, birth order, and number of siblings. This section also inquired about any physical health problems, hearing delays, language or cognitive developmental delays the infant might have had experienced.
2. **Caregiver Background:** This section collected demographic information about the primary and secondary caregivers, including their age, gender, level of education, family income, native language, knowledge of other languages, and number of people living in the household.

Caregivers were also provided with a log sheet to record key events and activities on the recording day, including feeding, play, and nap times. They documented the start and end times of the recording as well as the infant's nap time periods. These logs were used to identify the

corresponding 5-minute segments during which the infant was asleep. Because ADEX outputs AWC in 5-minute intervals, segments that overlapped with recorded nap times were excluded from analysis to ensure that AWC estimates reflected periods when the infant was awake.

Additionally, the caregivers received a LENA instruction (parent's guide) form as complementary to the oral instructions I provided, ensuring they understood how to properly use the LENA recorder and adhere to the study's protocol.

4.3.3 Manual Annotations

In addition to the automated outputs provided by LENA software, manual annotations were performed at the Baby Language Lab, Department of Psychology, University of Manitoba, Winnipeg, Manitoba, Canada. I used ELAN (version 6.3, 2022), a widely-used software for manually annotating audio data. Importantly, because automated LENA classifications are not sufficient for identifying main caregivers' speech and for distinguishing infant-directed from adult-directed speech, the present study supplemented LENA-derived metrics with extensive manual annotation to ensure accurate identification of speech registers. ELAN allowed for precise identification of IDS and ADS utterances produced by the primary caregivers, mothers, within the recorded segments. Specifically, each recording was manually annotated to ensure that high quality and accurate utterances from primary caregivers were captured for subsequent analysis. More details regarding the manual annotations will be provided in the following sections.

4.3.4 Acoustic Analysis Software

The Praat software (version 6.0.56; Boersma & Weenink, 2022) was employed to conduct analysis of the acoustic features of caregiver utterances. Praat is a well-established phonetic

software that allows for the precise measurement of various acoustic parameters, including fundamental frequency (f_0)—the acoustic correlate of perceived pitch. These measurements were critical for understanding how Persian caregivers adjusted their speech patterns when speaking to infants and adults. A Praat script was created and used to automatically measure the acoustic features of primary caregiver’s utterances, including their mean f_0 , and to provide a final output for statistical analysis. The Praat script used for acoustic analysis is available on the Open Science Framework (OSF, link:

https://osf.io/xgfvz/overview?view_only=a5ac63f2c8404cb2ab48bbe03d454589).

4.3.5 Statistical Analysis Software

The statistical analyses were conducted using R (version 4.4.3, 2025-02-28) in RStudio (Version 2024.12.1+563), an open-source free programming language and software environment, widely used for statistical computing and visualizations. In this study, R was used for all the descriptive and inferential analyses, as well as data visualization. Furthermore, my advisor and I, shared a private repository in Github for the study in order to collaboratively manage and track the code development, and ensure version control throughout the analysis process. This facilitated transparency and efficient communication during the statistical workflow. All R scripts used for this study are openly available on OSF.

4.4 Procedure

4.4.1 Recruitment

Recruitment for this study was conducted through various daycares, the social media platform Instagram, the Gahvareh application, and word-of-mouth referrals. The Gahvareh application is a popular Persian-language platform in Iran that connects parents with childcare

resources, parenting advice, and early childhood development information. In this study, most of the volunteer participants were recruited through the Instagram account *farsi.infant*, managed by me, along with word-of-mouth referrals. Instagram was chosen as the primary online platform given its popularity in Iran. According to Statcounter GlobalStats, it is the most widely used social media platform (69.3% usage in October 2021), far surpassing Facebook and Twitter usage. This trend of increasing Instagram usage made it an effective platform to maximize visibility of the study advertisement.

Similar to other study materials, study advertisements were created both in English and Persian. Also, both paper and online versions contained identical content to ensure consistency across recruitment sources. The Persian version was distributed during data collection. Both the English and Persian versions are attached in Appendix 6 and 11, respectively.

The advertisement was posted in various daycares and kindergartens across Mashhad, where staff indicated suitable locations for placement, such as walls or bulletin boards. Due to the limited number of daycares in Mashhad, the advertisement was also distributed in kindergartens, as caregivers of older children may have had younger infants who would fit the study criteria. I provided the daycare and kindergarten staff with details regarding the study, participant requirements, and recruitment procedures. Some daycares and kindergartens opted not to participate due to various reasons, including their age range limitations or the need for an official Iranian governmental letter. Additionally, one copy of the advertisement was posted on the office door of one of the research committee members, located at the Faculty of Persian Literature and Humanities, at the Ferdowsi University of Mashhad, to increase visibility.

Interested volunteers contacted me via the contact information (phone number, email address, and Instagram account) provided in the advertisement. During an initial screening, I

asked the volunteers questions to verify eligibility based on criteria such as infant age, primary language, and city of residence. Eligible volunteers were then invited to a meeting, scheduled at a time and location convenient for them, to discuss the study and procedure in detail.

The inclusion criteria for participating in this study were:

1. All infants must be healthy and have typical development.
2. Infants must be in the age range of 6.0 to 13.0 months.
3. Persian must be the language spoken in their homes.
4. The parents of the infants must be native Persian speakers living in the urban areas.

4.4.2 Data Collection

Data collection took place in August-December 2022 in Mashhad, the second largest city of Iran, after Tehran. Mashhad's 2021 population was estimated at 3,264,101 (United Nations, Department of Economic and Social Affairs, Population Division, 2018). I traveled from Canada to Mashhad, Iran, with eight LENA DLPs and their special clothing in various sizes. I attempted to obtain official governmental permission to distribute the study advertisement across health and medical centers. However, this effort was unsuccessful, as the permission required current official transcripts from an Iranian university, and I needed to be enrolled as a full-time student at an Iranian institution. Therefore, other methods (as mentioned in the previous section) for distributing the study advertisement and finding participants were performed.

After finding the eligible volunteer participants, meetings were arranged at times and locations convenient for the participants. During these initial meetings, I explained the study

goals, reviewed the consent forms with them section by section, clarifying any questions or concerns they may have had about the consent form or the study, and ensuring they understand their rights such as to withdraw at any time without penalty. The caregivers were asked to thoroughly and carefully read the consent form, complete and sign it. In case the father of the infant was not present in the first meeting, I explained to the mother that the father of the infant must also agree that their infant participate in this study, and that they must sign the consent form as well. In Iran, legal guardianship of infants and children is typically their fathers; if the father is deceased, guardianship generally passes to the paternal grandfather. Caregivers were also asked to inform anyone who might be present in the home on the recording day about the recording, obtaining verbal and written consent if their voices would be captured.

In addition to the consent form, I provided participants with the other study materials: a demographic questionnaire, a log sheet, LENA instructions (parent's guide), and a LENA DLP along with appropriately sized clothing. After providing details about the other forms, I provided participants with detailed oral instructions on how to use the LENA devices. These instructions covered how to turn the device on when the infant awoke in the morning and off at bedtime at night. Participants were instructed to select a day for recording when they would be at home with the infant and engage in their usual daily activities (e.g., cooking, playing) to maintain a naturalistic environment. Detailed guidance was also given regarding moments when the device should be removed, such as during baths or activities that might damage the device, and the importance of keeping the device on during naps to capture a full day's language environment.

Participants were requested to complete a single recording session lasting approximately 12 hours, starting in the morning and ending at night. Regarding the recording durations, it should be noted that the lowest audio recording duration in this dataset was 10:41:11 (10

hours:41 minutes:11 seconds), and the highest duration was 13:36:23. Additionally, 40 of the audio recording durations were over 12 hours.

Upon completing the recording and filling out the forms, caregivers contacted me to arrange a second meeting to return the study materials. I then picked up the study materials. Compensation for participating in this study included a bank gift card valued at 3,000,000 IRR (equivalent to \$12) and a children's book from the series 'ترانه‌های می می نی و مامانی' (*Mimini and Mommy Songs*). Bank gift cards are a common and popular form of compensation and gift in Iran. Also, *Mimini and Mommy Songs* is a collection of illustrated stories written as songs, selected for their age appropriateness (group A, suitable for infants). A book from this collection was randomly chosen for each participant.

After collecting each LENA recorders, I connected them to the study laptop equipped with LENA pro software to transfer the audio data. Next, the LENA devices were recharged, and the clothing were washed and sanitized before being provided to the next participants.

4.4.3 Data Storing

After connecting the LENA devices to the study laptop, the audio data and the processed data by the LENA software were stored in a folder on the study laptop. That folder included multiple separate folders, each containing data from a participant. The folders were renamed as the participant names: Sub_01a, Sub_02a, ..., Sub_025a, Sub_01b, Sub_02b, ..., Sub_025b. Additionally, the LENA pro Grad version has a limitation that permits a maximum of 25 children in the database, with no option to delete an existing child profile. To accommodate more than 25 participants, I followed the official LENA guidelines for reusing child slots, which involved overwriting existing entries with new participant information while maintaining detailed records

to preserve data integrity. Specifically, child IDs were renamed systematically to distinguish between first and second uses (e.g., Sub_01a, Sub_01b; where a at the end of a participant ID refers to the first round of participants, and b refers to the second round), and key metadata such as date of birth, sex, and age at recording were carefully logged in both the Client Manager and Report List in the software platform. All files and metadata were exported before each overwrite, and data were tracked using an external log to ensure accurate linkage between recordings and participants.

The completed paper forms were all kept in a locked cabinet in my home in Mashhad, Iran. To secure data for long-term storage, all completed paper forms were scanned, and the electronic versions were stored in a separate folder on the study laptop. This process facilitated data transfer between countries and ensured the durability of the records. Therefore, the audio data, the LENA software output data, and the electronic scanned forms were all stored on the study laptop. They were further backed up on a password-protected external hard drive (model: Western Digital 2 TB) by me. Upon confirmation of the successful data transfer, all paper forms were destroyed in compliance with confidentiality requirements.

Due to the poor internet connection in Iran, transferring the collected data from Iran to the lab computers in Canada, through the University of Manitoba VPN, was not possible. Therefore, data was sent to the lab when I returned to Canada. I returned the study materials as well as the external hard drive to the lab. The password of external hard drive was also saved in a folder on the lab computer drives. It should also be mentioned that only lab members have access to the lab computers.

With participant permission, I plan to archive data from the 37 consenting families in a scientific repository (HomeBank; homebank.talkbank.org) following the publication of initial

findings. Only data from participants who explicitly agreed to data sharing will be included in the repository.

4.4.4 Research Ethics

As with other studies using longform recordings, ethical challenges such as privacy and informed consent were carefully considered (Casillas & Cristia, 2019). During data collection, caregivers received detailed oral and written information about the study, including their right to withdraw at any time without penalty. Given that infants are unable to provide consent, the study protocol emphasized their comfort and safety. Caregivers were instructed to remove the LENA device and its specialized clothing if the infant showed signs of discomfort, such as crying or distress, ensuring that participation remained voluntary and responsive to the child's well-being. Additionally, the consent process was adapted to reflect cultural norms in Iran. The consent form included a dedicated section for legal guardians—typically the fathers in the Iranian context—and both caregivers were asked to review and sign the form.

Cultural and linguistic factors further complicated the ethical considerations. The population under study differed significantly from Western cultures, and research of this nature is rarely conducted in Iran. Moreover, many Iranian caregivers were unfamiliar with the LENA system and the study procedures. To ensure cultural and linguistic alignment with participants, I—a native Persian speaker born and raised in Iran—conducted all data collection on-site in Iran.

This research, under protocol number HE2022-0170, was approved by the University of Manitoba Research Ethics Board on August 3, 2022 (see Appendix 12 for the ethics' approval letter of this study). The Human Ethics Office (HEO) operates in accordance with the current Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans-TCPS 2 (2022).

4.4.5 Data Labeling

As mentioned earlier, LENA software identifies meaningful audio (human speech sounds), non-speech sounds (e.g., noise, electronic media), and interfering speech signals, excluding the interfering signals during analysis (Xu et al., 2009). This process allows the LENA software to automatically convert audio data into quantitative estimates, including Adult Word Count (AWC) and Conversational Turn Count (CTC), which were used for this study.

While the automated annotations provided by the LENA software were invaluable for analyzing the infants' language environment, manual annotation was required also for portions of the data. This step was essential to identify main caregiver speech and distinguish between infant-directed speech (IDS) and adult-directed speech (ADS) utterances, a task that the LENA software cannot perform.

RA recruitment began in February 2023 and was conducted through the Baby Language Lab. Given the time constraints and the extensive workload required to complete the manual annotation, a total of 9 student research assistants were recruited, at different times, to assist with the manual annotation process. The recruited RAs included both native and non-native Persian speakers. Native Persian speakers were critical for accurately distinguishing between the IDS and ADS registers in Persian and for recognizing the primary female caregiver's voice among other female speakers, a task that was particularly challenging for non-native speakers.

All RAs were required to obtain training certifications in human subject research, specifically the Course on Research Ethics (CORE) and Personal Health Information Act (PHIA) modules, if they had not already done so, and to complete and sign the lab confidentiality agreement before starting their annotations. The training process included detailed instruction on

using the ELAN software with an annotation scheme adapted from the ACLEW template (Soderstrom et al., 2021) for annotation. Additionally, each RA reviewed an annotation instruction file prepared by me, which outlined all the necessary guidelines and details of the project (see Appendix 13). This document provided a comprehensive understanding of the tasks required for accurate and consistent annotation.

The RAs worked under my direct supervision, and I held regular meetings to monitor progress, address any questions or concerns, and ensure accuracy. The project goals were thoroughly explained during these meetings. To standardize their work, all RAs initially annotated the same two files, which were reviewed by me. Written feedback was provided, and when necessary, follow-up meetings were held to discuss the comments and clarify any misunderstandings. A sample feedback file is included in Supplementary Materials B on OSF.

Files annotated by non-native Persian RAs were subsequently reviewed by native Persian RAs to ensure accuracy and correct any potential errors. All the files were reviewed by our native Persian RAs (called the reviewers), including myself, and they were all PhD students, either at the Psychology or Linguistics Department at the University of Manitoba. All the annotation works were tracked in an Excel spreadsheet tracker (see Supplementary Materials B on OSF).

RAs were encouraged to raise questions or discuss any issues encountered during annotation with me. If I was unable to resolve a particular issue, it was escalated to the study advisor and lab Director, Dr. Soderstrom, for further discussion and resolution. Regular updates, questions, and concerns were addressed through communication channels on the Baby Language Lab Slack platform and regular lab meetings. Manual annotation for all the files was completed

in February 2025. The entire manual annotation process, in total, spanned two years (see how manual annotation was performed in ELAN software in Appendix 14).

4.4.6 Acoustic Analysis

RAs were asked to manually listen to 5-minute segments of the longform audio recordings and identify 120 IDS and 120 ADS utterances per participant. This number was chosen because the study required a final set of 100 IDS and 100 ADS utterances per participant for acoustic analysis. By identifying more than the minimum, I ensured that after excluding utterances that were unsuitable (e.g., due to noise or overlapping sounds and speech), at least 100 utterances per category remained for analysis. In case where exclusions reduced the number below the minimum 100 utterances in either category, the reviewer returned to the recording to identify additional utterances (either within the 5-minute codes already existed or by creating additional codes; see Supplemental Materials B) until the target of 100 IDS and 100 ADS utterances was reached (see Appendix 13, Annotation Instructions, for more details).

I followed the segmentation procedures where an “utterance” was defined acoustically, as a section of speech bounded by pauses (Fernald & Simon, 1984). The utterance selection was based on three criteria: First, the utterances should have had good quality for acoustic analysis purposes. Second, they should not have contained any kind of noise or overlapping speech. Finally, the beginning and end of each utterance were needed to be precise and accurate so that the whole utterance was segmented.

As discussed earlier, for my research questions 4 and 5, I wanted to measure the following acoustic features of Persian mothers’ utterances:

1. Mean-F₀ (Hz)

2. Mean F₀-range (Hz)
3. Mean F₀-variability (Hz)
4. Mean Utterance Duration (Sec)

To analyse the prosodic characteristics of the final 200 utterances for each participant, I used the Praat software (version 6.0.56; Boersma & Weenink, 2022) and developed a Praat script to extract acoustic features of the utterances such as mean pitch, pitch range, pitch variability, and utterance duration (Praat script on OSF; IDS/ADS utterances in Praat on Supplementary Materials B on OSF). After exporting the text-delimited outputs from the ELAN software for each participant, the files were imported into Praat. The script was then run on each file to automatically extract the prosodic measurements from the first 100 IDS and 100 ADS utterances. I ran the Praat script individually for all 50 participant files, saving each output as an Excel spreadsheet. These 50 output files—one per participant—were subsequently imported into R and merged into a single spreadsheet, a dataset, for statistical analysis.

Chapter 5: Demographic and SES Influences on Linguistic Input of Persian Infants

5.1 Introduction

This chapter presents the findings from descriptive and inferential analyses addressing the first three research questions. Descriptive results provide an overview of the adult speech quantity that Persian infants heard per 5 minutes, followed by inferential results examining the relationships between infant and caregiver characteristics and the quantity of adult speech input. Each research question is addressed in turn, with statistical tests, assumption checking, visualizations, and interpretations. Full assumption-checking outputs are provided in Supplementary Materials A on OSF.

5.1.1 Variables and Data Processing

Adult Word Count (AWC): The quantity of adult speech or AWC data was derived from the automated estimates of the LENA Pro software. Additionally, the Advanced Data EXtractor (ADEX) software was used to provide data based on 5-minute intervals. Therefore, for Research Questions 1 and 2, the AWC used in my analyses was the mean AWC estimate based on the 5-minute interval output of ADEX. For each participant, I retained only full 300-second segments (5 minutes) and excluded segments overlapping caregiver-reported nap intervals (using R scripts and the lubridate library). I then aggregated AWC by computing the mean across retained segments, yielding a length-invariant measure of average adult words per 5-minute block.

Other LENA metrics: The same 5-minute aggregation procedure was applied to additional LENA-derived variables, including Female Adult Speech (FAN_Word_Count) and Male Adult Speech (MAN_Word_Count). Each metric was summarized as the mean per 5-minute block after excluding nap intervals and partial recordings. FAN and MAN word counts

were used in Research Question 3 analyses to examine gendered differences in caregiver speech input. These comparisons tested whether Persian infants received significantly more input from female versus male adults, complementing the AWC analyses reported for RQ1–RQ2.

Additionally, Conversational Turn Count (Turn_Count) and Child Vocalizations (Child_Voc_Count) were aggregated but not included in the present inferential models; they were retained for descriptive context and potential future analyses.

Predictors and coding: Infant age was computed in days from caregiver-reported months/days and entered as an uncentered continuous predictor; infant sex was modeled as a categorical factor.

Handling variable recording length: Because my dependent measures are means per standardized 5-minute window with nap segments removed, they are comparable across recordings of different lengths.

5.2 Study Findings

5.2.1 Findings from Descriptive Statistics

5.2.1.1 AWC and Caregiver Speech Measures

On average, Persian infants heard approximately 103 words per 5 minutes, which is about 1,234 words per hour. Moreover, infants received more speech from female adults than from male adults. On average, female adult speech amounted to approximately 85 words per 5 minutes, while male adult speech averaged approximately only 18 words per 5 minutes. These descriptive statistics indicate that female caregivers were the predominant source of linguistic input, contributing approximately five times more speech than male caregivers.

5.2.1.2 Audio Recording Measures

Across the sample, the total recording duration amounted to [605 hrs:19 mins: 0 secs] of naturalistic audio data collected in naturalistic home environments. On average, each participant contributed [12 hrs: 6 mins: 22.6 secs] of audio data.

Table 2

Table 2: Descriptive Statistics for AWC, Female and Male Adult Speech, and Audio Length

Measure	<i>M</i>	<i>SD</i>	<i>Median</i>	<i>Min</i>	<i>Max</i>
AWC	102.8	49.34	96.8	28.28	253.22
Female Adult Speech	84.82	41.85	78.11	25.19	212.5
Male Adult Speech	17.98	13.27	12.69	1.23	50.57
Audio Recording Length	12: 6: 22.6		12: 02: 22	10: 41: 11	13: 36: 23

Note: AWC, Female and Male Adult Speech measures are per 5 minutes.

5.2.2 Findings from Inferential Statistics

5.2.2.1 Infant Demographics and Speech Quantity

In this section, I aim to find answer to the first research question of the study:

Research Question 1: Is there any relationship between the age and sex of the Persian infants and the quantity of speech they receive?

In this question, the independent variables are infant age and infant sex, and the dependent variable is the quantity of speech infants receive, or Adult Word Count (AWC). In order to find out if there is any relationship between infant age, infant sex, and AWC, I

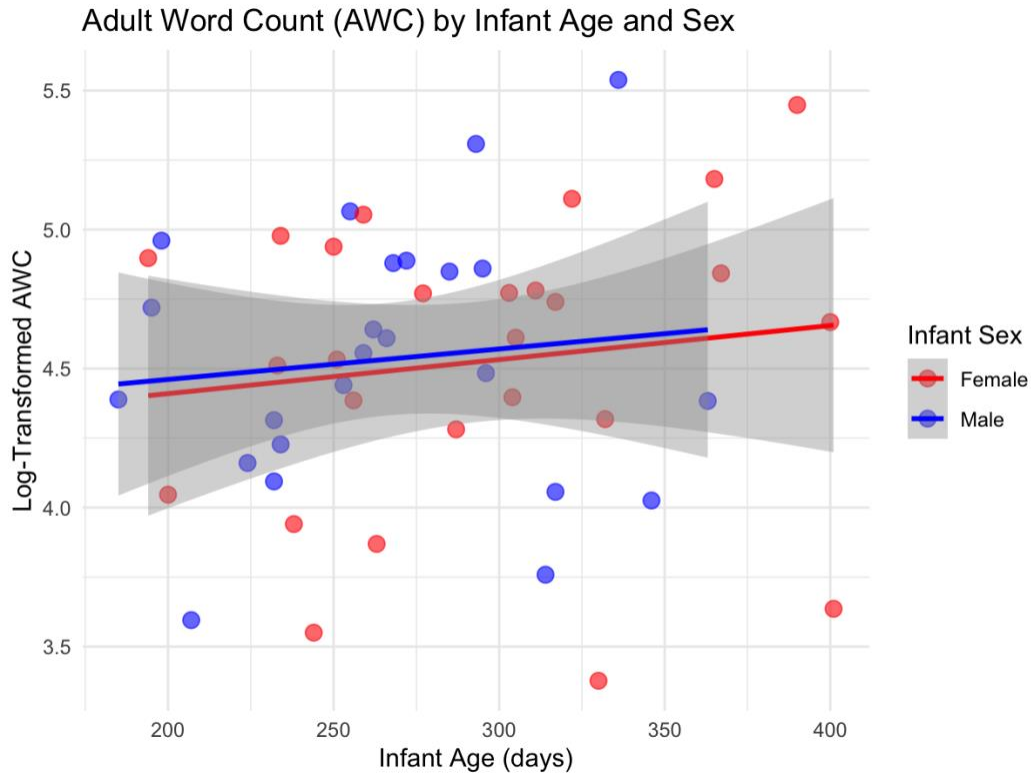
performed a multiple linear regression model using the `lm()` function in R. Before interpreting the results from the multiple linear regression analysis, the five key assumptions for regression model were checked to ensure that the results of the regression analysis are valid. The results of assumption checking were as follows: Overall, the four assumptions of linearity, independence of residuals, normality of residuals, and no multicollinearity were satisfied for the model. However, homoscedasticity was violated. Therefore, I address it to ensure accurate standard errors, p-values, and confidence intervals. To address heteroscedasticity, I decided to transform the dependent variable (AWC), using log to stabilize the variance. Transforming AWC changed the results of assumption checking; therefore, the assumption of homoscedasticity was satisfied for my regression model (full assumption-checking outputs are provided in Supplementary Materials A on OSF).

Next, I ran the model with the transformed AWC. I interpreted the R results from the multiple linear regression model, with the dependent variable AWC transformed (full model outputs are available on OSF).

Research Question 1 Results: A multiple linear regression was conducted to examine the effect of infant age and sex on the log-transformed AWC. The overall model was not statistically significant, $F(2, 47) = 0.38$, $p = .68$, and the effect size was very small ($R^2 = .016$), indicating that only 1.6% of the variance in AWC was explained by the predictors. Neither infant age ($b = 0.001$, $p = .38$) nor infant sex ($b = 0.041$, $p = .78$) significantly predicted AWC. Hence, the results of the multiple linear regression model indicated that there was no significant relationship between infant age or infant sex, and AWC (see Figure 1).

Figure 1

Figure 1: Distribution of Log-Transformed AWC by Infant Age and Sex



5.2.2.2 Caregiver Socioeconomic Status and Speech Quantity

In this section, I aim to find answer to the second research question of the study:

Research Question 2: Is there any relationship between the Persian caregivers' socioeconomic status (SES)—including family income and maternal education—and the quantity of speech their infants receive?

In this research question, the independent variables or predictors were family income and the maternal education level, and the dependent variable or outcome was the quantity of speech,

measured as AWC averaged per 5-minute segment (with nap segments excluded). Although family income and maternal education are ordinal in principle, in our regression models they were entered as categorical (factor) predictors with dummy coding (i.e., level-specific contrasts relative to a reference level). Maternal education had three levels (high school or less, bachelor's, master's or higher), and family income had four levels (lowest, low, medium, highest), with each non-reference level contrasted against a reference category.

First, to examine the relationship between Persian caregivers' SES and the quantity of speech their infants receive, I employed a multiple linear regression model. Before interpreting the test results, I reviewed and checked the key assumptions for the model. Overall, the three assumptions of Independence of Residuals, Homoscedasticity, and No Multicollinearity were satisfied for our model. However, the Normality of Residuals assumption was not strongly satisfied. I decided to address the Normality of Residuals assumption violation by transforming AWC, such that I did in research question 1. I re-checked the assumption of normality of residuals, employing log AWC and the R results indicated that the assumption of normality of residuals was satisfied for our model.

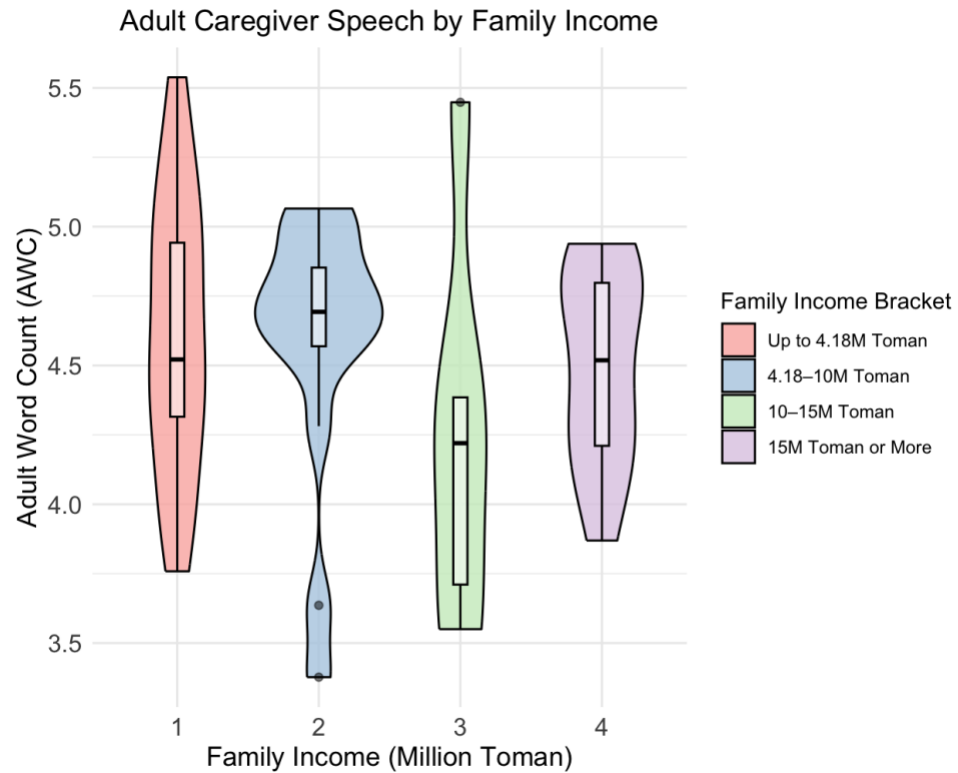
Research Question 2 Results: To address whether caregivers' family income and maternal education level were associated with AWC, a linear regression was performed with log-transformed AWC. The overall model was not statistically significant, $F(5, 44) = 1.07, p = .38$, and the effect size was small ($R^2 = .108$), indicating that approximately 10.8% of the variance in AWC was explained by the predictors. None of the individual predictors reached statistical significance. Compared to families in the lowest income category, families in the second, third, and fourth income brackets did not differ significantly in log AWC ($ps = .79, .14, \text{ and } .87$,

respectively). Similarly, caregiver education level was not a significant predictor, with both the middle and higher education levels yielding non-significant effects compared to the lowest education group ($ps = .56$ and $.33$). These results suggest that neither family income nor maternal education level was significantly associated with the amount of adult speech infants were exposed to in this sample, or AWC.

Additionally, I performed violin plots to visualize the distribution of log-transformed AWC across family income brackets (see Figure 2). The plot shows overlapping distributions across groups, consistent with the regression results indicating no reliable effect of income on AWC.

Figure 2

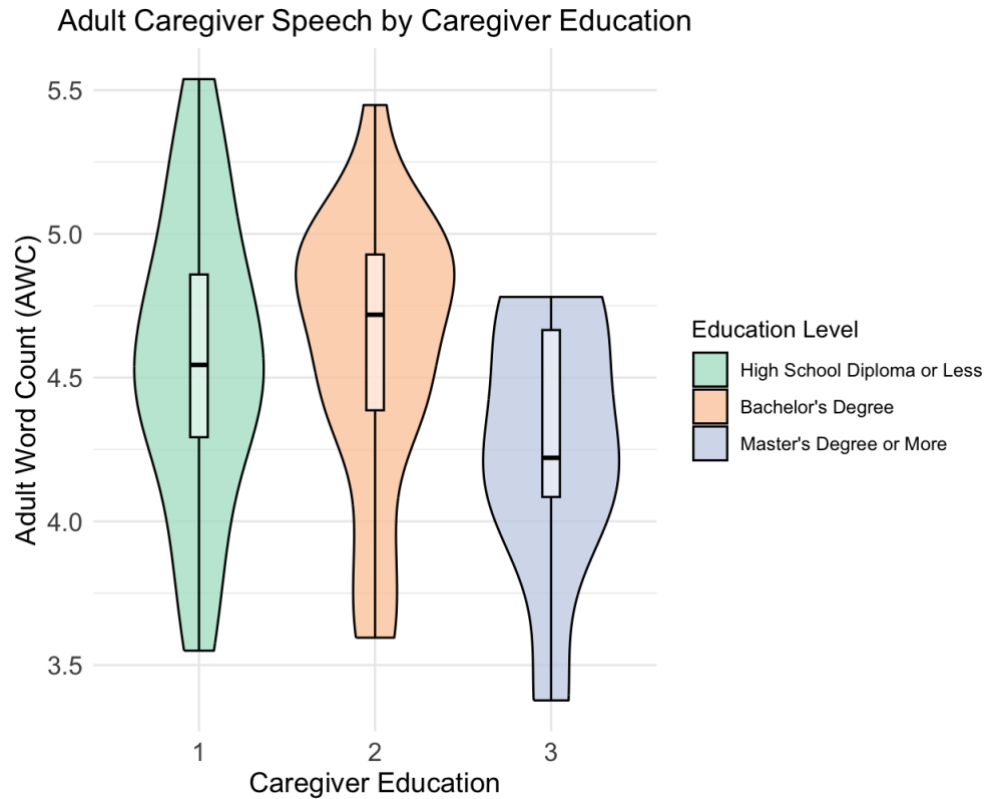
Figure 2: Distribution of Log-Transformed AWC Across Family Income



Violin plots were also used to visualize log-transformed AWC across maternal education levels (see Figure 3). The distributions largely overlapped, consistent with regression results showing no significant effect of caregiver education on AWC.

Figure 3

Figure 3: Distribution of Log-Transformed AWC Across Caregiver Education



Overall, neither infant age nor infant sex nor caregiver SES significantly predicted adult word count. Effect sizes were small for age and sex and modest for SES. These results are consistent with prior studies reporting no associations between demographic factors and speech quantity (e.g., Gilkerson et al., 2017; Bergelson et al., 2023). It is also possible that the present sample ($N = 50$) was not large enough to detect subtle associations, if they exist. Taken together, the non-significant findings likely reflect a combination of genuinely small underlying associations and the limited sample size available for detecting modest effects.

5.2.2.3 *Speech Quantity and Caregivers' Contributions*

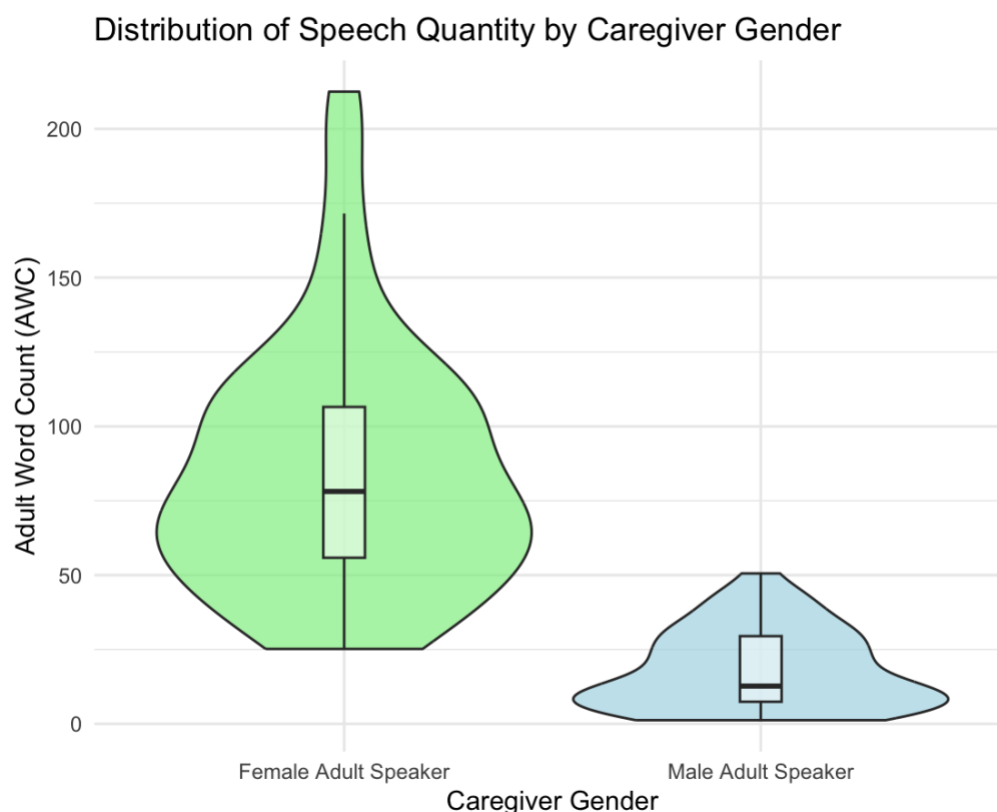
In this section, I aim to find answers to the third research question of the study:

Research Question 3: Do Persian infants receive more speech from female or male adult speakers?

In this research question, the independent variable is caregiver gender, and the dependent variable is the quantity of speech infants receive from adults. For this research question as well, I used the results from the automated estimates of the LENA software which include estimates of Female Adult Near (FAN) and Male Adult Near (MAN), indicating the estimates of adult words near the target infant or participant infant. The results from checking the assumptions indicated that, overall, the two assumptions of Paired Observations and Continuous Data are satisfied for our test. However, the assumption of No Outlier is partially violated; I decided to retain them, and the Normality of Differences assumption is violated. Therefore, I decided to use a non-parametric alternative to paired-samples t-test, Wilcoxon signed-rank test, which does not assume normality, and is robust to outliers, as ranks (rather than raw values) are used. This test compares the medians of the two groups. The R results for Wilcoxon signed-rank test indicated:

Research Question 3 Results: A Wilcoxon signed-rank test showed a significant difference in speech quantity between female and male adult caregivers ($V = 1275, p < .001$). On average, infants heard significantly more speech from female adults ($M = 84.8, SD = 41.9$; Median = 78.1) than from male adults ($M = 18.0, SD = 13.3$; Median = 12.7). Therefore, I conclude that there is a significant difference in the quantity of speech infants received from female versus male adult speakers, with female adult speakers contributing significantly more speech than male adult speakers (see Figure 4).

To evaluate the magnitude of this difference, an effect size r was computed using the Z-score approximation of the Wilcoxon test, and it was calculated as $(r <- z / \text{sqrt}(n))$ in R. The result was $r = 0.86$, which represents a very large effect size, indicating a substantial and meaningful difference in caregiver speech quantity by gender.

Figure 4*Figure 4: Distribution of Speech Quantity by Speaker Gender*

Taken together, these findings point to a consistent gender imbalance in speech input of Persian infants, which is explored further in Chapter 7.

5.3 Chapter Summary

This chapter examined how infant age, sex, and caregiver socioeconomic status related to the quantity of adult speech infants received, and whether infants heard more speech from female versus male adults. The results indicated no significant associations between infant age, sex, or SES (maternal education, family income) and the amount of adult speech, as measured by AWC. These findings are consistent with prior research showing that AWC is highly variable and

not strongly predicted by demographic factors. In contrast, a clear gender difference emerged:

Compared to male adults, female adults contributed substantially more speech to infant linguistic input, echoing cross-linguistic and cross-cultural studies but with an even larger effect size in the Iranian context. This highlights the cultural salience of maternal speech input in shaping the early language environment of Persian-learning infants. These findings will be further discussed and contextualized in detail in Chapter 7.

Chapter 6: Prosodic Patterns and Developmental Changes in Persian Infant-Directed Speech

6.1 Introduction

This chapter presents findings on the prosodic features of IDS and ADS produced by Iranian, Persian-speaking mothers. The prosodic features measured in this study include mean pitch, pitch range, pitch variability, and utterance duration. Specifically, I examined differences in these prosodic modifications between IDS and ADS, as well as changes in IDS prosodic features across the infant age range of 6 to 13 months. The findings of this chapter contribute to our understanding of the extent to which Persian caregivers in Iran modify their speech when talking to their infants relative to adults, in response to developmental changes in infants, and in comparison with caregiver speech modifications across different languages and cultures.

6.1.1 Variables and Data Processing

First of all, I exported the data from all 50 participants from the ELAN software to Praat grid format. To extract acoustic features, I developed a Praat script that reads all utterances previously identified and annotated as IDS and ADS (see Praat Script on OSF). Using this Praat script and the exported ELAN files, I ran the script individually for each of the 50 participant files. This process generated 50 CSV output files, one per participant.

I also manually checked the CSV files to ensure the script has successfully extracted the data. Next, I imported the CSV files from my GitHub repository into R for statistical analysis. Some files contained ‘undefined’ values (utterances that Praat could not process), which I converted to NA by first reading all values as character and then recoding them as numeric. This ensured that R could properly handle missing values during analysis.

As discussed in chapter 4, I had over 100 IDS and over 100 ADS utterances per participant, as RAs were instructed to identify more than 100 of each speech type to ensure that, after excluding utterances with noise, overlap, or other issues, at least 100 usable utterances per category remained for analysis. Additionally, a target of 100 utterances per speech category was chosen to provide a sufficiently large and representative sample for robust acoustic analysis while remaining feasible for manual annotation.

I wanted precisely 100 IDS and 100 ADS be selected per participant. Therefore, I added to the R code to select the first 100 IDS and the first 100 ADS utterances, and to report if any of the files had less than 100 utterances for either IDS or ADS. This occurred because Praat is unable to process some utterances (e.g., due to noise or overlapping speech), which resulted in ‘undefined’ values. The result was 7 files, which were indicated to have less than either IDS or ADS or both. These files were as follows:

Table 3

Table 3: Files with Fewer than 100 IDS/ADS Utterances

File Name	Total IDS	Total ADS
Sub_018b	97	
Sub_019a	96	
Sub_020b	72	
Sub_024b	99	
Sub_03b	99	92
Sub_08b	98	
Sub_09b	99	

I manually checked these files and added additional utterances to reach them to the minimum number of 100 that was required for performing acoustic analysis. The process for

selecting additional utterances involved identifying subsequent 5-minute segments with high AWC or CTC, creating new 5-minute codes on each file, manually listening to these additional 5-minute segments of the recording, and identifying extra ADS or IDS utterances as needed, until the target was reached. Most of these 7 files needed a few additional IDS utterances, except file Sub_020b which had only 72 utterances. This file had been annotated by the RAs, and reviewed by me. We listened to the whole 12 hours manually in order to find enough utterances, but the primary caregiver in this file rarely talked to the target infant. Therefore, this was the only file that, at the end, had less than the minimum number of 100 IDS utterances. Furthermore, file Sub_03b had 92 utterances, which was due to the recording situation and the context in which the recording was happening; the caregivers and target infant were spending some hours in car while driving.

After adding additional utterances and exporting the updated CSV files, I replaced the previous versions with the new files to ensure that all annotated data were included in the final analysis. In order to make sure that these updated files included enough utterances, I ran the R code again, and this time, it was indicated that all the files had enough utterances (except Sub_020b). Rather than excluding this participant, I retained the file in the dataset, as the number of utterances was still sufficient to contribute to the analyses without biasing the overall results.

6.1.2 Statistical Analysis

The aim of this chapter is to explore the following two research questions:

Research Question 4: Do Persian caregivers modify the prosodic characteristics of their speech when addressing their infants relative to adults? If so, in what ways?

Research Question 5: How do the prosodic characteristics of Persian caregivers' IDS vary when addressing infants aged 6 to 13 months?

In order to find out if Persian caregivers modified their speech when talking to infants versus adults and if their modifications changed across infant's age range, I performed a Linear Mixed-Effects Model (LMM) for each of the prosodic features separately. In this study, linear mixed-effects models were fitted using the `lmer()` function from the `lmerTest` package in R, with significance testing for fixed effects, which applies Satterthwaite's approximation to estimate degrees of freedom. This method has been shown to control Type I error rates reasonably well in small to moderate-sized samples (Luke, 2017). Nonetheless, p-values in mixed-effects models should still be interpreted with caution due to the complexities of estimating degrees of freedom in hierarchical data structures (Luke, 2017; Kuznetsova et al., 2017).

To complement the significance testing, I calculated the effects sizes for the IDS–ADS differences in each prosodic feature (Research Question 4), as well as the developmental change across infant age (Research Question 5), using semi-partial R^2 for all the 4 models. I computed semi-partial R^2 values using the `partR2` package in R. Reporting effect sizes allows for a more meaningful interpretation of the practical magnitude of differences, beyond statistical significance. Finally, for Research Question 4, I compared my findings on IDS–ADS differences in Persian caregivers' prosody with the results of a recent meta-analysis research. Specifically, for mean pitch and pitch variability, I calculated Hedges' g and compared the values with the values of the recent meta-analysis. Specifically, Cohen's d was calculated by dividing the fixed effect estimate by the residual standard deviation, and Hedges' g was obtained by applying the standard correction for small sample bias. These cross-linguistic comparisons highlight

similarities and differences between Persian and other languages, providing insight into the prosodic characteristics of the speech directed to infants across the globe.

6.2 Study Findings

To provide an overview of the prosodic characteristics of Persian caregivers' speech, table 4 presents descriptive statistics (number of utterances, means, and standard deviations) for each prosodic feature in IDS and ADS utterances. These statistics summarize overall patterns in mean pitch, pitch range, pitch variability, and utterance duration across the full set of analyzed utterances. Participant-level summaries of these prosodic measures, calculated as averages per caregiver, are provided on the project's OSF page as supplementary materials (in Supplementary Materials B) to support transparency and reproducibility.

Table 4

Table 4: Descriptive Summary for Prosodic Features of Persian Utterances

	Mean Pitch		Range		Variability		Utterance Duration	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
ADS	244.01	56.58	202.00	116.62	47.66	28.32	1.59	0.96
IDS	284.71	77.86	216.24	123.87	56.18	34.05	1.22	0.71

To examine whether Persian caregivers modified their prosody when addressing infants versus adults (RQ4), and whether such modifications changed with infant age (RQ5), I fit separate linear mixed-effects models for each prosodic feature. Each model included speech type (IDS vs. ADS), infant age (in days), and their interaction as fixed effects, with random intercepts for participants. The predictor *xdsLabel* contrasted speech type, with ADS as the reference level and IDS coded relative to ADS. Infant age (*age_in_days*) was entered as an uncentered

continuous predictor. Prior to analysis, undefined values were recoded as NA and excluded (this procedure was applied consistently across all prosody models). Additionally, to facilitate interpretation of the age slope for IDS, I fit a second LMM using only IDS utterances for each prosodic feature.

For visualization, violin box plots were used to illustrate RQ4 results (speech type differences), and scatter plots with regression lines were used for RQ5 results (developmental trends). Unlike the LMMs, which were based on utterance-level data (~10,000 utterances), the RQ5 figures were created at the participant level (though the codes for visualizations at both utterance and participant level have remained in the R script). This approach provides a clearer visualization of overall patterns, with each participant contributing two data points—one for IDS and one for ADS—resulting in a total of 100 data points across the sample.

6.2.1. Mean Pitch

Descriptively, mean pitch was substantially higher in IDS ($M = 285$ Hz, $SD = 77.9$) than in ADS ($M = 244$ Hz, $SD = 56.6$), as shown in Table 4. The LMM estimated a large difference between IDS and ADS: Persian mothers raised their pitch by an average of approximately 88 Hz when speaking to infants relative to adults ($\beta = 87.78$, $SE = 6.72$, $t = 13.06$, $p < .001$).

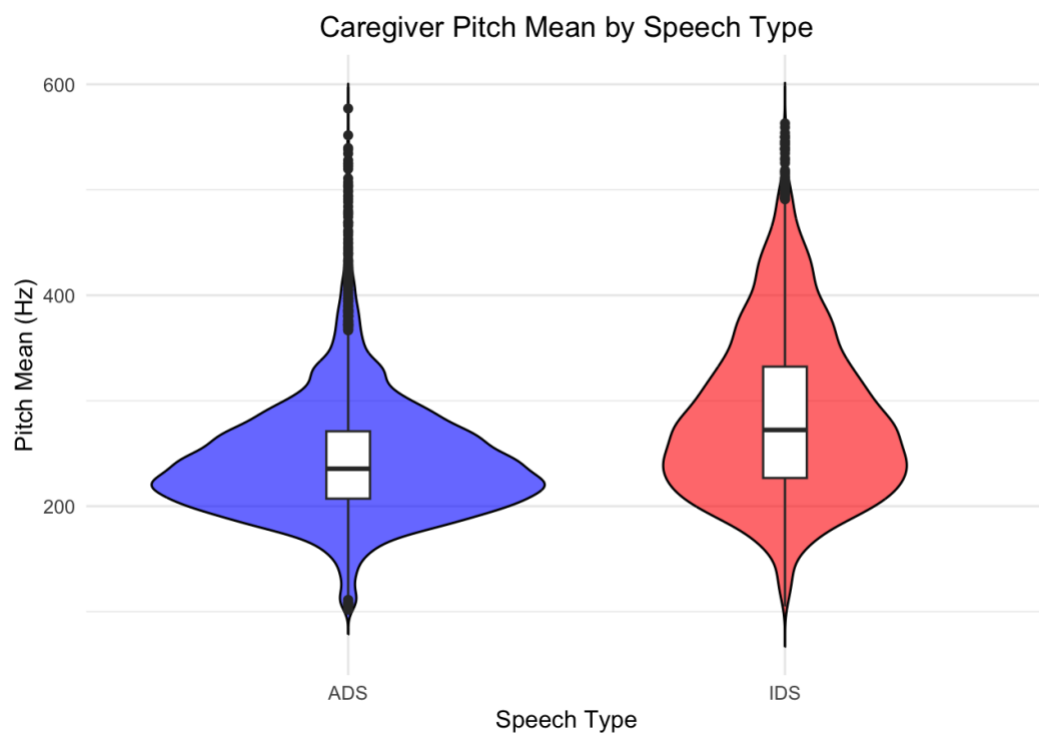
For ADS, the slope of infant age was positive but there was no clear evidence of an age-related change in pitch ($\beta = 0.09$, $p = .15$). Similarly, for IDS, the results from the IDS-only LMM showed a negative age slope that was not reliably different from zero ($\beta = -0.074$, $SE = 0.066$, $t = -1.116$, $p = 0.27$). However, the interaction between speech type and infant age was statistically significant ($\beta = -0.167$, $SE = 0.02$, $t = -7.13$, $p < .001$), suggesting that the difference between IDS and ADS in average pitch became smaller with increasing infant age. This pattern

likely reflects two modest and imprecise age-related trends in opposite directions for IDS (slightly decreasing) and ADS (slightly increasing), which together result in a detectable divergence between the two slopes.

Taken together, these results provide a clear answer to RQ4 and RQ5: Persian caregivers used substantially higher mean pitch in IDS than in ADS, but there was no strong evidence that the degree of this mean pitch modification changed systematically across the infant age range examined. Full model outputs are available on OSF.

Figure 5

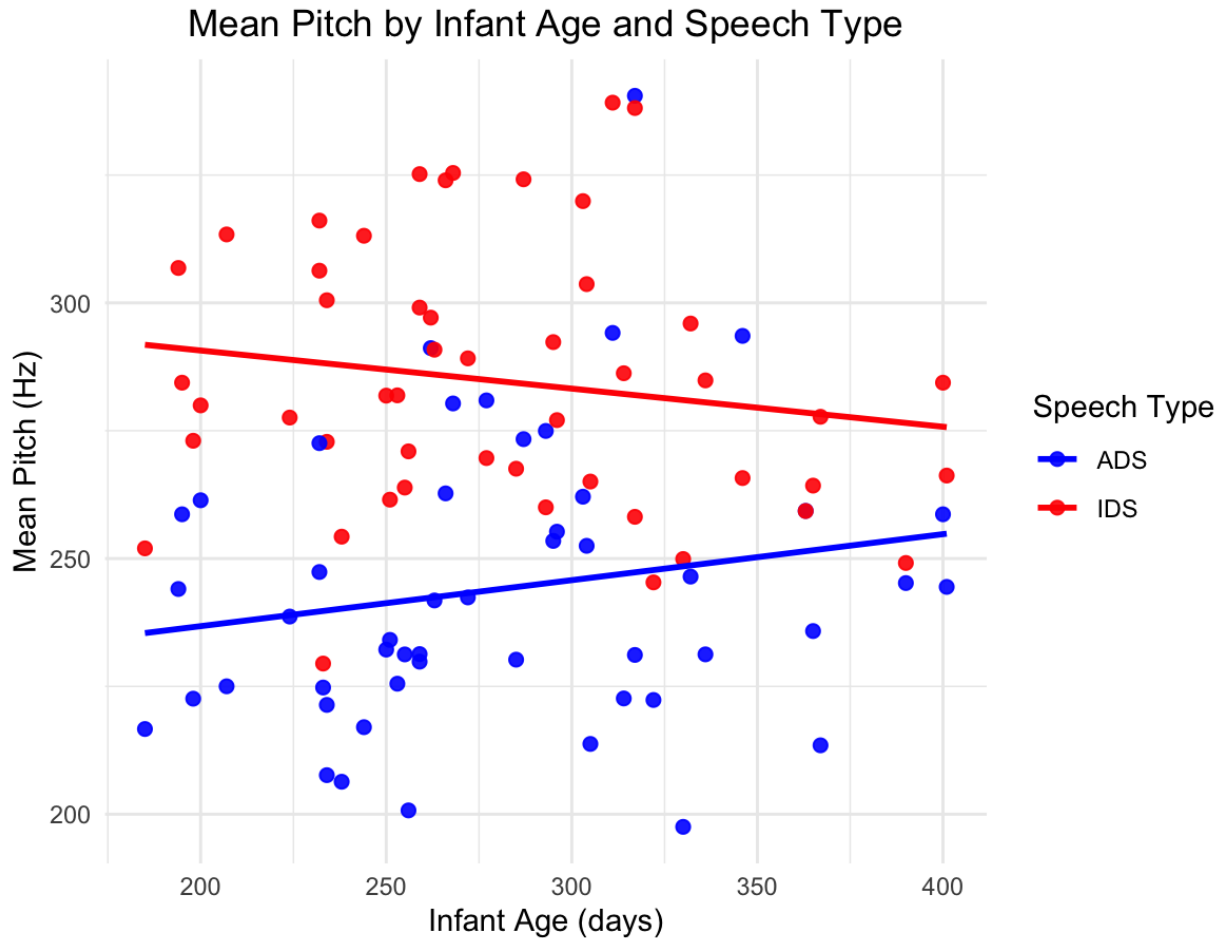
Figure 5: Primary Caregiver Mean Pitch by Speech Type



Note. This figure shows mean pitch distributions in IDS and ADS for research question 4.

Figure 6

Figure 6: Primary Caregiver Mean Pitch by Infant Age and Speech Type



Note. This figure shows mean pitch as a function of infant age for IDS and ADS for research question 5.

To assess the magnitude of the fixed effects in the linear mixed-effects model predicting mean pitch, I computed semi-partial R^2 values. The semi-partial R^2 for the full model was 0.0862 (95% CI: 0.0769–0.1009), indicating that approximately 8.6% of the variance in mean pitch was explained by the fixed effects of speech register, infant age, and their interaction. For RQ4, the

semi-partial R^2 for speech register (IDS vs. ADS) was 0.0139 (95% CI: 0.0054–0.0295), meaning that speech register uniquely accounted for about 1.4% of the variance in pitch mean after controlling for age and random participant effects. For RQ5, the interaction between speech register and infant age explained an additional 0.0042 of variance (95% CI: 0.0000–0.0197), indicating a small effect. These semi-partial R^2 values provide a variance-based estimate of the unique explanatory contribution of each predictor. The structure coefficients further indicated strong associations between the predictors and the model's predicted values ($SC = 0.98$ for speech type and $SC = 0.90$ for the interaction), reinforcing the relevance of both main and interaction effects despite the modest unique variance explained.

6.2.2 Mean Pitch Across Languages

To quantify the magnitude of the difference in mean pitch between IDS and ADS, I computed Hedges' g . The effect size was based on the fixed effect estimate from the linear mixed-effects model and the residual standard deviation. Hedges' g was selected because it provides a standardized measure of effect size that adjusts for small sample bias and is well suited for within-subjects designs, such as the present comparison where each participant contributed both IDS and ADS utterances. Importantly, using Hedges' g allowed for meaningful cross-linguistic comparisons with previous studies that report standardized effect sizes for similar prosodic features in other languages. Specifically, Cohen's d was calculated by dividing the fixed effect estimate (87.78 Hz) by the residual standard deviation (64.03 Hz), and Hedges' g was obtained by applying the standard correction for small sample bias. This yielded an uncorrected Cohen's d of approximately 1.37 and a corrected Hedges' g of approximately 1.35. Cohen (1988, 1992) provided guidelines for interpreting effect sizes, with values of 0.20, 0.50,

and 0.80 for Cohen's d and Hedges' g commonly considered indicative of small, medium, and large effects, respectively. According to Cohen's (1988, 1992) benchmarks, this reflects a large effect size. Hence, the large effect size indicates that caregivers' use of IDS was associated with a substantially higher mean pitch compared to ADS in the Persian sample.

To situate my results within the broader literature, the following table compares mean f_0 between Persian IDS/ADS in the current study and findings from Cox et al. (2023), a meta-analysis of 88 studies across diverse languages and cultures that examined systematic acoustic modifications in IDS. Their results provide a useful benchmark for interpreting cross-linguistic similarities and differences in IDS prosody.

Table 5

Table 5: Hedges' g for IDS–ADS Difference in Mean Pitch Across Languages

Language	Hedges's g (f_0 mean)
Swedish	2.11
US English	1.68
Polish	1.65
New Zealand English	1.65
British English	1.56
French	1.53
Persian	1.35
German	1.34
Italian	1.30
Danish	1.29
Australian English	1.29
Canadian English	1.21
Finnish/Swedish	1.19

Mandarin Chinese	1.17
Hungarian	1.14
Sri Lankan Tamil	1.11
Tagalog	1.06
Japanese	1.04
Korean	1.00
Dutch	0.97
Tsimane	0.89
Quiche Mayan	0.87
Norwegian	0.83
Kenyan/Fijian	0.72
Jamaican English	0.68

As seen in the table 5, the languages are reported from the Cox et al. (2023) study, and the result of my study is highlighted in pink. The comparison of results indicates that Persian IDS showed a large effect size for f_0 mean ($g \approx 1.35$), very close to German, and ranking among the highest across languages.

6.2.3 Pitch Range

Descriptively, pitch range was somewhat wider in IDS ($M = 216$ Hz, $SD = 124$) than in ADS ($M = 202$ Hz, $SD = 117$). The LMM estimated a modest tendency for caregivers to use a wider pitch range in IDS compared to ADS ($\beta = 20.97$, $SE = 12.18$, $t = 1.72$, $p = .085$), although this effect was small and uncertain. This pattern suggests a possible expansion of pitch range in IDS, but the evidence was not strong based on the present sample.

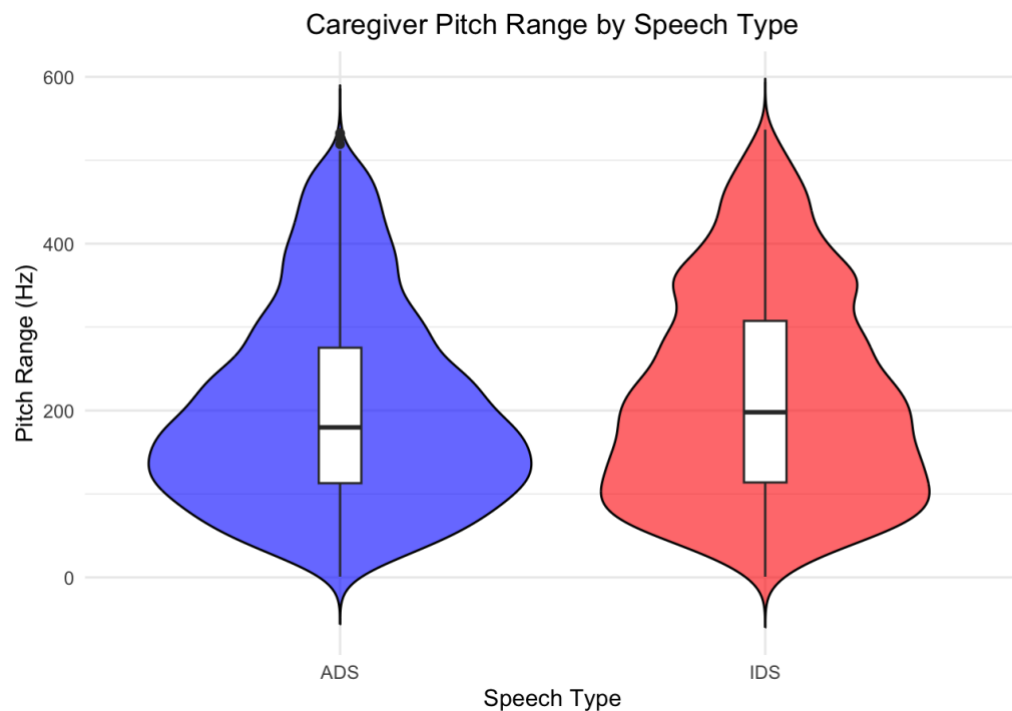
For ADS, there was no clear evidence of an age-related change in pitch range ($\beta = 0.017$, $SE = 0.088$, $t = 0.197$, $p = 0.844$). Similarly, for IDS, the IDS-only model showed an age slope

that was very close to zero and not reliably different from zero ($\beta = -0.004$, $SE = 0.097$, $t = -0.044$, $p = 0.965$). The interaction between speech type and age was also non-significant ($\beta = -0.024$, $SE = 0.042$, $t = -0.56$, $p = 0.5735$), indicating that the relative difference between IDS and ADS pitch range remained stable across the infant age range of 6–13 months.

Taken together, these results suggest that while there was a small tendency for caregivers to use a wider pitch range in IDS than in ADS, the evidence for this effect was weak. There was also no indication that pitch range modification varied systematically with infant age. Full model outputs are available on OSF.

Figure 7

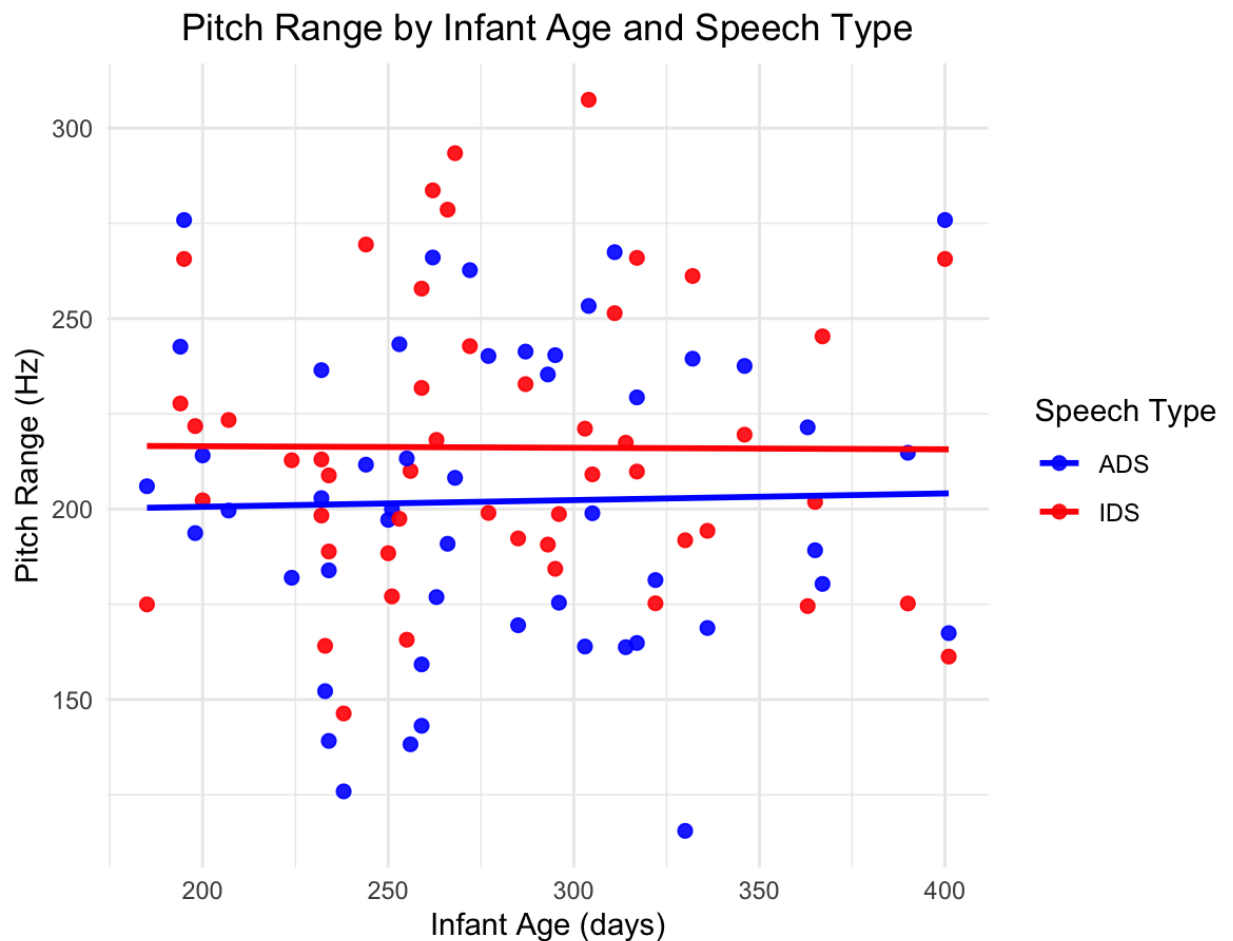
Figure 7: Primary Caregiver Pitch Range by Speech Type



Note. This figure shows the distribution of pitch range in IDS and ADS for research question 4.

Figure 8

Figure 8: Primary Caregiver Pitch Range by Infant Age and Speech Type



Note. This figure shows pitch range as a function of infant age in IDS and ADS for research question 5.

To evaluate the effect sizes associated with the predictors in the pitch range model, I computed semi-partial R^2 values. The semi-partial R^2 for the model was 0.0035 (95% CI: 0.002–0.0124), indicating that only a small portion (0.35%) of the variance in pitch range was explained by the fixed effects of speech register, infant age, and their interaction. The semi-partial R^2 for

speech register (IDS vs. ADS) was 0.0003 (95% CI: 0.000–0.0092), reflecting a very small amount of unique variance attributed to speech type (RQ4). Similarly, the interaction between speech register and age explained virtually no unique variance ($R^2 = 0.0000$, 95% CI: 0.000–0.0089), suggesting that infant age did not significantly moderate the difference in pitch range between IDS and ADS (RQ5). The structure coefficients for both the main effect ($SC = 0.99$) and the interaction ($SC = 0.95$) were relatively high, indicating alignment with the model's predicted values. These results suggest that, while pitch range may vary descriptively across speech types and infant age, it does not uniquely explain variation in this sample and contributes minimally to the model when controlling for other predictors.

6.2.5 Pitch Variability

Descriptively, pitch variability (measured by pitch SD) was higher in IDS ($M = 56.2$ Hz, $SD = 34.1$) than in ADS ($M = 47.7$ Hz, $SD = 28.3$). The LMM estimated a substantial difference between IDS and ADS: Persian caregivers used greater pitch variability in IDS than in ADS ($\beta = 15.86$, $SE = 3.18$, $t = 4.98$, $p < .001$), corresponding to an increase of about 16 Hz.

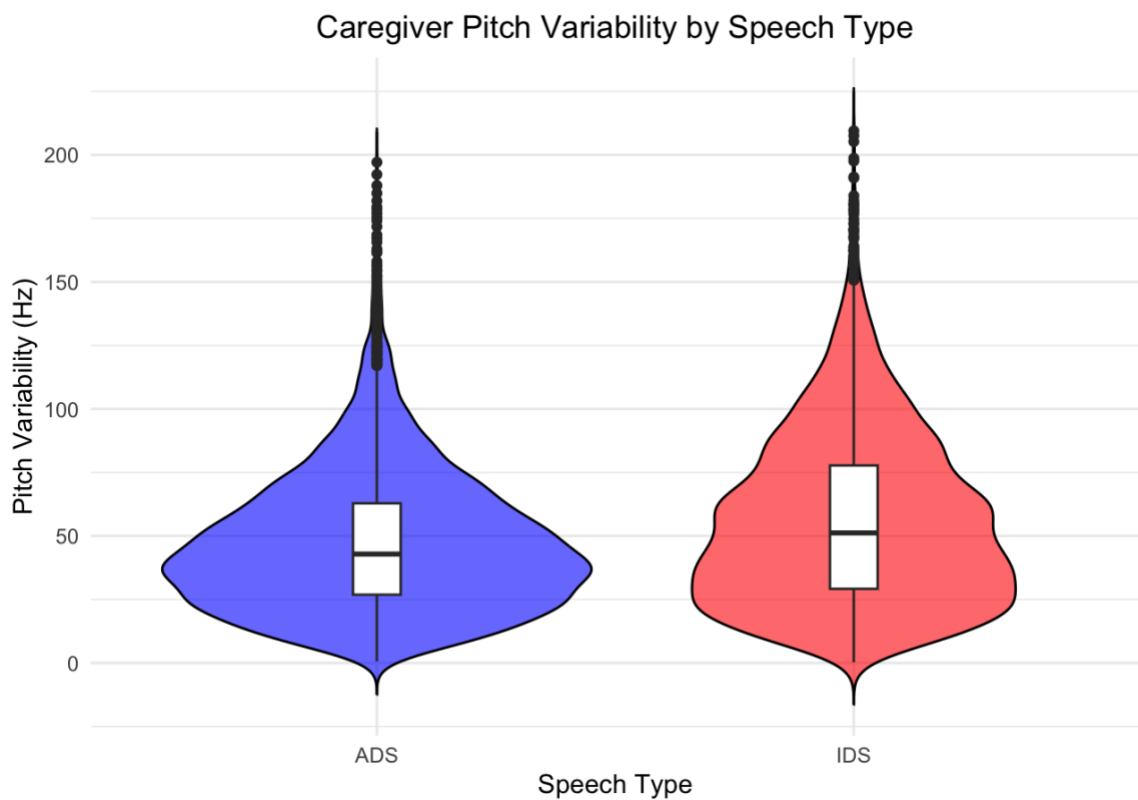
For ADS, there was no clear evidence of an age-related change in pitch variability ($\beta = 0.018$, $SE = 0.022$, $t = 0.833$, $p = .40$). Similarly, for IDS, the IDS-only model indicated a small negative age slope that was not reliably different from zero ($\beta = -0.007$, $SE = 0.025$, $t = -0.28$, $p = 0.77$). However, the interaction between speech type and infant age was significant ($\beta = -0.026$, $SE = 0.011$, $t = -2.35$, $p = .018$), suggesting that the difference between IDS and ADS in pitch variability gradually narrowed with increasing infant age. This pattern likely reflects modest and imprecise age-related tendencies—slightly increasing variability in ADS and slightly

decreasing variability in IDS—that together produced a detectable divergence between the two slopes.

Together, these findings indicate that Persian caregivers used greater pitch variability in IDS relative to ADS, but there was no strong evidence that the magnitude of this pitch modification changed systematically with infant age. Full model outputs are available on OSF.

Figure 9

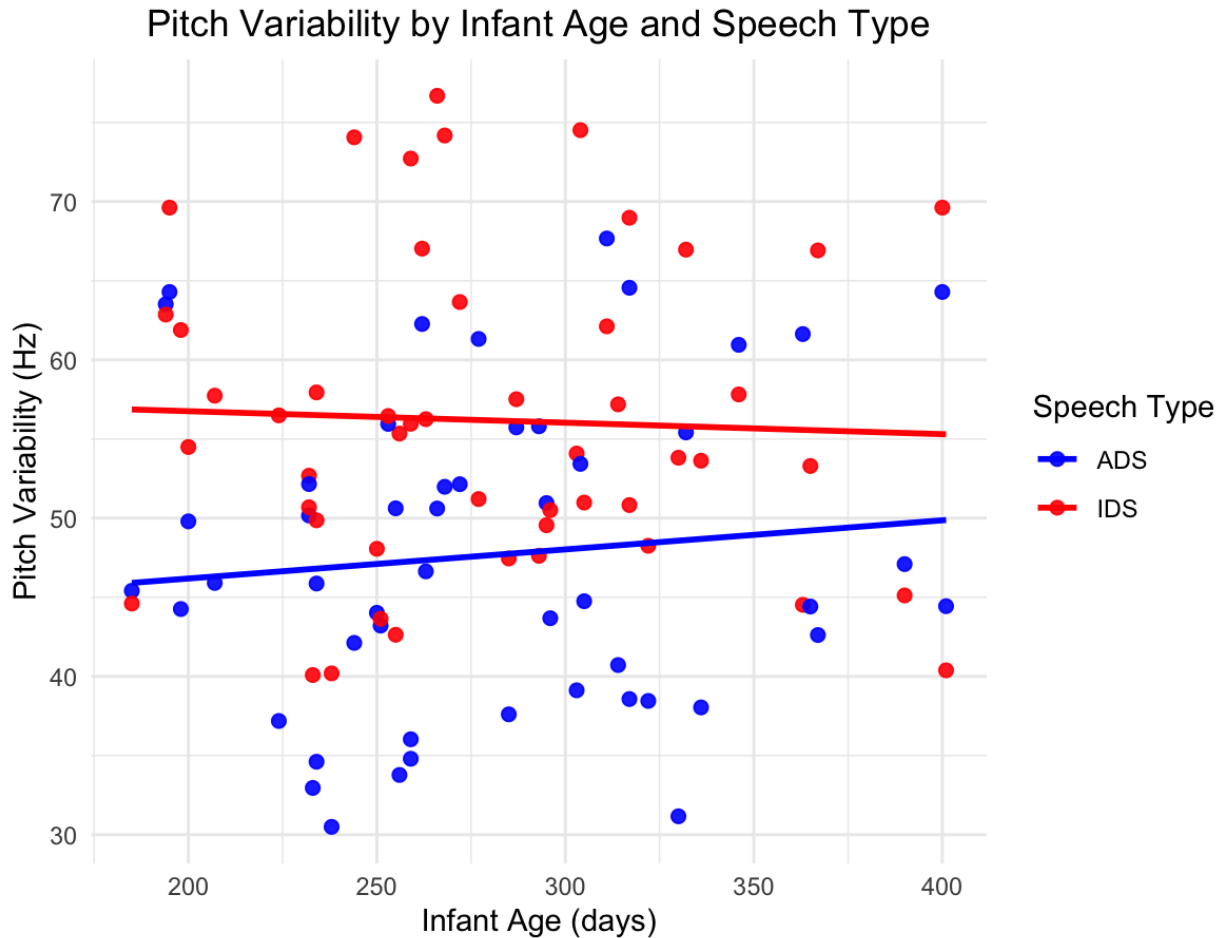
Figure 9: Primary Caregiver Pitch Variability by Speech Type



Note. This figure shows pitch variability distributions in IDS and ADS for research question 4.

Figure 10

Figure 10: Primary Caregiver Pitch Variability by Infant Age and Speech Type



Note. This figure shows pitch variability as a function of infant age for IDS and ADS for research question 5.

To assess the contribution of the predictors in the pitch variability model, I calculated semi-partial R^2 values. The semi-partial R^2 for the full model was 0.0187 (95% CI: 0.0149–0.0281), indicating that approximately 1.9% of the variance in pitch variability was explained by the fixed effects of speech register, infant age, and their interaction. The semi-partial R^2 for

speech register (IDS vs. ADS) was 0.0023 (95% CI: 0.0000–0.0117), suggesting that speech type uniquely accounted for a small portion of variance in pitch variability when controlling for other factors (RQ4). The interaction between speech register and infant age contributed 0.0005 of unique variance (95% CI: 0.0000–0.0100), indicating a very small age-related change in the IDS–ADS difference (RQ5). Although the semi-partial R^2 values were low, the structure coefficients were relatively strong for both the main effect ($SC = 0.98$) and the interaction ($SC = 0.93$), reflecting substantial alignment with the predicted values. Together, these results suggest that while pitch variability is modestly influenced by speech type, age-related modulation of this effect is present but explains very little unique variance in the model.

6.2.6 Pitch Variability Across Languages

Additionally, to quantify the magnitude of the difference in pitch variability between IDS and ADS, I computed Hedges' g using R, as in previous analyses of mean pitch. The effect size was based on the fixed effect estimate from the linear mixed-effects model and the residual standard deviation. Specifically, Cohen's d was calculated by dividing the fixed effect estimate (15.86 Hz) by the residual standard deviation (30.31 Hz), and Hedges' g was obtained by applying the standard correction for small sample bias. This yielded a corrected Hedges' g of 0.51. According to Cohen's (1988, 1992) benchmarks, this reflects a medium effect size, indicating a moderate increase in pitch variability in IDS compared to ADS. Hence, the medium effect size indicates caregivers' use of IDS was associated with a significantly greater pitch variability in IDS compared to ADS.

To situate my results within the broader literature, the following table present a comparison of mean f_0 variability between Persian IDS/ADS in the current study and the meta-analysis results as reported in Cox et al. (2023).

Table 6

Table 6: Hedges' g for IDS–ADS Difference in Pitch Variability Across Languages

Language	Hedges's g (f_0 variability)
Danish	1.21
US English	0.92
Norwegian	0.89
Canadian English	0.82
Polish	0.66
British English	0.57
New Zealand English	0.55
Japanese	0.55
Kenyan/Fijian	0.55
Cantonese Chinese	0.51
Persian	0.51
Australian English	0.49
Scottish English	0.45
Mandarin Chinese	0.42
Italian	0.40
Finnish/Swedish	0.40
Sri Lankan Tamil	0.36
Tsimane	0.35
Korean	0.31
Hungarian	0.27
Tagalog	0.26

Dutch	0.17
Swedish	0.16
German	0.14
French	0.13

As seen in the table 6, the languages are reported from the Cox et al. (2023) meta-analysis and the result of my study is highlighted in pink. The comparison of results indicates that Persian IDS showed a moderate effect size for f_0 variability ($g \approx 0.51$), close to Australian English, and similar to Cantonese Chinese, falling in the mid-to-upper range of those reported by Cox et al. study.

6.2.7 Utterance Duration

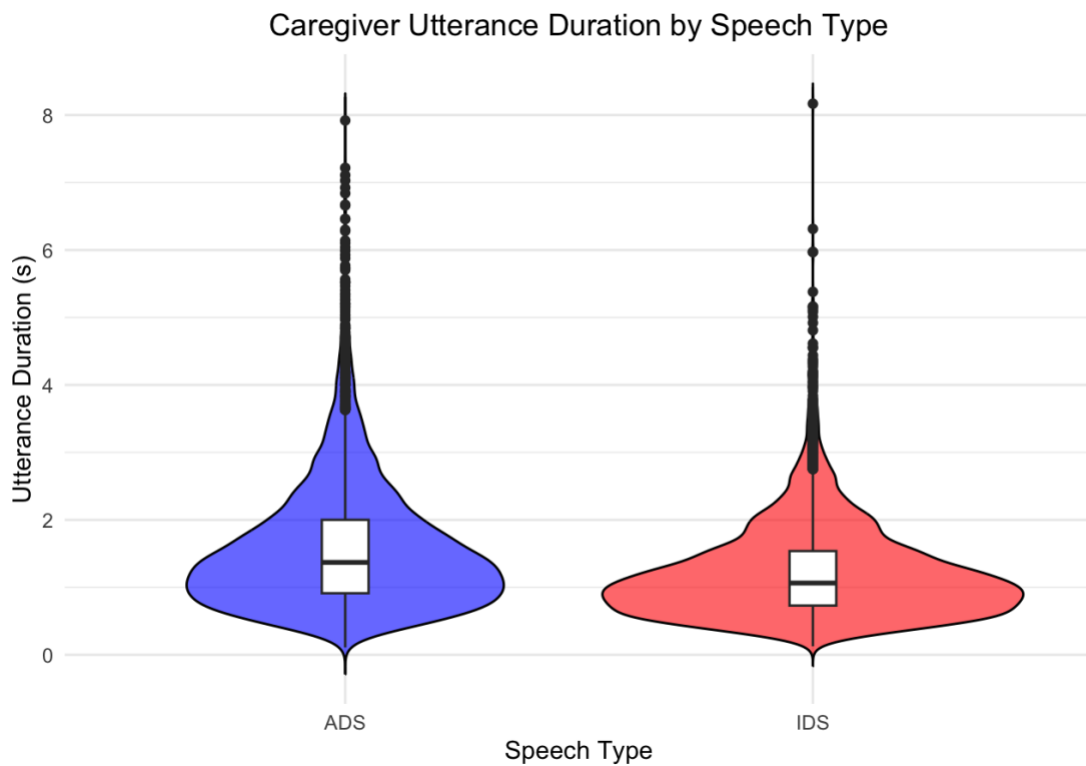
Descriptively, utterances were shorter in IDS ($M = 1.23$ s, $SD = 0.71$) than in ADS ($M = 1.59$ s, $SD = 0.96$). The LMM estimated a substantial difference between IDS and ADS: utterances in IDS were about 0.38 seconds shorter than in ADS ($\beta = -0.381$, $SE = 0.086$, $t = -4.39$, $p < .001$).

For ADS, there was no clear evidence of an age-related change in utterance duration ($\beta = -0.00089$, $SE = 0.00054$, $t = -1.646$, $p = 0.105$). Similarly, for IDS, the IDS-only model indicated a small negative age slope that was not reliably different from zero ($\beta = -0.00083$, $SE = 0.00059$, $t = -1.406$, $p = 0.166$). The interaction between speech type and infant age was non-significant ($\beta = 0.000050$, $SE = 0.00030$, $t = 0.167$, $p = 0.867$), suggesting that the relative difference between IDS and ADS remained stable across the infant age range.

Together, these findings indicate that Persian caregivers produced shorter utterances in IDS compared to ADS, but there was no strong evidence that this modification varied with infant age across the range of 6 to 13 months. Full model outputs are available on OSF.

Figure 11

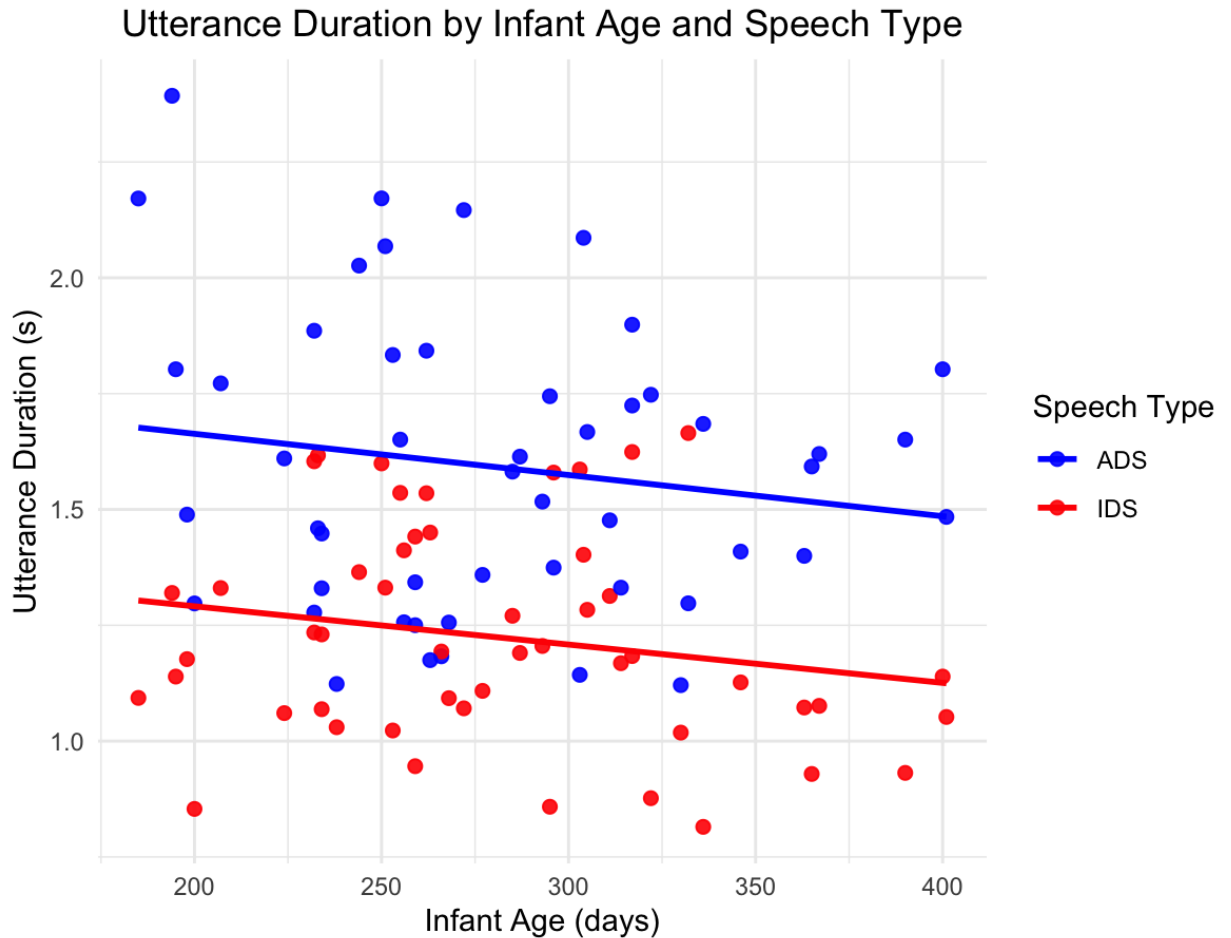
Figure 11: Primary Caregiver Utterance Duration by Speech Type



Note. This figure shows the distribution of utterance duration in IDS and ADS for research question 4.

Figure 12

Figure 12: Primary Caregiver Utterance Duration by Infant Age and Speech Type



Note. This figure shows utterance duration as a function of infant age for research question 5.

To quantify the contribution of each predictor in the model of utterance duration, I calculated semi-partial R^2 values. The semi-partial R^2 for the full model was 0.0476 (95% CI: 0.0395–0.0596), indicating that the fixed effects explained approximately 4.8% of the variance in utterance duration. The semi-partial R^2 for speech register (IDS vs. ADS) was 0.0018 (95% CI: 0.0000–0.0141), suggesting that speech register uniquely accounted for a small proportion of variance in duration after controlling for infant age and participant-level variability (RQ4). The interaction between speech register and infant age showed no unique value ($R^2 = 0.0000$, 95% CI: 0.0000–0.0124), indicating that the effect of speech type on utterance duration remained

stable across the age range studied (RQ5). Despite the small semi-partial R^2 values, structure coefficients for both speech register ($SC = -0.97$) and the interaction term ($SC = -0.98$) were strong and negative, reflecting a high alignment with the predicted values. These results support a modest but consistent main effect of speech type on utterance duration and no significant age-related modulation of this pattern.

6.3 Assumption Checking Summary

Assumption checks were conducted for all four linear mixed-effect models used to examine mean pitch, pitch range, pitch variability, and utterance duration. Each model was evaluated for linearity and homoscedasticity, normality of residuals, residual independence, and the appropriateness of random effects. More details on each assumption checking for each of the four LMMs are provided in Supplementary Materials A on OSF. I only provide a brief overall summary for the assumption checking of our LMMs. Overall, diagnostic plots and simulations indicated that the residuals were approximately normally distributed and exhibited no major violations of linearity or homoscedasticity. While a small number of outliers were observed in the models for pitch variability and utterance duration, these were isolated cases and did not affect overall model fit. Random intercepts for participants were retained in all models due to meaningful between-subject variance. Overall, these diagnostics confirmed that all four models for mean pitch, pitch range, pitch variability, and utterance duration met the assumptions required for valid and reliable inference.

6.4 Summary of Findings

The results of the Linear Mixed-Effects Models and corresponding visualizations indicate that Persian caregivers systematically modify several prosodic features of their speech when addressing infants compared to adults. Specifically, Persian mothers tended to use higher mean pitch, greater pitch variability, and shorter utterances in IDS than in ADS. Pitch range showed a small tendency to be wider in IDS, although the evidence for this effect was weak.

Across all prosodic features, there was no strong evidence that caregivers' speech patterns varied systematically with infant age within the 6–13 month range. Comparison with a recent meta-analysis further suggested that Persian IDS showed one of the largest cross-linguistic effect sizes for mean pitch, and a moderate effect size for pitch variability, placing Persian within the mid-to-upper range across languages.

Table 7

Table 7: Summary of Findings (RQ4-RQ5)

Prosodic Feature	IDS vs. ADS?	IDS Changes with Age?	Semi-Partial R ² (RQ4/RQ5)	Hedges' g (RQ4)
Mean Pitch	Yes ($p < .001$)	No ($p = 0.27$)	0.0139 / 0.0042	1.35 (Large)
Pitch Range	Marginal ($p = .085$)	No ($p = 0.96$)	0.0003 / 0.0000	0.17 (Small)
Pitch Variability	Yes ($p < .001$)	No ($p = 0.77$)	0.0023 / 0.0006	0.51 (Medium)
Utterance Duration	Yes (ADS > IDS) ($p < .001$)	No ($p = 0.16$)	0.0018 / 0.0030	0.45 (Medium)

6.5 Conclusion

This chapter investigated how Persian primary caregivers (mothers) modified the prosodic features of their speech when addressing infants versus adults, and whether these modifications varied as a function of infant age. Using Linear Mixed-Effects Models on utterance-level data from 50 participants (9972 utterances), I analyzed four key prosodic features: mean pitch, pitch range, pitch variability, and utterance duration. The results indicated clear differences between IDS and ADS for mean pitch, pitch variability, and utterance duration (all $p < .001$), suggesting that Persian caregivers systematically adjust these aspects of speech prosody when speaking to infants relative to adult. Moreover, Persian IDS showed one of the largest cross-linguistic effect sizes for mean pitch and a moderate effect size for pitch variability. However, there was no strong evidence that any of the four prosodic features varied systematically with infant age across the range of 6–13 months. Taken together, my results support the view that IDS is a prosodically distinct speech register, reflecting similar tendencies and variations cross-linguistically and cross-culturally.

Chapter 7: Study Contributions and Future Directions

7.1 Introduction

This final chapter synthesizes the key findings of the study, highlighting their theoretical, methodological, and data contributions, and considers their implications, limitations, and directions for future research.

In this study, I investigated the linguistic input of Persian-learning infants in Iran, focusing on both the quantity of speech input and the prosodic characteristics of primary caregiver speech. Specifically, I examined whether infant and caregiver characteristics (such as infant age, sex, and caregiver socioeconomic status, as measured by family income and maternal education) influenced the quantity of adult speech infants heard, and whether female and male adults contributed differently to this input. I further investigated how Persian mothers modified the prosodic features of their speech—such as mean pitch, pitch range, pitch variability, and utterance duration—when addressing infants versus adults, and whether these prosodic features changed across the infant age range of 6 to 13 months.

7.2 Summary of Key Findings

I investigated the relationship between infants' and caregivers' demographic characteristics and the linguistic input infants received. First, I examined whether infant age and sex predicted the quantity of adult speech input, but neither variable showed a significant association. Second, I tested whether caregiver socioeconomic status, including family income and maternal education, predicted adult speech quantity, and again found no significant effects.

Third, I investigated who contributed more to infants' speech input and found that female adults contributed significantly more speech than male adults.

Turning to prosodic features, I examined whether Persian mothers modified the prosodic characteristics of their speech when addressing infants relative to adults. Results indicated that Persian mothers tended to use higher mean pitch, greater pitch variability, and shorter utterances when addressing infants relative to adults. However, pitch range showed only a small tendency to differ between IDS and ADS, and the evidence for this difference was weak. Comparison with a recent meta-analysis further suggested that Persian IDS showed one of the largest cross-linguistic effect sizes for mean pitch, and a moderate effect size for pitch variability. I further examined whether prosodic modifications in Persian mothers' IDS change across infant age range of 6 to 13 months, and found no strong evidence that any of the four prosodic features changed systematically with infant age.

In summary, the key findings of this study are that Persian female adults contributed the majority of infants' linguistic input, and that Persian IDS, compared to ADS, featured a higher mean pitch, greater pitch variability, and shorter utterances.

7.3 Study Contributions

7.3.1. Theoretical Contributions

This study demonstrates a striking gender asymmetry in Persian infants' early language input, with female adults providing $4.7\times$ more speech than male adults. This gap is notably larger than the $1\text{--}3\times$ differences typically reported in North American samples (Bergelson, Casillas et al., 2019; Pancsofar & Vernon-Feagans, 2006). This pattern likely reflects traditional gender roles in Iranian households, where mothers often act as primary caregivers while fathers are

typically the main financial providers (Javadian & Singh, 2012; Riahinia & Azimi, 2008). In contrast, in some Western individualist contexts, this gender gap is narrowing as fathers increasingly help with childcare responsibilities (Coltrane, 2000; Craig & Mullan, 2011; Sullivan, 2021). These findings underscore the role of cultural and structural factors in shaping the linguistic input available to infants, and open avenues for further research on how gendered caregiving practices influence language development across diverse societies.

Equally important are the findings of what did not predict speech quantity. Demographic variables—including infant age, infant sex, and caregiver SES—showed no significant association with AWC. These patterns align with a substantial body of work. For example, Gilkerson et al. (2017) found no association between AWC and infant age, and Brushe et al. (2020) reported large variability in AWC even within education groups. More recently, Bergelson et al. (2023) showed in a global sample that adult talk was not systematically predicted by child sex or SES (measured as maternal education). Together with the present findings, this evidence suggests that the amount of speech infants hear is highly variable and may not map neatly onto demographic predictors. Instead, individual, cultural, and interactional dynamics likely play a larger role in shaping the quantity of infants' linguistic input. Therefore, my findings support a shift toward more ecologically grounded accounts of early language input and highlights the need for future research to focus more on the contextual factors that drive variability across diverse settings.

At the prosodic level, Persian caregivers showed distinct modifications when addressing infants compared to adults. Persian mothers tended to use higher mean pitch, greater pitch variability, and shorter utterances in their speech to infants relative to adults, a pattern that is consistent across many languages (Beebe et al., 1988; Cox et al., 2023; Fernald et al., 1989;

Garcia, 1977; Grieser & Kuhl, 1988; Kitamura & Burnham, 2003; Papoušek et al., 1987; Shute & Wheldall, 1989; Stern et al., 1983; Trainor et al., 2000; van de Weijer, 1977). In contrast, pitch range showed only a small tendency to differ between IDS and ADS, with weak evidence for a reliable difference, consistent with some reports (Broesch & Bryant, 2015; Kitamura et al., 2001) but contrasting with others that have documented a wider pitch range in IDS (Fernald & Simon, 1984; Fernald et al., 1989; Garnica, 1977; Narayan & McDermott, 2016; Stern et al., 1983). Cross-linguistic comparison with a large-scale meta-analysis further showed that Persian IDS exhibited a large effect size for mean pitch, ranking among the highest across languages and comparable to German and Italian, as well as a moderate effect size for pitch variability, ranking among the mid-to-upper and similar to Cantonese Chinese and Australian English (Cox et al., 2023). Overall, the prosodic patterns observed in Persian IDS support the notion of similar communicative tendencies across languages and cultures, while also revealing language-specific differences that challenge the universality assumed in WEIRD-centric frameworks. Furthermore, cross-linguistic comparisons showed that while the direction of prosodic modifications in Persian IDS aligns with trends observed across many languages, the magnitude of these prosodic modifications varies. Together, these findings enrich theoretical models of IDS, by providing evidence from an understudied, Middle Eastern, collectivist context.

When examining developmental changes across the infant age range of 6 to 13 months, there was no strong evidence for systematic age-related change in any of the prosodic features. Mean pitch and pitch variability remained relatively stable across infant age, despite some studies reporting developmental fine-tuning of these features (e.g., Amano et al., 2006; Cox et al., 2023; Gergely et al., 2017; Han et al., 2020; Kondaurova et al., 2013; Niwano & Sugai, 2002; Raneri, 2015; Stern et al., 1983; Vosoughi & Roy, 2012). The stability of pitch range and

utterance duration across infant age aligns with some prior work (Narayan & McDermott, 2016), though other studies have reported developmental shifts in these features over time (e.g., Garnica, 1977; Murray et al., 1990; Sherrod et al., 1977; Stern et al., 1983). Also, the effect sizes for age-related trends were small, indicating that within this age window, Persian caregivers' prosodic patterns remained relatively stable. Theoretically, these findings suggest that developmental fine-tuning of IDS prosody may not be a universal phenomenon across all cultures and time windows. Instead, the timing and extent of prosodic adjustments may vary cross-linguistically and culturally, underscoring the importance of incorporating diverse populations like Persian-speaking families to refine models of IDS development.

Taken together, my findings offer novel cross-linguistic evidence from Persian that both supports and refines existing theoretical frameworks of infant linguistic input and more specifically, IDS. By incorporating data from an underrepresented linguistic and cultural setting, this research highlights the importance of building more inclusive theories of infant linguistic input, and more specifically, how caregiver speech may support aspects of early language development. Rather than assuming uniformity, my results emphasize the diversity of infants' language environments and point to potential culture-specific adaptations in caregiver speech.

7.3.2. Methodological Contributions

This study demonstrates the feasibility and value of using naturalistic longform audio recordings to examine infants' language environments in an underrepresented Middle Eastern context. To my knowledge, this is the first study to use the LENA system in Iran, thereby extending its application beyond the Western settings where it has been predominantly deployed. Given the high cost and limited accessibility of LENA devices and its software in low- and middle-income regions (Léon et al., 2024), this work illustrates how careful planning and

complementary tools can make large-scale naturalistic data collection possible in resource-limited contexts.

Importantly, my methodological approach addressed a key limitation of LENA's automated classifications: its inability to reliably distinguish between IDS and ADS. This challenge is not unique to Persian; even in English-speaking datasets, manual annotation remains essential for accurate register classification. By combining LENA's quantitative measures (e.g., AWC) with manual IDS/ADS annotations, my study demonstrates a hybrid workflow that balances efficiency with linguistic accuracy—an approach that can serve as a model for similar work in other non-WEIRD contexts.

Additionally, I developed and implemented a Praat script pipeline that automatically extracted acoustic measures from manually annotated ELAN files. This made it possible to conduct detailed prosodic analyses on approximately 10,000 utterances, a task that would have been impossible through manual measurement alone. This demonstrates the scalability of combining ELAN and Praat for large naturalistic datasets and provides a replicable workflow for other researchers working with extensive speech corpora.

Together, these methodological innovations contribute to best practices for cross-cultural IDS research, particularly in contexts where resources are limited and language-specific tools are lacking. My study shows how adapting existing technologies and combining manual and automated methods can yield both quantitatively robust and linguistically precise analyses, thereby broadening the methodological toolkit available for studying early language environments globally.

7.3.3. Dataset Contributions

I provided a large-scale dataset from the language environment of 50, 6- to 13-month-old Persian-learning infants in Iran—a dataset from an understudied ME population. My dataset consists of over 600 hours of naturalistic, high-quality audio data together with some levels of manually annotated data, including the primary caregiver's speech directed to target infants and adults.

My dataset provided rich descriptive data on sociocultural information and SES variation, including family income, parental education, parent jobs, household size, number of target infants' siblings, birth order, knowledge of other languages, and the role of other adult caregivers such as grandparents, among other detailed data. Also, my dataset provides estimates of AWC, CTC, and CVC. Lastly, my manually annotated data provides acoustic analysis information on the prosody of Persian mothers' speech directed to infants and adults.

My dataset lays the groundwork for future Persian-language analyses. It will be available in HomeBank for re-use. The data shared with other researchers will include demographic and annotated data from 50 participants, and raw data (the longform recordings) from 37 participants. However, I may select a limitation on the level of accessibility to my dataset to protect participant privacy and comply with ethical requirements. This approach balances data sharing with the need to safeguard sensitive personal information.

7.4 Study Implications

The findings of this dissertation carry several implications for research and practice in the context of early language development:

1. Gender Imbalance in Speech Input: The strong asymmetry between female and male caregiver speech underscores the importance of considering gender roles in language interventions. Efforts to increase fathers' and male caregivers' involvement in speech to infants may help diversify infants' input.
2. Cultural caregiving norms: The especially strong gender gap in linguistic input likely reflects sociocultural patterns in Iran, where mothers are primary caregivers. This underscores the need for culturally sensitive models of caregiver–infant interaction, which may differ substantially from Western dual-earner family structures. In addition, nearly half of the families in my sample reported that other caregivers, most often grandmothers, also played caregiving roles, highlighting the importance of considering extended family members in models of infant language environments.
3. Socioeconomic status and variability: The lack of association between SES (family income, maternal education) and AWC suggests that speech quantity is not uniformly determined by socioeconomic factors in this Iranian sample. Interventions should recognize the high within-group variability in caregiver input rather than assuming systematic SES effects across families.
4. Prosodic exaggeration in IDS: Findings that primary caregivers use higher pitch, greater pitch variability, and shorter utterances in IDS compared to ADS, highlight caregiver modifications in speech to infants. Programs promoting early communication can build on this natural responsiveness.
5. Cross-linguistic research: By documenting medium to large effect sizes for prosodic modifications in Persian IDS, the study emphasizes the value of including non-WEIRD,

and more specifically, ME populations in cross-linguistic IDS research to avoid overgeneralizing from Western contexts.

6. Methodological guidance: The combination of naturalistic longform audio recordings, LENA-based estimates, and manual annotation provides a model for future research in non-WEIRD contexts. Researchers studying IDS in similar cultural settings should consider adopting a mixed-method approach to balance efficiency and accuracy.

7.5 Limitations of the Study

My study focused on infants aged 6 to 13 months, a critical period for prelinguistic and early linguistic development. While this age range was selected to capture Persian caregiver speech in a specific range, analysing the prosodic features of caregivers' speech and its changes across the developmental milestone, it may limit the generalizability of findings to younger or older infants whose language experiences and interactional patterns may differ.

One of the limitations of the study is that data collection took place during a period of political and social unrest in Iran, which may have affected participant recruitment. Limited or disrupted internet access during this time reduced the effectiveness of online outreach and likely impacted the final sample size. As a result, some participants were informed about the study through word of mouth rather than formal recruitment channels, such as study's Instagram account. This may have influenced the demographic composition of the sample, potentially overrepresenting families with existing connections to the research team.

Another potential methodological limit of my study is that I used the automated output of the LENA software for some part of my analysis, which is mainly my exploratory analysis in research question 1 and 2. I used LENA estimates of AWC for the quantity of speech input

infants received from their adult caregivers. Although research indicates that AWC and CVC metrics are reliable estimates across some languages and cultures (Cristia, Bulgarelli, & Bergelson, 2020; Cristia et al., 2021; Gilkerson et al., 2015), the validity of these estimates has never been tested in Persian language; its accuracy in detecting and classifying speech in Persian has not been established. As a result, the possibility of misclassification or underestimation of speech input cannot be ruled out. The effectivity of AWC from the LENA software output could be affected by the fact that my audio data included speech from multiple household members, usually relatives, and grandparents spending some time at the infant house, and therefore, there were overlapping speech from multiple adult speakers, mostly reported by the research assistants working on the manual annotations. LENA estimates delete the overlapping speech from the automated analysis, and therefore, the AWC estimates may underestimate the real number of Persian adult speech. This limitation may have introduced measurement error, which in turn could have attenuated true associations and contributed to the non-significant findings observed in Research Questions 1 and 2. Future work should consider validating the LENA algorithms for Persian or using complementary methods, such as manual verification, to enhance measurement validity.

Finally, another potential limitation is that although I used the automated estimates from the LENA automated output as my sampling method, the manual annotations I performed were somewhat subjective, as it was ultimately the decision of the research assistant annotators to annotate an utterance they heard or skip to the next utterance they hear. The reviewers also had to make a decision whether to keep the utterance, or to remove it, based on their subjective ideas regarding the quality of utterances. However, since each file was once annotated by an annotator

and once was reviewed by a reviewer, this diminished the subjectivity of the manual annotation task.

7.6 Directions for Future Research

7.6.1 Expanding Contextual Coverage

My study included participants from urban areas of the city of Mashhad in Iran. There is no specific dialect in Mashhad, although some lexical items and a few syntactic structures are only used in Mashhad. Future studies could include different populations, including rural areas of Iran or different cities in which diverse dialects are used, such as Turkish, Kurdish, and Mazandarani; hence, multilingual households in Iran. Furthermore, future studies should expand to include other Middle Eastern countries, adopting approaches that explicitly consider how culture shapes infants' language environments. In many Middle Eastern contexts, child-rearing responsibilities are distributed across extended family networks, meaning that infants often receive input not only from parents but also from grandparents and other relatives. Examining the linguistic contributions of these diverse caregivers would allow researchers to investigate how cultural values, family structures, and caregiving practices influence the quantity, quality, and type of speech infants hear. Such work would contribute to a more nuanced understanding of how cultural variability shapes linguistic input including IDS and ADS, while also challenging assumptions derived primarily from Western nuclear-family models of caregiving.

Furthermore, future studies may include covering a broader infant age range, for instance, infants between 0-3 years of age, in order to include more developmental milestones. To my knowledge, there is no such naturalistic data from the language environment of Persian infants in Iran; therefore, it would be an essential contribution to have a broader infant age range and a

dataset that could be used for future research, not only for Iran but also for other countries in the Middle East, as these areas remain understudied.

7.6.2 Longitudinal and Outcome-Oriented Studies

Future studies may include longitudinal research in Persian language, which is missing from the research across the globe on the language environment of infants and children. These studies provide analysing and tracking infants over time, for instance, to relate the features of infant's linguistic environments to their future language outcomes.

Moreover, future studies using naturalistic data may examine the role of Persian IDS features, such as pitch modifications in predicting expressive/receptive vocabulary. Furthermore, future studies may include an older age range, in order to examine the Persian MacArthur-Bates Communicative Development Inventories (MB-CDIs)—parent report instruments capturing important information about children's developing abilities in early language—on the participants to examine their language development.

7.6.3 Cross-Linguistic and Cross-Cultural Comparisons

Future research should conduct direct cross-linguistic comparisons of Persian IDS with both Western and non-Western languages to better situate Persian within broader linguistic and cultural patterns. Beyond prosody, examining interactional features—such as turn-taking structures and timing of parental responses to infant vocalizations—will provide a more comprehensive picture of how cultural practices shape caregiver–infant communication.

Additionally, investigating the functions of Persian IDS (e.g., soothing, attention regulation, teaching) and comparing it across linguistic and cultural contexts will shed light on the extent to which these functions are universal versus culturally adapted. Such cross-cultural

comparative work would deepen theoretical models of IDS and contribute to a more inclusive understanding of infants' early language environments.

7.6.4 Technological and Methodological Advancements

Future studies may focus on how to identify and distinguish between utterances that are infant-directed versus adult-directed, using contextual clues, such as the speaker's pitch and the speakers present at the auditory environment of infants.

Furthermore, the LENA algorithms were originally developed using a sample of English speakers, and the validity of the software output, including the AWC, CTC, and CVC, among other estimates have never been analysed across some ME languages including Persian. While the LENA algorithm is closed-source and cannot be trained on other languages, the validity could be measured using comparison between its automated estimates with manual annotations. Additionally, the validity of open-source tools, such as VTC and ALICE, could be examined on Persian language, and the tools could be adapted to Persian as well.

Finally, future studies may explore multimodal data collection in Iran, including video data, which captures not only the audio environments, but also the visual environment such as eye contact, facial expressions, and gestures, which have important role in infant development.

7.7 Final Remarks

This dissertation has examined the linguistic input of Persian-learning infants in Iran, focusing on both the quantity of caregiver speech and the prosodic characteristics of IDS in Persian mothers. By combining naturalistic, long-form home audio recordings with both automated and manual annotations, as well as detailed acoustic analyses, the study provides novel evidence on adult caregiver contributions to Persian infants' linguistic input in Iran. It also

documents how Persian caregivers modify the prosodic features of their speech when speaking to their infants compared to adults, and whether these patterns shift between 6 to 13 months of age. In doing so, this work addresses a significant gap in the literature and highlights the prominent contribution of Persian female adults to the linguistic input of the infants, key prosodic features of IDS, and methodological considerations for studying caregiver–infant interactions in non-WEIRD Middle Eastern contexts.

The findings carry broader significance for theories of infant language development by showing how Persian caregivers' speech input to their infants are shaped by both universal communicative tendencies (e.g., more exaggerated prosody when addressing infants versus adults) and culturally specific practices (e.g., the strong gender asymmetry in speech input from female versus male adults). They underscore the importance of considering socioeconomic, linguistic, cultural, and demographic contexts—such as extended caregiving networks—when interpreting caregiver speech patterns. While the scope of the study is limited to Persian-learning infants and their families in Iran, its methodological approach of combining LENA-based quantity measures with manual prosodic annotation demonstrates a model for future research in underrepresented populations. By applying this framework in other Middle Eastern or non-WEIRD contexts, future studies can test whether the observed patterns of input quantity and prosodic modification generalize across cultures or reflect local caregiving practices.

Looking ahead, further studies could expand the sample to other Middle Eastern contexts or Iranian languages and dialects, examine a broader infant age range and longitudinal patterns beyond the first year, and integrate measures to assess infants' responsiveness to prosodic

features. Such work would deepen our understanding of how early language environments vary across languages and cultures and what these differences mean for early language development.

Ultimately, by situating Persian linguistic input and IDS within the broader tapestry of global caregiver speech, this dissertation contributes to building a more inclusive and culturally representative science of infant linguistic environment and early language development. My vision is to advance a global developmental science—one that values the unique contributions of each culture and context, without assuming they must align with universal patterns or be defined by their differences; languages and cultural contexts are unique in their own ways. I hope this work serves as both a foundation and a call to action for researchers to engage more deeply with non-WEIRD, especially Middle Eastern populations, to ensure that infant language learning and developmental research reflects the full breadth and richness of human experience.

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Appendix 1: Statement on the Use of Generative AI

Throughout this dissertation, I used generative AI (ChatGPT, OpenAI) only for writing support (e.g., editing, improving clarity, and rephrasing text), and for programming support (e.g., suggesting R code and Praat scripts). I critically reviewed, verified, and adapted all AI-assisted contributions.

Appendix 2: Participant Information and Consent Form (English)



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Participant Information and Consent Form

Research Project Title: Infant-directed Speech in 6- and 12-month-old Iranian, Persian-learning Infants

Principal Investigator: Sara Montazeri, 3rd Year Ph.D. in Developmental Psychology

Email: farsi.infant@umanitoba.ca, 09011679921

Research Supervisor: Dr. Soderstrom, Professor, Department of Psychology

Email: M_Soderstrom@umanitoba.ca, (204) 474-8777

This consent form, which is only part of the process of informed consent, should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information. You will be given a copy of this form to keep for your records and reference.

Purpose: Sara Montazeri is conducting this study as her Ph.D. dissertation, under the supervision of Dr. Melanie Soderstrom. The purpose of this research is to examine the language environment of the 6- and 12-month-old Iranian, Persian-learning infants. We hope to learn more about how Iranian, Persian-speaking caregivers can best support their infant's language development.

Participation: We will first ask you to complete a questionnaire about your background and home life. We will also provide you instructions about how to use the LENA device, which will be used for the home audio recordings. You will use the recording device during your typical activities on a normal day with your infant, ideally for the whole day. You will dress your infant in special clothing designed to hold the recording device. The clothing will be provided by the research team. The device will be placed in a pouch hidden in the front chest pocket of the clothing. Once the recording is complete, a research team member will meet with you at your home or another mutually agreed upon location to pick up the recording device. You will be asked to describe the activities you participated in with your infant throughout the day and note the start and end times of the recording session on the LENA Recording Sheet. Then, we will

analyze the audio recording using a computer program designed to calculate information such as how much language is directed to the infant with the recording device.

This study will be collecting three types of information which will be outlined together with their methods of collecting them below:

1. *Home Audio Recording:* The LENA DLP is a small wearable audio recorder that records and stores audio. It is connected to a software suite that processes the audio to provide estimates of the speech in the environment (e.g., number of words produced in the hearing of the infant). In addition, human research assistants will listen to, and transcribe and annotate, parts of these recordings.
2. *LENA Language Report:* The LENA DLP allows for automated reports to be made using a computer program designed to examine an infant's home language environment based on the audio recording collected from the LENA device (for example, an estimate of how much speech your child hears). This information will be generated using this software.
3. *Demographic Questionnaire and LENA Recording Sheet:* The Demographic Questionnaire will collect information about your household such as what languages are being spoken and who cares for your infant. The LENA Recording Sheet will collect information about the start and end time of your recording session, as well as the activities you participated in with your infant during the recording process.

Risks, Benefits and Withdrawing from the Study: There are no specific benefits to participating, but you may gain a sense of accomplishment for your contribution as a caregiver, and/or may learn some things about how you can improve your language interactions with your infant. We hope that you and your infant find this to be an enjoyable and educational experience. The risks associated with participating in this experiment are no more than everyday life (see below regarding confidentiality of the recordings). Occasionally children become upset and do not want to wear the recording device. Your participation is voluntary. You are free to stop participating and/or to request that your data be withdrawn at any time. To withdraw from the study, simply email farsi.infant@umanitoba.ca or contact the Principal Investigator directly. You can fully withdraw from the study until at least July 2023. After that date, it may not be possible to withdraw some parts of your data, depending on whether they have been published. You can ask for your audiorecordings to be deleted at any time and we fully comply the best of our ability.

Confidentiality, Storage and Transportation: Should you choose to participate in the study, we would protect the identities of mother, infant, and others present on the recording. Please note that participants are likely to use names and other identifying information during the course of every day conversation, and it would not be possible to remove this information from the recording itself. Moreover, the LENA device will record private conversations in the home. During the recording, you can temporarily pause the device at any time if you wish to keep something private from our staff. We ask that you do this as little as possible. ***If you are uncomfortable with the contents of your audio recording, you may request that we delete it***

without viewing the contents when we collect the recording device, and this request will be respected.

Because the study is being conducted through the University of Manitoba, all study materials will be transported from Iran to Winnipeg, Canada at the conclusion of the recording phase of the study. While in Iran, all paper materials will be kept in a secure location by the study Investigator (Sara Montazeri). Your audio recording will be downloaded off of the recording device and kept on a password protected laptop computer that is used only for this purpose by the study Investigator. Paper materials will be scanned and stored on the laptop computer for transportation. All paper copies with the exception of this consent form will be shredded, and any temporary electronic copies created during the scanning process will be deleted. The study Investigator will then carry all study materials back to Canada on the laptop computer, which will be kept with her at all times during travel, as will the consent forms. A copy of the study materials may also be sent by secure data transfer to our laboratory at the University of Manitoba prior to departure for back-up purposes. Once in Winnipeg, the electronic study materials will be transferred to a secure server at the University of Manitoba, and will be kept indefinitely unless you request that they be deleted. Recordings and related materials may also be stored on trusted secure private servers outside of the University designed for the storage of confidential information.

Only current students, affiliated researchers or employees of the lab will access these files in order to conduct their research or University of Manitoba officials for the purpose of verifying our compliance with standards of ethical research practice. We will also ask for your permission (see below) to share the recordings with other researchers. You can participate in the study without giving this permission. It is our intention to keep your information fully confidential. Please note, however, that there may be limits to our ability to keep your files confidential in the case of legal or ethics concerns. All study materials (except consent forms) will be stored according to a 4-digit numeric key to preserve your confidentiality. The link between your contact information and your numeric code will be kept indefinitely which is necessary in case a participant requests that we delete their audio files. Please also remember that any identifying information in the recordings themselves or any resulting transcriptions will remain.

Publication of the results: We plan to share the results of this study in publications and presentations at research conferences, and in academic journals, as well as on the web, the University of Manitoba's institutional repository (MSpace), and other public forums. No confidential information will be shared in any presentations, publications, or other forms of study results. Referring to individuals may be required to report our findings or describe the sample in some cases (e.g. "one family included a great-grandmother in the household"), but individual identities will not be revealed. Also, it may occasionally be necessary to allow remote access to our files to technical support for the LENA system. This access would always be supervised by the lab director (Dr. Soderstrom) and lab personnel to make sure your files remain confidential.

Feedback: We will be happy to answer any questions that you may have before, during, or after the study period. We hope that you are interested and engaged in the research project. Because the research process takes time, particularly when the project involves infants, it could be a while before we have any results. You are able to call/email us at any time if you are curious how things are going. You are also able to check the lab website at www.babylanguagelab.ca,

Instagram account *uofmbabylanguagelab*, or Facebook account “The Baby Language Lab at the University of Manitoba”, which has information on past and present study information.

Compensation: You will receive a 300,000 Toman bank gift card and a story book upon agreeing to participate in this research study. You will also be able to keep the gift card and the book after withdrawing from the study.

Optional permission for future use: The various types of information collected in this study (described above) may be useful to other researchers looking at topics both related and unrelated to the current study. We would like your permission to allow limited access of your data to researchers who request it. If you give permission, your data will be shared on a researcher data-sharing site that is designed to ensure the confidentiality of participants. You have the right to remove this additional permission at any time in which case those researchers will be expected to delete any recordings or other information in their possession. We would also like to be able to play short audio clips to non-scientists for the purpose of collecting information about your recordings for research purposes. To give this permission, please check the box and initial where indicated below. You may still participate in the current study even if you do not give this additional permission.

☐ Checking this box indicates my permission for myself and my child to being audiorecorded.

Initials

☐ Checking this box indicates my permission for the current research team and their collaborators to use my data in the case that I withdraw partway through the study, unless I indicate otherwise to the researchers.

Initials

☐ Checking this box indicates my permission for future use of my recording and data beyond the current study by the current research team and their collaborators.

Initials

☐ Checking this box indicates my permission to use, store, and share my recording and data from this study in research databases or registries for future use by additional researchers from outside of this institution. I understand that while my confidentiality will be respected by those researchers, the recording may contain identifying information that cannot be removed, like my voice or things said

during the recordings. Under no circumstances will researchers publish my identity or make the recording publicly available. While the University of Manitoba researchers will make every effort to ensure that only researchers who abide by these rules gain access to the recordings and data, it is understood that the University of Manitoba researchers do not directly control the behaviour of researchers outside the University of Manitoba.

Initials

- ☐ Checking this box indicates my permission for short clips of my recording to be played for non-scientists for research purposes. These short clips would not contain any identifying information such as my name or that of my infant. It is possible, though unlikely, that someone might recognize me by my voice.

Initials

Your signature on this form indicates that you have understood to your satisfaction the information about participation in the research project and agree to participate. Signing this form does not waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities. You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer not to answer, without consequence. You should feel free to ask for clarification or new information throughout your participation in the research.

This research has been approved by the Research Ethics Board at the University of Manitoba, Fort Garry campus. If you have any concerns or complaints about this project you may contact any of the above-named persons or the Human Ethics Coordinator (HEC) at 204-474-7122, or email humanethics@umanitoba.ca. A copy of this consent form will be offered to you to keep for your records and reference.

1. I wish to receive a report from this study: Yes ☐ No ☐

If yes, please provide your email address or other way to reach you:

Option to delete recording (to be filled out after the recording has occurred):

Initialling this box indicates the research team can <i>keep</i> my infant's home audio recording after it has been processed by the computer software.	Initialling this box indicates my request for the research team to <i>delete</i> my infant's home audio recording after it has been processed by the computer software.	Initialling this box indicates my request for the research team to <i>delete</i> my recording without processing the data.
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Note: As described above, some data and information from this study may be sent outside of the University of Manitoba to other researchers, organizations, or made publicly available. This is for further analysis, testing, as part of the research study, or a requirement by a granting agency or journal. Any information sent out of the University of Manitoba will not show your name or address, or any other identifiable personal information about you. However, despite efforts to keep your personal information confidential, absolute confidentiality cannot be guaranteed. Your personal information may be disclosed if required by law.

Signature of Participant: _____

Date: _____

Researcher and/or Delegates Signature: _____

Date: _____

Signature of Parent/Guardian (if needed): _____

Date: _____

Additional Household members (who may appear in the recording):

Signature

Signature

Signature

Appendix 3: Demographic Questionnaire (English)



Demographic Questionnaire

Please note: *Responses to these questions are entirely voluntary.*

The information you provide to us will be very helpful in our research.

Please ask if you have any questions or concerns about your responses or how they will be used.

To be filled out by the experimenter:

Data code: -----

Study code: -----

Date: -----

1. Parent Information:

Parent 1

Age: -----

Gender: -----

Nationality: -----

Education:

- a) Highschool diploma or less
- b) Bachelor's degree (or other similar post-secondary degree)
- c) Master's degree or more

Job: -----

Did you have experience with infants before becoming a parent?

- a) Yes
- b) No

If yes, describe: -----

How often you are away from your infant? -----

Parent 2 (Please leave this section blank if no second parent is involved in your infant's care):

Age: -----

Gender: -----

Nationality: -----

Education:

- a) Highschool diploma or less
- b) Bachelor's degree
- c) Master's degree or more

Job: -----

Did they have experience with infants before becoming a parent?

- a) Yes
- b) No

If yes, describe: -----

How often is Parent 2 away from your infant? -----

2. Children in your family:

Infant participating

Date of Birth (Year/Month/Day): -----

Sex:

- a) Male
- b) Female

Does your infant have siblings?

- a) Yes
- b) No

If yes,

Date of Birth (Y/M/D): -----

Male ☐

Female ☐

Date of Birth (Y/M/D): -----	Male ☐	Female ☐
Date of Birth (Y/M/D): -----	Male ☐	Female ☐
Date of Birth (Y/M/D): -----	Male ☐	Female ☐

3. Household:

Who are the adult members in your household? ----- Are there grandparents or other family members outside the household involved in the infant's care? a) Yes b) No If yes, please describe: ----- Household Monthly Income: a) 41,797,500 IRR or less b) 41,797,500 IRR – 100,000,000 IRR c) 100,000,000 IRR - 150,000,000 IRR d) 150,000,000 IRR or more
--

4. Formal infant care:

Does your infant attend daycare? a) Yes b) No If yes, what type? a) In home b) Childcare center c) Other If yes, how often does your infant attend daycare? -----

5. Language Background:

What is your native language? -----

What language(s) are often used at home? -----

Do you know any languages other than Persian?

- a) Yes
- b) No

If yes, describe: -----

6. Infant Background:

Was your infant born prematurely?

- a) Yes
- b) No

Infant Due Date (Year/Month/Day): -----

Is your infant from a multiple birth?

- a) Yes
- b) No

If yes,

- a) Identical
- b) Fraternal
- c) Not sure

Are you aware of any hearing impairments or difficulties in your infant?

- a) Yes
- b) No

If yes, please explain: -----

Are you aware of any language or cognitive impairment or delay in your infant's development?

- a) Yes
- b) No

If yes, please explain: -----

Is there anything else we should know about your infant (e.g., physical characteristics) not addressed above that might influence how they behave in this study?

a) Yes

b) No

If yes, please explain: -----

Appendix 4: LENA Recording Sheet (English)



LENA Recording Sheet

Infant-directed Speech in 6- and 12-month-old Iranian, Persian-learning Infants

ID: _____ (To be Completed by the Experimenter)

Date: _____

START TIME: _____

END TIME: _____

Please record naptime throughout the day:

NAP TIME

START TIME (HH:MM AM/PM)	END TIME (HH:MM AM/PM)

Please note the time if you pause the recording device during the day.

PAUSE TIME

START TIME (HH:MM AM/PM)	END TIME (HH:MM AM/PM)

--	--

Please record an overview of activities completed throughout the day. Please complete this at the end of the day (not throughout the day while interacting with your child), as a summary. Use the back of the paper, if required.

ACTIVITY CATEGORIES (examples):

PLAYTIME STORY TIME OUTSIDE VISITS TV TIME BATH TIME

ACTIVITIES (start and end times)	LOCATIONS	COMMENTS

Appendix 5: Home Recordings — A Guide for Parents (English)



Home Recordings — A Guide for Parents

**** Please do the recording for a full day (from when your infant wakes up, to when they go to sleep at the end of the day. Please leave the recording device on the entire day. Also please make sure you are doing the recordings on days when you are with the infant for most of the day.**

Using the LENA Device

1. To turn the device on, press and hold the power button.
2. To start a recording, press and hold the REC button. An indication that the device is recording will appear on the screen.
3. If you need to pause the recording press and hold the REC button again. An indication that the device is paused will appear on the screen. You will want to pause the device at the end of the recording before turning it off.
4. To turn the device off, press and hold the power button.
5. The device may be paused during the recording; all we ask is that you accurately record the time you pause the device as well as the time that you un-pause and continue the recording.
6. Please do not turn the device off for naptime! It can simply be removed from the vest and placed in close proximity to the infant i.e., under the crib or on a nearby table.

Using the Observation Sheets

1. Please accurately record the time that you start the recording, as well as the time that you finish. This is a big help when it comes to matching the observation sheet to the recording!
2. Please record the time your infant spends napping (start and end times), and any times that you paused the device. Please also record any other times that the

device was not located in the pocket in the vest, or the recording might not be as good, such as if the infant was wearing a coat.

3. At the end of the day, please write a brief summary of the activities, locations, and any other important comments or things you think we should know.

Making the best recording:

- Covering the LENA clothing blocks sounds just like wearing earmuffs does for you. So please keep LENA clothing OVER sweaters and light jackets if possible.
- During baths or naps, it's best to keep the LENA recorder in the LENA clothing dry and as close as possible to the infant. The LENA device can take a small amount of splash but should not be submerged. Just remember to put the LENA clothing back on your infant afterwards!
- For safety and for a good recording, please make sure the LENA device is not underneath any seatbelt straps during travel.

Your contribution to the project is very much appreciated. We thank you for your time and effort! When you are finished your recording, please email farsi.infant@umanitoba.ca or call or text 09011679921 and we will arrange a time to pick up the recording device.

Appendix 6: Study Advertisement (English)



Invitation to cooperation and participation in research

We need a number of volunteers **residing in Mashhad** to participate in scientific research. The purpose of this research is to investigate the language environment of infants and its impact on their language development.

If you have an infant who is **6 to 13 months old** and you are willing to record their voice for a full day at home, you are invited to participate in this research. A **gift card** and a **story book** will be presented to each of the volunteers who participate in this research as a way of thanks and remembrance.

Ways of communication: farsi.infant@umanitoba.ca
Instagram: [farsi.infant](#)
Phone Number: 09011679921 (WhatsApp)

Principal Investigator: Sara Montazeri
Advisor: Dr. Melanie Soderstrom

Appendix 7: Participant Information and Consent Form (Persian)



P404 Duff Roblin Building
190 Dysart Rd
Winnipeg, Manitoba
Canada R3T 2N2
Telephone (204) 474-9338

فرم اطلاعات و رضایت شرکت‌کنندگان

عنوان پژوهش: گفتارنوزادمدارانه در کودکان ۶ و ۱۲ ماهه فارسی‌زبان
پژوهشگر اصلی: سارا منتظری، دانشجوی سال سوم مقطع دکتری، رشته روانشناسی رشد
ایمیل: farsi.infant@umanitoba.ca
شماره تلفن همراه: ۰۹۰۱۱۶۷۹۹۲۱

استاد راهنما: دکتر سودستروم، استاد گروه روانشناسی رشد
ایمیل: M_Soderstrom@umanitoba.ca

این فرم رضایت، که تنها بخشی از فرآیند رضایت آگاهانه است، به شما ایده کلی درباره موضوع تحقیق و مشارکت شما را می‌دهد. اگر می‌خواهید جزئیات بیشتری را در مورد چیزی که در اینجا ذکر شده است، یا اطلاعاتی که در اینجا ذکر نشده است، بدانید، آن را با ما در میان بذارید. لطفاً این متن را با دقت بخوانید و اطلاعات محتوی آن را درک کنید. یک کپی از این فرم به شما داده می‌شود تا برای سوابق و مرجع خود نگهداری کنید.

هدف: این پژوهش بخشی از رساله دکتری سارا منتظری زیر نظر دکتر ملانی سودستروم می‌باشد. هدف این پژوهش بررسی محیط زبانی کودکان فارسی‌زبان ۶ و ۱۲ ماهه ایرانی است. با انجام این پژوهش قصد داریم در مورد اینکه چگونه سرپرستان فارسی‌زبان می‌توانند به بهترین شکل از رشد زبانی کودک خود حمایت کنند، بیشتر بیاموزیم.

مشارکت: ابتدا از شما می‌خواهیم یک پرسشنامه دموگرافیک در مورد پیشینه و زندگی خانگی خود تکمیل کنید. همچنین دستورالعمل‌هایی را در مورد نحوه استفاده از دستگاه لینا که برای ضبط های صوتی خانگی استفاده می‌شود، به شما ارائه می‌دهیم. شما از دستگاه ضبط در طول فعالیت‌های معمول خود در یک روز عادی با کودک خود و به‌طور ایده آل برای کل روز استفاده خواهید کرد. لباس مخصوصی که برای نگه داشتن دستگاه ضبط طراحی شده است را به کودک خود می‌پوشانید. این لباس توسط تیم پژوهشی تهیه خواهد شد. دستگاه ضبط در کیسه‌ای در جیب قفسه سینه لباس قرار می‌گیرد. هنگامی که ضبط کامل شد، یکی از اعضای تیم پژوهشی با شما در خانه یا مکان دیگری که مورد توافق دوجانبه قرار گرفته است، ملاقات می‌کند تا دستگاه ضبط و لباس مخصوص و فرم‌ها را تحویل بگیرد. از شما خواسته می‌شود تا فعالیت‌هایی را که در طول روز با کودک خود در آن شرکت کرده‌اید، توضیح دهید و زمان شروع و پایان جلسه ضبط را در برگه ثبت، یادداشت کنید. سپس، ضبط صدا را با استفاده از یک برنامه رایانه‌ای که برای محاسبه اطلاعاتی مانند میزان زبانی که مخاطب آن کودک شمامست، تجزیه و تحلیل می‌کنیم.

این مطالعه سه نوع اطلاعات را جمع‌آوری می‌کند که در زیر به همراه روش‌های جمع‌آوری آن‌ها توضیح داده می‌شود:

۱. **ضبط صوتی خانگی:** لینا دی ال پی یک ضبط کننده صوتی پوشیدنی کوچک است که صدا را ضبط و ذخیره می‌کند. لینا به مجموعه نرم افزاری متصل است که صدا را پردازش می‌کند تا برآوردی از گفتار در محیط ارائه دهد (به عنوان مثال، تعداد کلمات تولید شده در اطراف کودک). علاوه بر این، دستیاران پژوهشی به بخش‌هایی از این ضبط‌ها گوش داده، و آن‌ها را رونویسی و حاشیه‌نویسی می‌کنند.

۲. **گزارش زبانی لینا:** لینا دی ال پی با استفاده از یک برنامه رایانه‌ای که به منظور بررسی محیط زبانی خانگی کودک طراحی شده است، بر اساس ضبط صوتی جمع‌آوری شده از دستگاه لینا، گزارش‌های خودکار ایجاد می‌کند (به عنوان مثال، برآوردی از میزان گفتاری که کودک شما می‌شنود). این اطلاعات با استفاده از این نرم افزار تولید خواهد شد.

۳. **پرسشنامه دموگرافیک و برگه ضبط صوتی لینا:** پرسشنامه دموگرافیک اطلاعاتی را در مورد خانواده شما جمع‌آوری می‌کند، مانند اینکه به چه زبانی در محیط خانه صحبت می‌شود و چه کسی از کودک شما مراقبت می‌کند. برگه ضبط صوتی لینا اطلاعاتی را در مورد زمان شروع و پایان جلسات ضبط و همچنین، فعالیت‌هایی را که شما با کودک خود در طول مدت ضبط انجام داده‌اید، جمع‌آوری می‌کند.

ریسک‌ها، مزایا و کناره‌گیری از پژوهش: هیچ مزیت خاصی برای شرکت در این پژوهش وجود ندارد، اما ممکن است با مشارکت خود به عنوان یک مراقب در این پژوهش، احساس موفقیت به دست آورید و/یا ممکن است چیزهایی در مورد اینکه چگونه می‌توانید تعاملات زبانی خود را با کودک خود بهبود بخشید، بیاموزید. امیدواریم که شما و کودکان تجربهای لذت بخش و آموزشی داشته باشید. ریسک مربوط به شرکت در این

پژوهش بیشتر از زندگی روزمره نیست (در رابطه با محرمانه بودن موارد ضبط شده به بخش‌های زیر مراجعه کنید). گاهی اوقات کودکان ناراحت میشوند و نمیخواهند دستگاه ضبط را ببینند. مشارکت شما داوطلبانه است. شما از آیدک که مشارکت را متوقف کنید و/یا درخواست کنید که داده‌های شما در هر زمانی برداشته شوند. برای انصراف از مطالعه، کافی است به آدرس اینترنتی ما ایمیل بزنید یا مستقیماً با پژوهشگر اصلی تماس بگیرید. تا تاریخ ژوئیه ۲۰۲۳ می‌توانید به‌طور کامل از مطالعه خارج شوید. پس از آن تاریخ، بسته به اینکه برخی از داده‌های شما منتشر شده باشند، ممکن است امکان حذف آن‌ها وجود نداشته باشد. شما می‌توانید در هر زمان درخواست کنید که ضبط‌های صوتی‌تان حذف شوند و ما به‌طور کامل تا جایی که می‌توانیم به آن عمل می‌کنیم.

محرمانه بودن، ذخیره سازی و انتقال: در صورت مشارکت در پژوهش، ما از هویت مادر، کودک و سایر افراد حاضر در ضبط محافظت می‌کنیم. لطفاً توجه داشته باشید که شرکت‌کنندگان احتمالاً از نام‌ها و سایر اطلاعات قابل شناسایی در طول مکالمه روزانه استفاده می‌کنند و حذف این اطلاعات از خود ضبط امکان‌پذیر نخواهد بود. علاوه بر این، دستگاه لینا مکالمات خصوصی را در خانه ضبط می‌کند. در طول ضبط، اگر می‌خواهید چیزی را از ما مخفی کنید، می‌توانید به‌طور موقت دستگاه را متوقف کنید. از شما می‌خواهیم که این کار را تا حد امکان کمتر انجام دهید. اگر در رابطه با محتوای ضبط صوتی خود احساس ناراضی‌تی دارید، می‌توانید درخواست کنید که هنگام جمع‌آوری دستگاه ضبط، آن را بدون مشاهده محتویات، حذف کنیم و این درخواست مورد احترام قرار خواهد گرفت.

از آنجایی که این پژوهش از طریق دانشگاه منیتوبا انجام می‌شود، در پایان مرحله ضبط، تمام مواد پژوهش از ایران به وینپینگ در کانادا منتقل می‌شود. در زمان حضور در ایران، کلیه مطالب کاغذی توسط محقق مطالعه (سارا منتظری) در مکانی امن نگهداری می‌شود. صدای ضبط شده شما از دستگاه ضبط باگیری می‌شود و در رایانه محافظت شده با رمز عبور نگهداری می‌شود که این رایانه فقط برای این منظور توسط محقق مورد استفاده قرار می‌گیرد. مطالب کاغذی اسکن شده و برای حمل و نقل در رایانه لب‌تاپ ذخیره می‌شوند. تمام نسخه‌های کاغذی به استثنای این فرم رضایت، تکه تکه و خرد شده و هرگونه نسخه الکترونیکی موقتاً ایجاد شده در طول فرآیند اسکن، حذف خواهد شد. سپس پژوهشگر اصلی تمام مطالب مطالعه را با رایانه پژوهش به کانادا برمی‌گرداند، که در طول سفر، به‌همراه فرم‌های رضایت، همیشه همراه او خواهد بود. همچنین ممکن است یک کپی از مطالب پژوهش با انتقال این داده‌ها به آزمایشگاه زبان ما در دانشگاه منیتوبا قبل از حرکت برای اهداف پشتیبانی ارسال شود. پس از ورود به وینپینگ، مطالب پژوهش الکترونیکی به یک سرور امن در دانشگاه منیتوبا منتقل می‌شود و به‌طور نامحدود نگهداری می‌شود مگر اینکه درخواست حذف آن‌ها را داشته باشید. ضبط‌ها و مطالب مرتبط نیز ممکن است در سرورهای خصوصی امن قابل اعتماد خارج از دانشگاه که برای ذخیره اطلاعات محرمانه طراحی شده‌اند، ذخیره شوند.

تنها دانشجویان فعلی، محققان وابسته یا کارمندان آزمایشگاه به این فایل‌ها دسترسی خواهند داشت تا تحقیقات خود یا مقامات دانشگاه منیتوبا را به منظور تأیید انطباق ما با استانداردهای عملکرد تحقیقات اخلاقی انجام دهند. ما همچنین برای به اشتراک گذاشتن فایل‌های ضبط شده با سایر محققان از شما اجازه خواهیم گرفت (به زیر مراجعه کنید). شما می‌توانید بدون دادن این مجوز نیز در مطالعه شرکت کنید. قصد ما این است که اطلاعات شما را کاملاً محرمانه نگه داریم. با این حال، لطفاً توجه داشته باشید که ممکن است محدودیت‌هایی برای توانایی ما برای محرمانه نگه داشتن فایل‌های شما در مورد مسائل حقوقی یا اخلاقی وجود داشته باشد. تمام مطالب مطالعه (به جز فرم‌های رضایت) طبق یک کد عددی چهار رقمی برای حفظ محرمانه بودن اطلاعات شما ذخیره می‌شود. پیوند بین اطلاعات تماس شما و کد عددی شما به‌طور نامحدود نگهداری می‌شود که در هنگام درخواست برای حذف فایل صوتی شرکت‌کنندگان، ضروری است. لطفاً همچنین به یاد داشته باشید که هرگونه اطلاعات شناسایی در خود ضبط‌ها یا هر رونویسی حاصل باقی خواهد ماند.

انتشار نتایج: در این پژوهش ما قصد داریم نتایج را در نشریات و ارائه‌ها در کنفرانس‌های تحقیقاتی، و در مجلات دانشگاهی، و همچنین در وب، سخنرانی‌ها، داده‌های دانشگاه منیتوبا (ام اسپیس) و دیگر انجمن‌های عمومی به اشتراک بگذاریم. هیچ اطلاعات محرمانه‌ای در هیچ گونه ارائه، نشریه یا سایر موارد به اشتراک گذاشته نخواهد شد. ارجاع به افراد ممکن است برای گزارش یافته‌های ما یا توصیف نمونه در برخی موارد لازم باشد (مثلاً "یک خانواده شامل مادر بزرگ نیز است")، اما هویت افراد فاش نخواهد شد. همچنین، ممکن است گاهی اوقات لازم باشد به پشتیبانی فنی دستگاه لینا اجازه دسترسی از راه دور به فایل‌ها را بدهیم. این دسترسی همیشه توسط مدیر آزمایشگاه زبان (دکتر سودستروم) و پرسنل آزمایشگاه زبان مورد نظرات قرار می‌گیرد تا از محرمانه بودن فایل‌های شما اطمینان حاصل شود.

بازخورد: ما با کمال میل به هر سؤالی که ممکن است قبل، در طول یا بعد از دوره پژوهش داشته باشید پاسخ بدهیم. امیدواریم که این پژوهش مورد علاقه و مشارکت شما قرار گرفته باشد. از آنجایی که فرآیند تحقیق به زمان نیاز دارد، به‌ویژه زمانی که پروژه در رابطه با کودکان است، ممکن است مدتی طول بکشد تا به نتیجه‌ای برسیم. اگر در رابطه با این پژوهش کنجکاو هستید، می‌توانید در هر زمانی با ما تماس گرفته و یا ایمیل بزنید. همچنین، می‌توانید به وبسایت آزمایشگاه و یا اکانت اینستاگرام یا فیس‌بوک ما مراجعه کنید تا اطلاعات مربوط به پژوهش‌های گذشته و فعلی را دریافت کنید.

Website: www.babylanguagelab.ca

Instagram: [nofinbabylanguagelab](https://www.instagram.com/nofinbabylanguagelab)

Facebook: [The Baby Language Lab at the University of Manitoba](https://www.facebook.com/TheBabyLanguageLabattheUniversityofManitoba)

هدیه مشارکت در پژوهش: در صورت موافقت با شرکت در این مطالعه تحقیقاتی، یک کارت هدیه یانکی به مبلغ ۳۰۰ هزار تومان و یک عدد کتاب داستان کودک دریافت خواهید کرد. پس از انصراف از پژوهش نیز می‌توانید کارت هدیه را پیش خود نگه دارید.

اجازه اختیاری برای استفاده در آینده: انواع مختلف اطلاعات جمع‌آوری شده در این مطالعه (توضیح داده شده در بالا) ممکن است برای سایر تحقیقاتی که به موضوعات مرتبط و غیر مرتبط با مطالعه فعلی نگاه می‌کنند، مفید باشد. از شما اجازه می‌خواهیم اجازه دسترسی محدود به داده‌های شما را برای تحقیقاتی که آن را درخواست می‌کنند، داشته باشیم. اگر اجازه بدهید، داده‌های شما در یک سایت به اشتراک‌گذاری داده‌های محقق که برای اطمینان از محرمانه بودن شرکت‌کنندگان طراحی شده است، به اشتراک گذاشته می‌شود. شما این حق را دارید که این مجوز اضافی را در هر زمانی حذف کنید، در این صورت از آن محققان انتظار می‌رود که هرگونه ضبط یا اطلاعات دیگری را که در اختیار دارند، حذف کنند. همچنین می‌خواهیم بتوانیم کلیپ‌های صوتی کوتاهی را برای افراد غیر پژوهشگر به‌منظور جمع‌آوری اطلاعات مربوط به ضبط‌های شما برای اهداف

تحقیقاتی پخش کنیم. برای دادن این اجازه، لطفاً کادر هایی را که در زیر نشان داده شده است، علامت بزنید و سپس، امضا کنید. حتی اگر این اجازه اضافی را ندهید، همچنان می‌توانید در پژوهش فعلی شرکت کنید.

علامت زدن در این کادر نشان دهنده اجازه من برای ضبط صدای من و فرزندم است. ☐
امضا: -----

علامت زدن در این کادر نشان دهنده اجازه من به تیم پژوهشی فعلی و همکارانشان است تا در صورتی که از بخشی از مطالعه انصراف دهم، از داده‌های من استفاده کنند، مگر اینکه خلاف آن را به محققان نشان دهم. ☐
امضا: -----

علامت زدن در این کادر نشان دهنده اجازه من برای استفاده در آینده از ضبط و داده‌هایم فراتر از مطالعه فعلی توسط تیم تحقیقاتی فعلی و همکارانشان است. ☐
امضا: -----

علامت زدن در این کادر نشان دهنده اجازه من برای استفاده، ذخیره و به اشتراک گذاری موارد ضبط شده و داده‌های من از این مطالعه در پایگاه داده‌های تحقیقاتی یا ثبت برای استفاده در آینده توسط محققان دیگر خارج از این موسسه است. من می‌دانم که اگر چه محرمانه بودن من توسط آن محققان محترم شمرده می‌شود، ضبط ممکن است حاوی اطلاعات شناسایی باشد که نمی‌توان آن‌ها را حذف کرد، مانند صدای من یا چیزهایی که در طول ضبط‌ها گفته می‌شود. پژوهشگران تحت هیچ شرایطی هویت من را منتشر نخواهند کرد یا فایل‌های ضبط شده را در دسترس عموم قرار نمی‌دهند. در حالی که پژوهشگران دانشگاه منیتوبا تمام تلاش خود را انجام خواهند داد تا اطمینان حاصل شود که تنها پژوهشگرانی که از این قوانین پیروی می‌کنند به موارد ضبط شده و داده‌ها دسترسی داشته باشند، قابل درک است که پژوهشگران دانشگاه منیتوبا مستقیماً رفتار محققان خارج از دانشگاه منیتوبا را کنترل نمی‌کنند. ☐
امضا: -----

علامت زدن در این کادر نشان دهنده اجازه من برای پخش کلیپ‌های کوتاه ضبط شده‌ام برای افراد غیر پژوهشگر برای اهداف تحقیقاتی است. این کلیپ‌های کوتاه حاوی هیچ گونه اطلاعات شناسایی مانند نام من یا نام فرزندم نیستند. ممکن است، هر چند بعید است، اما کسی مرا از روی صدایم بشناسد. ☐
امضا: -----

امضای شما در این فرم بیانگر آن است که اطلاعات مربوط به شرکت در پروژه تحقیقاتی را با رضایت خود درک کرده و با شرکت در آن موافقت کرده اید. امضای این فرم حقوق قانونی شما را نادیده می‌گیرد و محققان، حامیان مالی یا مؤسسات درگیر را از مسئولیت‌های قانونی و حرفه‌ای خود رها نمی‌کند. شما مختار هستید که در هر زمانی از پژوهش کناره‌گیری کنید و/یا از پاسخ دادن به هر سوالی که ترجیح می‌دهید به آن پاسخ ندهید، خودداری کنید بدون آنکه عواقبی داشته باشد. شما می‌توانید آزادانه در طول شرکت خود در تحقیق توضیح بیشتر یا اطلاعات جدید بخواهید.

این تحقیق توسط هیئت اخلاقی پژوهش در دانشگاه منیتوبا، پردیس فورت گری تأیید شده است. اگر در مورد این پروژه نگرانی یا شکایتی دارید، می‌توانید با هر یک از افراد ذکر شده در بالا یا هماهنگ‌کننده اخلاقی انسانی به شماره ۲۰۴-۴۷۴-۷۱۲۲ تماس بگیرید، یا به آدرس اینترنتی humanethics@umanitoba.ca ایمیل بزنید. یک کپی از این فرم رضایت به شما ارائه می‌شود تا برای سوابق و مرجع خود نگهداری کنید.

مایلم گزارشی از این مطالعه دریافت کنم: ☐ بله ☐ خیر
در صورتی که پاسخ شما بلی است، لطفاً آدرس ایمیل یا راه دیگری را برای برقراری ارتباط وارد کنید:

گزینه حذف ضبط (که باید پس از انجام ضبط تکمیل شود):

امضا در این کادر نشان دهنده درخواست من از تیم پژوهش برای حفظ صدای ضبط شده کودک من پس از پردازش توسط نرم‌افزار رایانه‌ای است.	امضا در این کادر نشان دهنده درخواست من از تیم پژوهش برای حذف صدای ضبط شده در خانه کودک من پس از پردازش توسط نرم‌افزار رایانه‌ای است.	امضا در این کادر نشان دهنده درخواست من از تیم پژوهش برای حذف ضبط من بدون پردازش داده‌ها است.
-----	-----	-----

توجه: همانطور که در بالا توضیح داده شد، برخی از داده‌ها و اطلاعات این مطالعه ممکن است خارج از دانشگاه مینیوتوبا برای سایر محققان و سازمان‌ها ارسال شود یا در دسترس عموم قرار گیرد. این کار به منظور تجزیه و تحلیل بیشتر و از مایش، به عنوان بخشی از مطالعه تحقیقاتی، یا الزامی توسط یک مجله پژوهشی یا سازمان اهدا کننده است. هر گونه اطلاعاتی که از دانشگاه مینیوتوبا ارسال شود، نام یا آدرس شما یا هر گونه اطلاعات شخصی قابل شناسایی دیگری را در مورد شما نشان نخواهد داد. با این حال، علیرغم تلاش‌هایی که برای محرمانه نگه داشتن اطلاعات شخصی شما انجام می‌شود، محرمانه بودن مطلق قابل تضمین نیست. اطلاعات شخصی شما ممکن است در صورت لزوم توسط قانون فاش شود.

امضای والدین شرکت‌کننده: _____

تاریخ: _____

امضای پژوهشگر/ یا نماینده تیم پژوهشی: _____

تاریخ: _____

امضای ولی حقوقی کودک (در صورتی که پدر کودک در قید حیات نباشد): _____

تاریخ: _____

امضای دیگر افراد در خانه (افرادی که ممکن است صدای آن‌ها در ضبط باشد): _____

تاریخ: _____

Appendix 8: Demographic Questionnaire (Persian)



پرسشنامه دموگرافیک

لطفاً توجه داشته باشید: پاسخ به این سوالات کاملاً داوطلبانه است.
اطلاعاتی که در اختیار ما قرار می‌دهید، در پژوهش ما بسیار مفید خواهند بود.
در صورتی که هرگونه سؤال یا نگرانی‌ای در مورد پاسخ‌های خود یا نحوه استفاده از آن‌ها دارید، لطفاً از ما بپرسید.

این قسمت باید توسط پژوهشگر تکمیل شود
کد داده:
کد مطالعه:
تاریخ:

۱. اطلاعات والدین

ولی شماره ۱

سن:

جنسیت:

ملیت:

تحصیلات:

(الف) دیپلم دبیرستان یا کمتر
(ب) کارشناسی (یا سایر مدارک تحصیلی مشابه)
(ج) کارشناسی ارشد یا بالاتر

شغل:

آیا قبل از پدر و مادر شدن، تجربه‌ای با کودکان داشتید؟

(الف) بله

(ب) خیر

در صورتی که پاسخ شما بلی است، لطفاً توضیح دهید:

هر چند وقت یک بار از کودک خود دور هستید؟

ولی شماره ۲ : (در صورتی که ولی دومی در مراقبت از کودک شما نقشی ندارد، لطفاً این بخش را خالی بگذارید).

سن:

جنسیت:

ملیت:

تحصیلات:

الف) دیپلم دبیرستان یا کمتر
ب) کارشناسی (یا سایر مدارک تحصیلی مشابه)
ج) کارشناسی ارشد یا بالاتر

شغل:

آیا قبل از پدر و مادر شدن، تجربه‌ای با کودکان داشتید؟

الف) بله

ب) خیر

در صورتی که پاسخ شما بلی است، لطفاً توضیح دهید:

هر چند وقت یک بار از کودک خود دور هستید؟

۲. فرزندان در خانه

کودک شرکت‌کننده (در پژوهش)

تاریخ تولد (سال/ماه/روز):

جنسیت:

الف) پسر

ب) دختر

آیا کودک شما خواهر و برادر دارد؟

الف) بلی

ب) خیر

در صورتی که پاسخ بلی است،

تاریخ تولد (سال/ماه/روز):

تاریخ تولد (سال/ماه/روز):

تاریخ تولد (سال/ماه/روز):

تاریخ تولد (سال/ماه/روز):

پسر دختر

پسر دختر

پسر دختر

پسر دختر

۳. خانوار:

افراد بزرگسال در خانوار شما چه کسانی هستند؟

آیا پدر بزرگ و مادر بزرگ یا سایر اعضای خانواده خارج از خانوار در مراقبت از کودک نقش دارند؟
 الف) بلی
 ب) خیر

در صورتی که پاسخ شما بلی است، لطفاً توضیح دهید:

درآمد ماهیانه خانوار:
 الف) ۴۱,۷۹۷,۵۰۰ ریال یا کمتر
 ب) ۴۱,۷۹۷,۵۰۰ – ۱۰,۰۰۰,۰۰۰ ریال
 ج) ۱۰,۰۰۰,۰۰۰ – ۱۵,۰۰۰,۰۰۰ ریال
 د) ۱۵,۰۰۰,۰۰۰ ریال یا بیشتر

۴. مراقبت رسمی از کودک

آیا کودک شما به مرکز یا موسسه‌ای جهت مراقبت و نگهداری می‌رود؟
 الف) بلی
 ب) خیر

در صورتی که پاسخ شما بلی است، نوع آن کدام است:
 الف) در خانه
 ب) مراکز مراقبت از کودکان، مهدکودک
 ج) موارد دیگر

در صورتی که پاسخ شما بلی است، اغلب چه مواقعی کودک شما به این مراکز می‌رود؟

۵. پیشینه زبان:

زبان مادری شما چیست؟

چه زبان(هایی) معمولاً در خانه استفاده می‌شود؟

آیا زبان دیگری جز فارسی بلدید؟
 الف) بلی
 ب) خیر

در صورتی که پاسخ شما بلی است، لطفاً توضیح دهید:

۶. پیشینه کودک

آیا کودک شما نارس به دنیا آمده است؟
 الف) بلی
 ب) خیر

تاریخ سررسید کودک (سال/ماه/روز):

آیا کودک شما از چند قلوزایی است؟

الف) بلی

ب) خیر

در صورتی که پاسخ شما بلی است،

الف) یکسان

ب) برادری

ج) مطمئن نیستم

آیا کودک شما اختلالات یا مشکلات شنوایی دارد؟

الف) بلی

ب) خیر

در صورتی که پاسخ شما بلی است، لطفاً توضیح دهید:

آیا کودک شما اختلال زبانی، شناختی و یا هیچ‌گونه تاخیر رشدی دارد؟

الف) بلی

ب) خیر

در صورتی که پاسخ شما بلی است، لطفاً توضیح دهید:

آیا چیز دیگری وجود دارد که ما باید در مورد کودک شما بدانیم (مثلاً ویژگی‌های فیزیکی) که در بالا به آن‌ها اشاره نشده است و ممکن است بر رفتار کودک شما در این پژوهش تأثیر بگذارد؟

الف) بلی

ب) خیر

در صورتی که پاسخ شما بلی است، لطفاً توضیح دهید:

تاریخ سررسید کودک (سال/ماه/روز):

آیا کودک شما از چند قلوزایی است؟

الف) بلی

ب) خیر

در صورتی که پاسخ شما بلی است،

الف) یکسان

ب) برادری

ج) مطمئن نیستم

آیا کودک شما اختلالات یا مشکلات شنوایی دارد؟

الف) بلی

ب) خیر

در صورتی که پاسخ شما بلی است، لطفاً توضیح دهید:

آیا کودک شما اختلال زبانی، شناختی و یا هیچ‌گونه تأخیر رشدی دارد؟

الف) بلی

ب) خیر

در صورتی که پاسخ شما بلی است، لطفاً توضیح دهید:

آیا چیز دیگری وجود دارد که ما باید در مورد کودک شما بدانیم (مثلاً ویژگی‌های فیزیکی) که در بالا به آن‌ها اشاره نشده است و ممکن است بر رفتار کودک شما در این پژوهش تأثیر بگذارد؟

الف) بلی

ب) خیر

در صورتی که پاسخ شما بلی است، لطفاً توضیح دهید:

Appendix 9: LENA Recording Sheet (Persian)



برگه ثبت و یادداشت

گفتار نوزادمدارانه در کودکان ۶ و ۱۲ ماهه فارسی‌زبان

کد: (توسط پژوهشگر تکمیل شود)

تاریخ:
 ضبط شماره:
 زمان شروع:
 زمان پایان:

لطفاً ساعت خواب کودک را در طول روز ثبت کنید:

ساعت خواب:

زمان شروع (دقیقه:ساعت)	زمان پایان (دقیقه:ساعت)

لطفاً در صورتی که دستگاه ضبط را در طول روز متوقف کردید، زمان آن را یادداشت کنید:

زمان توقف:

زمان شروع (دقیقه:ساعت)	زمان پایان (دقیقه:ساعت)

لطفاً فعالیت‌های انجام شده در طول روز را یادداشت کنید. این بخش را در پایان روز تکمیل کنید (نه در طول روز و در حین تعامل با کودک). در صورت نیاز از پشت برگه استفاده کنید.

مثال دستبندی فعالیت‌ها:

بازی کردن/قصه گفتن/بیرون رفتن/حمام کردن/غذا خوردن

توضیحات	مکان	فعالیت‌ها (زمان شروع و پایان)

Appendix 10: Home Recordings — A Guide for Parents (Persian)



ضبط‌های خانگی - راهنمای والدین

لطفاً ضبط را برای مدت یک روز کامل انجام دهید (از زمانی که کودک شما از خواب بیدار می شود تا زمانی که در پایان روز به خواب می رود) و دستگاه ضبط را در تمام روز روشن بگذارید. همچنین، مطمئن شوید که ضبط را در روزهایی که بیشتر در کنار کودک خود هستید، انجام می‌دهید.

طریقه استفاده از دستگاه ضبط صوتی لینا

۱. برای روشن کردن دستگاه، دکمه پاور را فشار داده و نگه دارید.
۲. برای شروع ضبط، دکمه رک (رکوردر) را فشار داده و نگه دارید. علامتی مبنی بر اینکه دستگاه در حال ضبط است، بر روی صفحه ظاهر می شود.
۳. اگر می‌خواهید ضبط را متوقف کنید، دکمه رکوردر را مجدداً فشار داده و نگه دارید. نشانه ای مبنی بر توقف دستگاه بر روی صفحه ظاهر می شود. لازم است که در پایان ضبط، پیش از آنکه دستگاه را خاموش کنید، آن را متوقف نمایید.
۴. برای خاموش کردن دستگاه، دکمه پاور را فشار داده و نگه دارید.
۵. ممکن است دستگاه در حین ضبط کردن متوقف شود. تنها کاری که باید انجام دهید این است که زمان توقف دستگاه و همچنین زمان لغو توقف و ادامه ضبط را به دقت یادداشت کنید.
۶. لطفاً دستگاه را زمانی که کودک شما در حال چرت زدن است، خاموش نکنید! به سادگی می توانید آن را از لباس مخصوص خود خارج کرده و سپس آن در مجاورت کودک، یعنی زیر تخت یا روی میز مجاور قرار دهید.

طریقه استفاده از برگه‌های ثبت و یادداشت

۱. لطفاً زمان شروع و پایان ضبط را به دقت یادداشت کنید. این کار کمک بزرگی به ما برای تطبیق دادن ضبط با برگه‌های ثبت و یادداشت است.
۲. لطفاً زمانی را که کودکان در حال چرت زدن است (زمان شروع و پایان)، و هر زمانی که دستگاه را متوقف کرده‌اید، یادداشت کنید. اگر هر زمان دیگری را نیز که دستگاه در جیب لباس قرار ندارد، یا ممکن است ضبط به خوبی نباشد، مثلاً اگر کودک شما ژاکت یا کاپشن پوشیده باشد، ثبت کنید.
۳. در پایان روز، لطفاً خلاصه‌ای از فعالیت‌ها، مکان‌ها و هر توضیح مهم دیگری را یادداشت نمایید.

طریقه تهیه یک ضبط مناسب

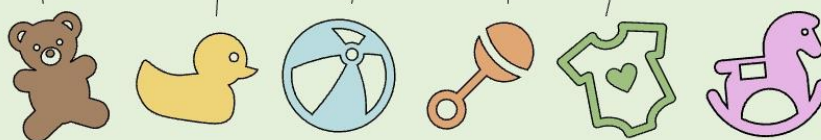
- پوشاندن لباس لینا، همانند پوشیدن گوش بند، صداها را مسدود می‌کند. بنابراین لطفاً در صورت امکان لباس لینا را در بالای سوییشرت و ژاکت و کاپشن بپوشانید.

- در هنگام حمام کردن یا چرت زدن، بهتر است دستگاه لینا را در لباس مخصوص آن به صورت خشک نگه داشته و تا جایی که ممکن است آن را در نزدیکی کودک قرار دهید. ممکن است لینا با پاشیدن مقدار کمی آب بر روی آن آسیبی نبیند، اما هرگز نباید در آب فرو رود. به یاد داشته باشید که لباس لینا را پس از استحمام، مجدداً به کودک خود بپوشانید.

- برای ایمنی و ضبط خوب، لطفاً مطمئن شوید که دستگاه لینا، در هنگام سفر و جابه‌جایی در وسیله نقلیه، در زیر بند کمر بند ایمنی قرار نگرفته باشد.

از مشارکت شما در این پژوهش، و از وقت و همکاری شما بسیار سپاسگزاریم. لطفاً در پایان ضبط، به آدرس اینترنتی farsi.infant@umanitoba.ca ایمیل بزنید و یا با شماره تلفن ۰۹۰۱۱۶۷۹۹۲۱ تماس بگیرید یا پیام دهید تا زمانی را با شما برای تحویل گرفتن دستگاه و لباس ضبط و فرم‌های پژوهش، هماهنگ کنیم.

Appendix 11: Study Advertisement (Persian)



دعوت به همکاری و مشارکت در پژوهش

به تعدادی داوطلب ساکن مشهد جهت شرکت در یک پژوهش علمی نیازمندیم. هدف از انجام این تحقیق، بررسی محیط زبانی کودکان و تاثیر آن بر رشد زبان آنها است.

اگر کودکی دارید که ۶ الی ۱۳ ماهه است و مایل به ضبط صدای او به مدت یک روز کامل در محیط خانه هستید، از شما دعوت می‌شود که در این پژوهش مشارکت نمایید. به هریک از عزیزان شرکت‌کننده در این پژوهش، یک عدد کارت هدیه و یک کتاب داستان به رسم تشکر و یادبود تقدیم می‌گردد.

راه‌های ارتباطی:
farsi.infant@umanitoba.ca
 ۰۹۰۱۱۶۷۹۹۲۱ (واتس‌آپ)
 farsi.infant (اینستاگرام)



Appendix 12: Ethics Approval Letter



University
of Manitoba

Research Ethics and Compliance

Human Ethics - Fort Garry
208-194 Dufour Road
Winnipeg, MB R3T 2N2
T: 204 474 8872
humanethics@umanitoba.ca

PROTOCOL APPROVAL

Effective: August 3, 2022

Expiry: August 2, 2023

Principal Investigator: Sara Montazeri
Advisor: Melanie Soderstrom
Protocol Number: HE2022-0170
Protocol Title: *Infant-directed Speech in 6- and 12-month-old Iranian, Persian-learning Infants*

Laura Funk, Acting Chair, REB1

Research Ethics Board 1 has reviewed and approved the above research. The Human Ethics Office (HEO) is constituted and operates in accordance with the current *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans*- TCPS 2 (2018).

This approval is subject to the following conditions:

- i. Approval is granted for the research and purposes described in the protocol only.
- ii. Any changes to the protocol or research materials must be approved by the HEO before implementation.
- iii. Any deviations to the research or adverse events must be reported to the HEO immediately through an REB Event.
- iv. This approval is valid for one year only. A Renewal Request must be submitted and approved prior to the above expiry date.
- v. A Protocol Closure must be submitted to the HEO when the research is complete or if the research is terminated.
- vi. The University of Manitoba may request to audit your research documentation to confirm compliance with this approved protocol, and with the UM *Ethics of Research Involving Humans*[Ethics of Research Involving Humans](#) policies and procedures.

Appendix 13: Annotation Instructions

Segmentation Instructions

By Sara Montazeri

February 2023

Last updated: April 2024

Goal: Identify **120 IDS utterances** and **120 ADS utterances** for each participant

1. The audio or wav. files as well as the csv. files have already been uploaded to the following location:

Shared (S:) > Soderstrom-Lab > CurrentStudies > Lab members studies > Sara's PhD study (Sara-SM)

*The csv. files for the participants 01a_03a are in this folder: Sub_01a-Sub_03a

*The csv. files for the rest of the participants are in this folder: ADEX-5min

*The csv. files are usually in order; however, if this is not the case, you may need to open each csv file to find the csv file you are looking for.

Example: You are looking for the csv. file of the participant Sub_010a. In order to find it, you need to open the "ADEX-5min" folder, then open the "Sub_01a-Sub_025a_ADEX_5mins" folder, and then count from the beginning of the files, usually the 10th csv. file is the csv. file for Sub_010a. If this is not the case, you may need to look for it in the other csv. files.

2. First, listen to the file and identify the person who is the (female) primary caregiver. If you encounter a situation where you believe the primary caregiver is male, please consult Sara Montazeri.
3. Use the ADEX exported csv. files to identify each participant's highest-volubility 5-minute chunks of Adult Word Count (AWC) and Conversational Turns Counts (CTC).
Read the example of the highest volubility of AWC and CTC in 5-minute chunks provided for you. You may need to work with Sara to ensure you can navigate any issues with time zones to make sure you are getting the correct 5-min segments.
4. Locate the highest 5-minute chunk of AWC for each participant. Within that 5-minute chunk, begin identifying and segmenting adult-directed speech (ADS) or A utterances, using basic ACLEW protocols (see below). You should only segment speech from the primary caregiver. See also below regarding excluding utterances. Once you have completely listened to the first 5-minute chunk of the highest AWC, count up the number of utterances you segmented. If it is less than 120 ADS utterance, go to the second-highest 5-minute chunk of AWC. Continue this procedure until you have segmented 120 ADS utterances.
5. Follow the steps mentioned above to find and segment 120 infant-directed speech (IDS) or C utterances from the primary caregiver for each participant. In doing so, however, use the information on the csv. files about the highest 5-minute chunk of CTC for each participant.
6. Please segment and annotate 120 ADS/A and 120 IDS/C utterances for each participant.

Exclusions: When doing segmentation, ensure the utterances you select are good quality for acoustic analyses. The primary caregiver should be relatively close to the audio recorder, and you should be able to hear them properly. Also, ensure the utterances you segment do not include any kind of noise or overlapping speech (e.g., when two or more people speak simultaneously). Moreover, please exclude any speech not in Persian for now. Other languages will have to be assessed more diligently. Finally, the length of each utterance should be a minimum of 1 second, and a maximum of 3 seconds; however, for now, let's test this out. As discussed in the lab meeting, perhaps lowering the minimum would be helpful. Use best judgment when considering if enough of the utterance is included.

Specific steps:

1. For a review of how to do the segmentation and annotation, please go to the below link:
<https://osf.io/b2jep/wiki/home/>
2. Open the wav. file of the participant in ELAN software.
3. Create one independent tier, FA1 (Female Adult 1, which is the primary caregiver of the key child, the mother).
4. Add a dependent tier for FA1, xds, which is the addressee of the utterance.
5. Transcription is not required; just put 0. for annotating the segments of the primary caregiver.
6. For the xds dependent tier, define two values of IDS/C and ADS/A. Label the already segmented utterances of FA1 as either IDS/C or ADS/A. *Note: When labeling the utterances as IDS/C, ensure that the primary caregiver (mother) is talking to the key or*

target child (IDS), not other children or pets. Also, when labeling the utterances as ADS/A, make sure that it is the primary caregiver (mother) talking to another adult (ADS).

7. To do the segmentation, use the *segmentation mode* in ELAN, and segment the utterances you hear from the primary caregiver (FA1). *Note: When doing the segmentation, please be precise with the beginning and end of each utterance. The onset and offset boundaries for each utterance should be accurate and precise. Make sure you capture the entire utterance within the bounds of your annotation:*

“... If you play back the annotation you made, you should be able to hear the complete utterance. So, err on the side of inclusion if you’re unsure of the exact boundary. That said, keep things tidy—don’t include hearable silences at the start and finish. The waveforms are a nice visual guide for this!” (Slide 16, Tutorial 4, ACLEW template)

8. For each participant, find and segment 240 utterances in total, 120 IDS/C utterances, and 120 ADS/A utterances.
9. Please feel free to ask Sara Montazeri any questions, comments, and feedback.

Additional Notes:

1. Do not segment IDS/C utterances from the caregiver humming to the key child, as they do not include any linguistic information.
2. Make sure you are using the ADEX output (and not the caregiver log sheets) to determine the "start time" for the purpose of locating the high-volubility chunks in the wav. file. It is

necessary for this to be exact TO THE SECOND, as the recordings don't start cleanly at a five-minute interval. And convert the data under the elapsed_time column from seconds to HH:MM:SS:MS. You can do this using this free convertor:

<https://www.inchcalculator.com/seconds-to-time-calculator/>

3. If a single 5-minute code has both high volubility AWC and CTC, feel free to identify IDS and ADS utterances in it.
4. It is crucial to distinguish instances where background noise exceeds the level of the utterance, potentially altering the main speaker's vocal qualities. In such cases, it is advisable to skip annotating these segments.
5. In order to segment the utterances of FA1 correctly, and not to mistakenly segment speech from other female speakers, both the annotators and reviewers should backtrack and reevaluate the voice by comparing it to previous utterances where the mom was alone with the infant.
6. Whenever a segment starts or ends in vowels (and some consonants as well), please segment further than where the waves are evident, to ensure that the whole utterance is segmented.

Appendix 14: Manual Annotation in ELAN

ELAN 63 - Sub_02a-SM.eaf

File Edit Annotation Tier Type Search View Options Window Help

Grid Text Subtitles Lexicon Comments Recognizers Metadata Controls

FA1

Nr	Annotation	xds@FA1	Begin Time	End Time	Duration
94.0		C	02:09:59.610	02:10:01.410	00:00:01.800
95.0		C	02:10:01.540	02:10:03.410	00:00:01.870
96.0		C	02:10:10.690	02:10:13.300	00:00:02.610
97.0		C	02:10:19.890	02:10:22.000	00:00:02.010
98.0		C	02:10:23.110	02:10:25.000	00:00:01.890
99.0		C	07:15:00.876	07:15:01.880	00:00:01.004
100.0		A	07:16:37.210	07:16:38.300	00:00:01.090
101.0		A	07:18:17.260	07:18:18.654	00:00:01.394
102.0		A	07:18:18.682	07:18:19.893	00:00:01.211
103.0		A	07:18:20.856	07:18:21.996	00:00:01.140
104.0		A	07:18:23.484	07:18:24.134	00:00:00.650
105.0		A	07:18:24.154	07:18:24.650	00:00:00.496
106.0		A	07:18:26.816	07:18:27.610	00:00:00.794
107.0		A	07:18:31.794	07:18:32.608	00:00:00.814

02:10:01.540 Selection: 02:10:01.540 - 02:10:03.410 1870

Text

20220916_110...

CHI
vcm@CHI
FA1
xds@FA1
code