Investigating Infant Directed Speech in a Young Mother Sample

by

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Abstract

How a mother linguistically interacts with her infant has lasting consequences for the infant's language development (Chase-Lansdale & Brooks-Gunn, 1994; Owen-Jones et al., 2013; Sarsour et al., 2011). There has been insufficient research describing the language environments of children born to *young mothers*, a term used here to describe both adolescent (18 years old and younger) and emerging adulthood (19-25 years old) mothers. No previous research has looked at maternal age and a specific type of speech, found to be of high importance in the language development process, infant-directed speech (IDS). The goal of this dissertation was to explore the type and quantity of speech infants of young mothers are exposed to, focusing on maternal IDS. I explored these variables by developing a unique labelling system (named ConvoLabel) to aid in the identification of maternal IDS in naturalistic infant language environment recordings completed by young Winnipeg mothers. The sample was comprised of 23 mothers (15 - 25 years of age), and their children (1 - 23 months of age). The Language ENvironment Analysis system, a digital recorder and software system, was used for naturalistic recording and analysis of infants' everyday experiences (totaling over 600 hours). I found that the young mothers in my sample were using IDS both acoustically, and numerically, in a manner that is like non-young mother populations (of a western context) reported in the literature (e.g., Bergelson et al., 2019; Bunce et al., 2020; McClay et al., 2022). The infants in my sample heard more maternal non-directive IDS than directive IDS, the IDS speech type hypothesized to be more favourable for language learning and infant engagement and responsiveness (Lacroix et al., 2002; McDonald & Pien, 1982; Pratt et al., 1992). The infants were found to hear a significant amount of speech not directed to them which likely plays a role in their language learning process. This research

project adds to the limited research exploring how young mothers are talking to their infants, while advancing methodology on the examination of IDS using a unique computer system.

Keywords: adolescent mother, emerging adulthood, young mother, infant, language environment, language development, infant directed speech, knowledge of infant development

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Chapter 1 – General Introduction

Language acquisition plays a vital role in forming human connection. How one's language develops is directly influenced by one's early caregivers. A caregiver's own early language experiences, attachment, culture, socio-economic status, knowledge, and mental state can impact the learner's language development (e.g., Becker Razuri et al., 2017; Vernon-Feagans et al., 2019). In most cases, an infant's first language experiences occur with their mother, who is typically the primary caregiver (Cummings, 1980; Sugden & Moulson, 2019). Maternal characteristics contribute to the quality and quantity of linguistic interactions between mother and child (Chase-Lansdale et al., 1994; Owen-Jones et al., 2013; Sarsour et al., 2011) and the child's cognitive and language development (Goldstein & Schwade, 2008). Understanding the array of components that contribute to maternal speech is of high importance.

One of the components contributing to maternal speech is maternal age. There has been insufficient research dedicated to describing the language environments of children born to mothers of a young age (specifically 25 years of age and under). The early contributions to this research (e.g., Barratt & Roach, 1995; Culp et al., 1991; Garcia et al., 1987) were unable to use the current advanced, naturalistic research methods that now exist, instead relying on interviews, laboratory observation, and short video recordings. Even recent research using updated methodology has failed to explore a specific type of speech, found to be of high importance in the language development process, commonly known as "babytalk" and scientifically termed infant-directed speech (IDS), within a young mother population. Consequently, an examination of maternal age and infant language exposure, with a focus on maternal IDS, is necessary due to the lack of contemporary research in this area.

The mother-infant dyad's environment impacts maternal language output and infant language learning in more ways than we currently understand (Sperry et al., 2020). Researchers have identified characteristics capable of impacting such structures (e.g., SES, culture, history); however, understanding the complexity of these unique but interrelated variables is ongoing (e.g., Ochs & Kremer-Sadl, 2020). Historically, these characteristics have been explored through a deficit-based lens, resulting in misplaced blame and a ripple effect of potential harm through misrepresentation (Sperry et al., 2020). Instead, acknowledgement of linguistic and cultural diversity amongst research samples is necessary. This approach helps researchers focus on the unique ways humans have adapted and evolved, allowing scientists to focus on human potential. In the current study, I placed a critical eye on previous research methods and conceptualizations and aimed to better understand the environments young mothers and their children living in a central Canadian city function within with a specific focus on language learning.

Ethical Approach to Research

Psychological science is in a constant state of evolution. A main theme weaving through my chapters involves understanding and communicating how research methods and conceptualizations of populations and variables have been discussed historically versus presently. I will draw from the Canadian Psychological Association Justice, Equity, Diversity, and Inclusion (JEDI) Committee (2022) and the Equity, Diversity, and Inclusion (EDI) framework from the American Psychological Association (Akbar & Parker, 2021) within this document. This involves citing inclusive research when available and critiquing dated and non-inclusive empirical research, describing my study sample and interpreting my results in a

culturally sensitive manner, and advocating for research and intervention approaches that are equal, diverse, and inclusive to the population studied.

Interpersonal Integration

Understanding caregiver-child dyads in the context of language learning is important because input from external sources (i.e., other individuals) directly influences our internal realm, creating and shaping how we view ourselves and the world around us (Siegel, 2001; Siegel & Bryson, 2012). This phenomenon, deemed "interpersonal integration" and discussed by Siegel and Bryson (2012, p. 122), reflects the idea that the brain is designed to communicate and cooperate internally (amongst regions) and externally (amongst individuals). How our brains grow and develop depends, in part, on the stimulation those closest to us provide (e.g., Rowe, 2021). Speech directed to infants is associated with increased brain development, with external stimuli creating internal growth; a finding that is strongest when examining conversational exchanges between infant and caregiver (Romeo et al., 2018). For this reason, the present examination of infant language will focus on the language environments young mothers provide to their infants, with a special focus on maternal speech directed to infants (IDS).

Beyond Language

This document focuses on infant language learning and the role of young mothers, but it is important to mention the widespread developmental aspects of the language learning process. Language learning commences in utero (Moon et al., 2013) and intensifies after birth (e.g., Ferguson & Waxman, 2017); it is involved in developing many mechanisms that help humans form an identity, build relationships, and contribute to the world (Nunan & Choi, 2010). When a child attends to language, they are also building their attention, processing, executive functioning, social interaction, reciprocal affective, interpersonal, and meaning-making skills

(Greenspan, 2002). During such occasions, they also expand their visual, auditory, and sensory processing capabilities and identify their role within their family structure and hierarchy (Greenspan, 2002). Language input contributes meaningfully to the developing brain while activating widespread internal and external mechanisms that benefit human functioning.

Outline

In this manuscript, I review: Chapter 2, an overview of infant language and IDS from a linguistic perspective, including the background and history of IDS, the ways IDS is defined and measured, the cross-linguistic nature of IDS, competing conceptualizations of language input more generally, and cultural variation of IDS with a special focus on Indigenous representation; and Chapter 3, an overview of maternal characteristics in young motherhood including maternal age, infant development knowledge, and living arrangements of young mothers, and their relation to infant development in general and language development in particular. In Chapter 4, I discuss the rationale for the current research project, the current study's aims, research questions, and methodology. In Chapter 5, I provide the analysis and statistical method used to answer my research questions and I describe the results of the study. In Chapter 6, I provide a summary of the research project by reviewing the main findings, contextualize the findings, discuss strengths of the current sample, limitations of the study, future research directions, and concluding remarks.

The overarching goal of this dissertation was to describe the language environments of infants born to young mothers using modern research methods and a novel computer program specifically created to quantify, measure, and describe maternal IDS in a meaningful way. I also aimed to enhance our understanding of the infant’s language environments by exploring the

maternal characteristics that may contribute to one's language experience with a special focus on maternal age and maternal infant development knowledge.

Chapter 2 – Infant Language

Language Development

In the first two years of life, children are particularly receptive to language input and experience and learn an enormous amount of language. This developmental stage, sometimes referred to as a 'critical' or 'sensitive' period for language learning, is known for rapid language acquisition unparalleled to any other developmental stage, playing a pivotal role in infant brain, cognitive, and language growth. We see major gains on the production and perception side of infant language learning. The progression of infant communication and language development is a rapidly evolving process (e.g., Fenson et al., 2000). Infants learn to differentiate language from other sounds in their environment (e.g., Ferguson & Waxman, 2017), differentiate content and function words (e.g., Shi et al., 1998), perceive prosodic and phonological components of language (e.g., Eimas et al., 1971; Mehler et al., 1988), and learn words, multi-word sentences, and sentence structure (e.g., Yang et al., 2017) amongst other skills. Language experiences substantially impact children's language achievements during the first two years of life, setting the foundation for individual, tailored brain development and neural pathway formation.

As a result, language development research and intervention have focused on the zero to two years age range to understand: (a) how children learn language so rapidly during this stage; (b) the unique ways caregivers use language to assist children with this process; and (c) factors that contribute to ideal language acquisition, such as language environment characteristics. Language learning is a complex phenomenon requiring sophisticated research methodologies designed to understand the factors that contribute to this process. I aimed to gain an understanding of these factors in a sample of infants born to young mothers, a population noticeably missing from this area of research.

Measuring Infant Language Environments

Research methodologies regarding children's language environments and development often include diary studies, child and/or parent in-person observation, standardized testing, parent reporting, audio and video recording and transcription, and data corpora. Early language research relied heavily on observation and lengthy manual reporting techniques. One of the first known research methods for examining children's language environments involved diary entries by parents or researchers. Diary studies have been used both in the past (e.g., Stern & Stern, 1928) and more recently (e.g., Naigles et al., 2009) by language researchers to study the evolution of language and language skills within children. The diary method involves asking parents to keep a diary and make an entry every time they observe a new language skill with their child. The benefit of this approach is the ability to observe the naturalistic language environment more accurately (Naigles et al., 2009). The downside of this technique is the expectation on the parent to attend to and be mindful of the diary entries in an already task-heavy child-rearing environment, the potential for reporting bias, and the variability in the consistency and content of parent entries.

Observation

An often-used method involves a research assistant observing a child (in either a home or laboratory-based setting) and manually recording or assessing their language environment and development (Goodwin & Goodwin, 2016). Well-studied limitations exist with this approach, such as the Hawthorne effect, where an individual or individuals being observed modify their behaviour due to being watched (McCarney et al., 2007). In child language research, this may increase speech or overall attention given to the child during observation periods. The way an individual may modify their behaviour is likely, in part, population specific. If a caregiver is

knowledgeable about the expected ideal behaviours being observed or examined, they may be better equipped to perform or model best practices as they are currently understood. Also, populations may vary in their motivation to modify behaviour or perform for the researchers. This phenomenon is important for researchers to be mindful of, as manual observation and recording may not accurately represent their behaviours when a researcher is absent. Also, laboratory-based observation projects designed to simulate home language environments and accompanying behaviours are often short in length and lack generalizability due to the artificial nature of the environment (Gilkerson et al., 2017).

A well-known example of this observation method involves a study completed by Hart and Risley (1992, 1995), originators of the 30 – Million Word Gap. They were among the first to collect comprehensive naturalistic home language environment data by visiting 42 participant homes once a month, for one hour, over three years. Due to the considerable resources required for the project, the researchers had trouble gathering representative samples of certain populations, such as low SES populations. The researchers would record the child's audio language environments during these visits. A researcher was present during the recording process, and participants were told to prioritize one-on-one interactions during the recording. Although the researchers were able to collect over 1,300 hours of audio data over those three years, transcription, coding, and analyzing the data took an additional four years after the data collection process was completed. This study design was considered ground-breaking for its time due to the resources and effort required to implement the study and analyze the data. A main limitation of the study design was that the audio recordings were short, capturing one hour out of the day. The research team used this hour to estimate the child's language input for the entire day. This limitation, along with the lack of representation amongst samples, likely compromised

the naturalistic authenticity of the environment. One of their findings, which has come to be known as the 30-Million Word Gap, claimed that low SES children are on track to hear 30 million fewer words than their high SES counterparts by age four (a finding discussed in more detail later).

Standardized Testing

Standardized testing, another commonly used method to assess language development, involves using reliable, validated, consistent testing protocol and testing materials completed with the person requiring assessment (Goodwin & Goodwin, 2016). Examples of standardized testing of language for young children include: the Peabody Picture Vocabulary Test (Version 4; Dunn & Dunn, 2007), the Sequenced Inventory of Communication Development (Version 2; Hendrick et al., 1984), the Preschool Language Scale (Version 5; Zimmerman et al., 2011), the Early Language Milestone Scale (Version 2; Coplan, 1993), and the Language composite of the Bayley Scales of Infant and Toddler Development (Version 3; Bayley, 2006). Standardized testing and parent reports can produce quantifiable data that can be compared between many populations and often provide reliable, valid results with a short time commitment and easy administration. Notable limitations exist with standardized testing as it is often reliant on the child's performance on the testing day, and it may not be representative of the child's typical functioning (e.g., due to health status, tiredness, novel environment), and examiner interpretation (Goodwin & Goodwin, 2016).

Standardized parent reports require the parent or caregiver of the child to complete questionnaires, ratings, or scales regarding their child's language environment/development, which are then calculated and compared to age-based norms. Examples of parental reports include the MacArthur Communicative Development Inventory (MCDI, Version 1; Fenson et al.,

1993), the Ages and Stages (Version 1; Bricker & Squires, 1999), and the Adaptive Behaviour Assessment System (Version 3; Harrison & Oakland, 2003). Limitations exist with parent reports, such as reporting bias and the overly structured format of indirect self-report, which may leave out valuable information (Goodwin & Goodwin, 2016).

Transcription

Transcription involves transcribing audio of a language environment and is often done using transcriber software such as the Computerized Language Analysis (CLAN; MacWhinney, 2000) or the EUDICO Linguistic Annotator (ELAN; Zheng & Peng, 2022). Transcription produces naturalistic rich data, immune to the artificial nature of other methods. However, transcribers are not immune from potential perceptual biases (e.g., variability in how utterance boundaries are defined). Other important limitations exist with transcribing, including the length of time it takes to transcribe, the difficulty of establishing inter-rater agreement, and the variability of environment impacting quality (e.g., location, recording device, and child age; Goodwin & Goodwin, 2016). Other limitations include the likely short length of the recording being transcribed, which is unlikely to capture the whole language environment and all interactions a child encounters in a day and may overestimate the richness of a child's language environment (Tamis-LeMonda et al., 2017). The presence of a recording device may also result in differences in the quantity of language versus when a recording device is not present (Shneidman & Goldin-Meadow, 2012). Bergelson et al. (2019) found further support for the influence of sampling context on participant language. They compared one-hour-long video recordings to day-long audio recordings, finding two to four times higher noun input and a higher frequency of questions and declarations in the former sampling method. They concluded that day-long audio recordings provide a more accurate representation of a typical day in an

infant's life in most cases (there was evidence to support the use of shorter recordings for some circumstances). The audio recording device used by Bergelson et al. is also used in the present study, the Language Environment Analysis Digital Language Processor (LENA DLP; LENA Research Foundation, 2011).

LENA

The current study uses the LENA Digital Language Processor and system, an audio recording device that has enhanced language research methods while also producing more ecologically sound data (LENA DLP; LENA Research Foundation, 2011). The LENA system allows for day-long, naturalistic, unobtrusive data collection accompanied by an automated speech analysis system. The LENA system allows a significant amount of data to be collected with limited resources. The LENA DLP (i.e., portable recording device) was designed to stay with a child throughout their entire day to collect data on the language environment and other sounds they are exposed to in a typical day. The LENA DLP fits in specially designed clothing worn by the child participant during recording times. It is light enough that children quickly habituate to its presence, weighing two ounces, and it can record language environments up to 16 hours in length (i.e., a full day). It is designed to record audio input from a natural language environment to capture spontaneous speech heard by the child on an average or typical day (Xu et al., 2009). Once the recording period is complete, the recording device (hardware) is connected to the LENA computer program (software). Automated estimates of key language environment variables are automatically generated into user-friendly data. The primary quantitative data output produced by LENA and used for this study are estimates of Adult Word

Count (AWC) and Child Vocalization Count (CVC; Xu et al., 2009). Please see Appendix A for a list of definitions of key LENA variables.

Greenwood et al. (2011) set out to replicate the findings of Hart and Risley's (1995) research, which used basic audio recordings to examine naturalistic home environments, with the LENA system (four of the authors in that study work/ed for LENA). The authors found that the amount of talk occurring in a child's home language environment differs significantly from family to family. Most of the adult speech was from females in the home, and hourly patterns of talk occurred on a rhythm associated with regular household routines such as sleep and eating. This project solidified LENA's system as a valid option for examining large quantities of naturalistic language data that might otherwise be missed.

When the LENA system was introduced, it revolutionized how infant language researchers collected data. Researchers can now collect large amounts of electronic data in a more naturalistic manner. More than 10 years have passed since LENA's introduction, and researchers are thinking of ways to advance the use of LENA and the type of information that can be examined from these naturalistic recordings, such as the exploration of IDS. Researchers are developing creative solutions to the limitations of the LENA device and software to gain an in-depth understanding of the speech infants are hearing. Additional information on the strengths and weaknesses of the LENA system are reported in the methods section below.

My research aimed to add to the limited literature currently available using the LENA recording system to identify the amount of maternal IDS present in day-long naturalistic language recordings. Since LENA software is unable to identify different types of adult speech (e.g., IDS versus Adult Directed Speech; ADS) it was used as the first step in this process. The second step involved creating a novel labelling system (ConvoLabel) that allowed human

labellers to manually estimate the percentage of ADS, maternal IDS, and maternal IDS directive/non-directive speech in a young mother sample with infants aged 0-24 months using LENA generated AWC estimates.

Data Repositories

Child language researchers have, for decades, worked in collaboration to share their data (corpora) by forming archives or repositories that can be used for analysis. Large repositories are essential to building, accessing, and testing data collected from around the world. Researchers may contribute and make use of large-scale data to assess the language characteristics in a child's language environment. An early example is Brown's (1973) project collecting child language transcript data which eventually contributed to the Child Language Data Exchange System (CHILDES; MacWhinney, 1992). The CHILDES database is still active and growing today (MacWhinney, 1996). Another example is the HomeBank database (VanDam et al., 2016), containing daylong audio recordings of children's naturalistic language environments. Meaningful cross-linguistic research projects examining how children learn language have come to fruition thanks to HomeBank (e.g., Soderstrom et al., 2021).

Best Practice when Measuring Infant Language Environments

Ultimately, given the limitations of any single approach, a combination of methodological approaches is most likely to yield a comprehensive picture of an infant's language development and environment. As a result, the current study relied on parental self-report (MCDI and a knowledge of infant development measure) and naturalistic language sampling using the LENA technology and the novel computer assisted annotation program created for this study (ConvoLabel) to understand the current research sample as thoroughly as possible given the available methods. I also make a meaningful contribution to the larger

research community by creating the McDivitt Corpus (McDivitt & Soderstrom, 2016), where my sample of young mothers contributes to large-scale cross-corpus research projects (e.g., Soderstrom et al., 2021). As with most scientific theory and discovery, our understanding of early language acquisition has evolved, and conceptualizations and definitions of important constructs have been formulated, revisited, and revised; IDS, the variable of interest for the current project, is no exception.

Infant-Directed Speech

While many researchers have studied IDS, the terminology and content has differed and evolved. One of the first researchers to examine the unique ways people speak to infants was Casagrande (1948), with other researchers exploring similar concepts (e.g., Austerlitz, 1956; Bynon, 1968; Voegelin & Robinett, 1954). Many early studies on speech directed at children included classifications and lists of specific observed words that were shortened or altered into child-friendly formats (e.g., choo-choo for a train). Initial investigations of IDS attempted to define this concept within the linguistic domain, all with a similar aim of identifying relevant characteristics; however, each using unique vocabulary and terminology (a sample of which is provided below). Ferguson (1964) was one of the first researchers to explore this concept cross-culturally. He did this by exploring babytalk's use in six languages: (Syrian) Arabic (Ferguson, 1956), Marathi (Kelkar, 1964), Comanche (Casagrande, 1948), Gilyak (Austerlitz, 1956), (American) English, and Spanish (Ferguson, 1956). He stated that within these cultures, "baby talk" is used to help children engage in babbling, something the children can expand upon later as more advanced language develops. Voegelin and Robinett (1954) used the term "mother language" to describe how adults may adjust their way of speaking for the advantage of children or others struggling to develop the language. Bynon (1968) called attention to the fact that most

previous research on child language development focused on child vocalizations and that more research must be done on the role of adults and their speech. He noted that once a child is born, the language environment shifts in a unique direction and no longer involves adults solely conversing with one another. He used the term "Nursery Language" to explain the unique structures and lexical items used when adults converse with children. Shatz and Gelman (1973) and Dunn and Kendrick (1982) showed that it is not just adults but children too who engage in "baby talk." Also, Lord (1975) found support for mothers modifying their speech based on the linguistic information provided by their infant. Over time, researchers have become increasingly consistent in their terminology, and infant-directed speech (IDS) is frequently used to describe this linguistic phenomenon.

Over seven decades of research has documented the progression of our understanding of IDS. IDS is comprised of a specialized set of properties distinct from speech directed to an adult (Soderstrom, 2007). Several properties of IDS which differentiate it from speech directed at adults include: (a) short utterances; (b) simple vocabulary; (c) exaggerated positive affect; and (d) variable and heightened pitch. While this list is not exhaustive, it highlights critical elements commonly targeted in research. Researchers believe these properties facilitate better language learning. IDS quantity and lexical diversity lead to favourable language outcomes in young children (Rowe, 2012), particularly when part of one-on-one interactions (Ramírez-Esparza et al., 2017). These properties also influence infant engagement, with infants showing a clear preference for IDS compared to ADS in laboratory-based settings (The ManyBabies Consortium, 2020).

Although research has begun to shed light on the role of IDS in language learning, important considerations and challenges regarding research methodology and construct

definition are present. At this time, although many characteristics of IDS have been well established in the research, a gold-standard or operational definition has not been agreed upon and is not consistently used when researching IDS and related constructs. Researchers can place different emphasis on the different aspects of IDS (e.g., speech that sounds like IDS versus speech directed to infants) when defining this variable for their research. Therefore, it is often impossible to compare research or findings from study to study due to inconsistencies or discrepancies in the characteristics or samples of IDS used for each study. Also, there is no threshold to determine when a characteristic of IDS is present or absent. Because a lack of cut-off scores has been determined (and may not be appropriate), the researcher must develop their own criteria for determining when speech is IDS versus other speech types. Studying all characteristics of IDS, qualitative and quantitative, is often unrealistic, so researchers pick and choose the characteristics of IDS they examine. Some researchers have focused on the qualitative, prosodic characteristics present in IDS (e.g., Spinelli et al., 2017), while others have taken a quantitative approach, focusing on all speech directed at a child regardless of prosodic differences (e.g., Weisleder & Fernald, 2013).

For this research project, IDS was deemed any speech from the mother (research participant) directed at the target child (research participant) or another child present during the recording who is approximately under eight years of age. To ensure this definition accurately captures the variable of interest, the speech identified as maternal IDS (speech directed at infants) in the present study was checked for variable and heightened pitch. Maternal IDS also underwent further classification to estimate the amount of directive and non-directive IDS utterances. A computer program called ConvoLabel (described in more detail later) was created to help streamline research assistants task of identifying and quantifying IDS in the present

sample. See Table 1 for the list of IDS characteristics included in this study, their definitions, and the methods and procedures used for examination of the variables. For this study, ADS was deemed as any speech directed at individuals who are approximately eight years of age or older or speech that is not IDS. Eight years of age was chosen as the estimated age cut-off as speech skills are typically well formed by this age (e.g., ability to make all speech sounds, use of grammar rules, comprehensive vocabulary, understanding of social norms related to language use, strong language recognition and expression skills; Amorim et al., 2021; Berk, 2022; Weimer et al., 2021). The current project also examined qualitative components of IDS, including the amount of directive and non-directive IDS present.

Table 1
Infant Directed Speech Definitions

IDS Characteristics	Definition for Present Study	Methods & Procedure of Examination
Quantitative		
Speech Directed at Child	IDS is deemed any speech that is directed at the target child (research participant) or another child present during the recording whom is approximately under eight years of age.	ConvoLabel: Labelers designate the IDS label to any speech from the mother which they judge is directed at children aged eight years of age or younger. The labelers use the available context, recording information, and participant information to judge who the speech is directed to.
Qualitative		
Directive vs. Non-Directive	Directive-IDS is defined as speech from an individual to a child which is a command, recommendation, or request, that communicates to the child that they should act, speak, or focus on something in their environment (McCathren, et al., 1995). Directive-IDS, as defined for this study, includes both directive (e.g., "wave goodbye") and prohibitive (e.g. "don't eat that") utterances, and questions (Kitamura & Burnham, 2003). For the purpose of this research project, all other speech (e.g., comforting, approving, questioning, narrating) should be considered non-directive-IDS.	ConvoLabel: If at least some of the mother's IDS is directed at the target child, the labelers lastly judge the amount of speech that is directive, and the amount of speech that is non-directive.
Pitch	IDS pitch was examined by comparing mother participant IDS (spoken to the target child) to mother participant ADS samples to determine if pitch differences exist and what these differences are.	LENA, ACLEW, and Praat: Clips of maternal speech (IDS and ADS) were run through automated acoustic analysis Python scripts in Praat created by research assistant Sarah MacEwan to analyze pitch (including data preparation and output).

Directive and Non-Directive Infant-Directed Speech

IDS can be further delineated into directive and non-directive forms. No universal definition of these forms currently exists. For this study, directive-IDS is defined as speech from an individual to a child, which is a command, recommendation, or request, that communicates to the child that they should act, speak, or focus on something in their environment (McCathren et al., 1995). Essentially, it is the act of a mother requesting a baby do what is directed (Kitamura & Lam, 2009). Directive-IDS includes both directive (e.g., "wave goodbye") and prohibitive (e.g., "do not eat that") utterances as well as directive questions (e.g., “Can you please clean up your toys?”; Kitamura & Burnham, 2003). For this research project, all other speech (e.g., comforting, approving, questioning, narrating) was considered non-directive-IDS. Non-directive IDS is hypothesized to be more beneficial to language learning since it is thought to elicit language and exchanges from children, resulting in increased child responsiveness (McDonald & Pien, 1982; Pratt et al., 1992) The non-directive speech type is correlated with advanced child language development when used by adolescent and adult mother populations (Lacroix et al., 2002). Directive and non-directive speech are important components within IDS because the frequency of directive versus non-directive speech changes as an infant grows; younger infants hear more non-directive speech, and older infants (this peaks around nine months of age) hear more directive speech (Kitamura & Burnham, 2003). Therefore, a mother's communicative intent may be influenced by the developmental stage of their infant (Kitamura & Burnham, 2003). In the present study, I categorized IDS as either directive or non-directive to further understand the speech young mothers are providing for their infants.

Important Considerations Regarding Infant-Directed Speech

Measuring Infant-Directed Speech.

Data provided by LENA recordings must go through an extensive transcription or IDS labelling process to identify and assess IDS. In 2013, Weisleder and Fernald took five-minute speech chunks from LENA recording data and manually estimated whether the speech chunk was speech directed to the child (i.e., IDS; aged 19- or 24- months of age) or speech directed to an adult (i.e., ADS). This research study found that more IDS was correlated with children becoming more effective at processing familiar words and resulted in children having superior expressive vocabularies at 24 months of age. They also found that the child's increased ability to process words positively correlated with language growth. Then, in 2014, Ramírez-Esparza et al. examined the relationship between language development and language input. They took 30-second speech chunks from LENA recording data and manually estimated whether the speech chunk contained IDS (infants aged 11-, 14-, and 33- months of age) or "standard speech" (i.e., ADS) depending on speech register, in two different settings (one-on-one and group social interactions). They found that overall speech quantity was not significantly related to language development, but IDS in the one-on-one social context was significantly related to language development. The authors also found that IDS was related to more advanced vocabulary output, and SES was positively related to IDS in the one-on-one social setting. Ramirez-Esparza et al. (2017) used the same methodology and found that both monolingual and bilingual (Spanish-English bicultural) infants exposed to more IDS produced more speech utterances and total productive vocabularies when 24-months of age. Interestingly, the bilingual infants were shown to benefit from non-one-on-one (group) and one-on-one ADS input in addition to the IDS input, indicating a distinctive and sophisticated language learning path is present for the bilingual-

bicultural infants compared to monolingual infants. In 2019, Bergelson et al. examined the IDS of children born in four North American cities by annotating (ADS versus IDS registers based on how the speech sounded) utterances from day-long naturalistic recordings heard by children 3-20 months of age[1]. They found that children with mothers categorized as higher educated heard more IDS than children with mothers categorized as lower educated. They also found that children heard less ADS as child age increased (IDS stayed constant). The type of speech input children are exposed to is likely impacted by child age; the current project will explore the amount of maternal IDS infants in the young mother sample are hearing, including directive and non-directive IDS in relation to child age. Weisleder and Fernald (2013) examined the speech directed to children, while Ramírez-Esparza et al. (2017) and Bergelson et al. (2019) examined the speech register. The four research studies that examined IDS using the LENA system show that IDS can be defined and explored by focusing exclusively on the quantitative or qualitative characteristics. Researchers have begun to explore new ways to measure IDS and the presence of IDS in novel populations and sub-populations.

The Cross-Linguistic Nature of Infant-Directed Speech.

Efforts to naturally explore infants' and young children's language experiences in various populations have been made. Recent research on infant language development emphasizes the importance of comprehensive (cross-cultural) and distinct (culturally specific) samples to expand our understanding of how children learn language from a global perspective. Cross-cultural research on IDS highlights its relevance in populations around the world. IDS characteristics have been found by language researchers in many languages, including but not limited to:

[1] There is overlap between the samples used in Bergelson et al.'s (2019) study and my project, as a sub-group of their sample was from the McDivitt Corpus. The research questions and methods are not similar.

American English (Fernald et al., 1989; Morikawa et al., 1988; Newman, 2003), Canadian English (Pegg et al., 1992), Australian English (Kitamura et al., 2001), British English (Fernald et al., 1989; Shute & Wheldall, 2001), French (Fernald et al., 1989), Italian (Fernald et al., 1989), German (Fernald & Simon, 1984; Fernald et al., 1989; Papoušek et al., 1987), Japanese (Fernald & Morikawa, 1993; Fernald et al., 1989; Morikawa et al., 1988; Niwano & Sugai, 2002), Mandarin Chinese (Grieser & Kuhl, 1988), Thai (Kitamura et al., 2001), Bantu Swahili (Broesch & Bryant, 2015), Spanish (Blount & Padgug, 1976), Hebrew (Zeidner, 1983) Luo (Blount, 1972), Lebanese (Farran et al., 2016), Fijian (Broesch & Bryant, 2015), Norwegian (Englund & Behne, 2006), and sign languages (Masataka, 1992; Reilly & Bellugi, 1996). An infant's preference for IDS has also been found in a variety of cultures (Cooper & Aslin, 1990; Dunst et al., 2012; Fernald, 1985; Hayashi et al., 2001; Kitamura & Lam, 2009; Newman & Hussain, 2006; Pegg et al., 1992; Santesso et al., 2007; Singh et al., 2002; The ManyBabies Consortium, 2020; Werker & McLeod, 1989).

Despite the robust research mentioned above, populations and languages may differ in the characteristics or how intense the characteristics of IDS are (e.g., Floccia et al., 2016). North American IDS has exhibited strong, more identifiable IDS characteristics (Fernald et al., 1989). Differences in IDS characteristics present in language/populations will limit the comparison of results between languages/populations; it is unknown how accurately IDS from different languages can be reliably and validly compared.

One should be cautious of applying measurement, research tools, and findings from one population to another and making conclusions based on findings that are not sensitive to population or cultural differences. Although IDS characteristics have been found in numerous languages and cultures, researchers are not always looking at the same IDS characteristics

(usually, one or two characteristics, such as pitch or utterance length, are selected to differentiate IDS from other language types). Some argue that cross-linguistic and cross-cultural phenomena should not be directly equated, or extreme caution is needed when comparing them (Casillas & Cristia, 2019). It is also undoubtedly justifiable, and in many cases advantageous, to focus on one population in isolation without making direct comparisons to another. When researching understudied populations or cultures, one must view the individual as rooted in context and not separate from it to understand and acknowledge individual variation (Sperry et al., 2020). The main disadvantage to focusing on specific populations when researching IDS is that it conflicts with two driving principles of developmental scientists, generalizability and universality. Therefore, it depends on the goals of the researcher and population when deciding on a cross-cultural versus culturally-specific focus. Instead of viewing these two approaches to language research, cross-cultural and culturally specific, as in conflict, we should view them as complementary approaches necessary to advancing the field.

Aside from known variation in IDS characteristics across cultures, there is also variation in how much (if any) IDS children hear across cultures (e.g., Casillas et al., 2020; Casillas et al., 2021; Cristia et al., 2019). Although many researchers view IDS as the gold standard speech type on the path to language acquisition, children from cultures and communities where IDS is not the predominant form of language heard still develop language efficaciously (Brown & Casillas, 2020; Brown & Gaskins, 2014; Casillas et al., 2020). The extent to which speech not directed to infants is aiding in language acquisition and the extent to which infants are able to learn from other speech types, particularly for infants under 2 years of age is still up for debate (e.g., Foushee et al., 2016; Ma et al., 2011).

Although research and understanding of IDS are growing cross-culturally, it is nowhere near representing most of humankind (Henrich et al., 2010). Our ways of asking research questions, carrying out research projects, and interpreting and disseminating findings are confined to perspectives aligning with often English-speaking developed populations (Bennis & Medin, 2010; Majid & Levinson, 2010). This practice is problematic when one applies these concepts to populations that have not been adequately studied. It is problematic because failing to take population differences into account may lead us to interpret population variability as a deficit, and it could result in misinformed treatment and policy formation if applied to different cultures or populations (unknowingly pushing them to conform to dominant practices and lose their unique cultural language diversity and strength). For example, when Hart and Risley (1995) examined the language environments of children from different SES strata, the lowest SES group comprised Black children, and the highest SES group comprised primarily White children. The findings from their study were then disseminated widely (e.g., in the New York Times, Washington Post, Too Small to Fail White House Initiative; Kuchirko, 2019; Shankar, 2014), and the potential role of ethnicity or cultural variation in their findings was lost. Thus, their project lacked a focus on language environment variation that may be related to ethnicity and may be functional for each population. If Hart and Risley (1995) had more explicitly examined the ethnicities of the participants or focused on other aspects of the language environment, their findings and the dissemination of their biggest claim might have looked very different.

One must also try to distinguish between theoretical and clinical/intervention research contextually. Researchers should clearly distinguish whether they publish scholarly thoughts or findings to indicate intervention or natural variation. The work of Hart and Risley and the 30 – Million Word Gap exemplifies the impact of applying narrow conclusions to broad contexts.

Their research study has had a significant impact on the research world and the public world and may have led to interventions that were inappropriate for certain populations that were not well represented in their study (i.e., low SES families, families from understudied ethnicities). Interventions targeting low-income children (e.g., Avineri et al., 2015) and children from understudied populations (e.g., Weber et al., 2017) must be critically considered in terms of appropriateness (i.e., fit).

Important Considerations Regarding Infant Language Development

Important considerations about conceptualizing and researching infant language learning have been raised. The primary considerations discussed below include the universal phenomenon of functional human variation, the importance of Indigenous representation in the current study sample, and how broadening our methods and perspectives can help define and measure infant language. Thematically, these considerations represent current topics language researchers are critically examining to prioritize the understanding of diversity in language learning without forgoing the importance of patterns, themes, and universality where appropriate.

Universal Functional Human Variation

According to Kline et al. (2018) culture is a universal phenomenon that creates variation amongst human beings and this diversity creates dialectical conflicts with researchers' desire to find universal psychological principles. There are efforts to re-think our priorities (away from one-size-fits-all) to instead focus on humans' developmental flexibility and functional developmental variations, which more accurately represents our sophisticated adaptability, diversity, and evolution. Developmental flexibility (a human's ability to develop based on their surroundings) and human variation are hard-wired into our biology. Variation is an unavoidable, advantageous part of the developmental process, something that can differ substantially due to

innumerable variables playing a role. The goal of research should be to understand an environment's role in affecting development; genes require environmental and cultural influences, and they evolve together.

Once we treat environment, culture, and biology as interconnected, we are free from the black-and-white thinking patterns that have plagued past research. Instead, we can ask how these variables influence the development of traits within a given population, allowing researchers to build complex but necessary road maps of developmental processes instead of remaining too broad in their thinking. A critical stance is that developmental processes lead to a range of adaptive, healthy, practical results (Kline et al., 2018). As researchers, we must use culturally and environmentally appropriate research methods to accurately define and assess this necessary and functional universal human variation.

Indigenous Representation

In the present study, I examined IDS spoken by young mothers in the Canadian-English speaking city of Winnipeg. My population of young mothers had a relatively high representation from Indigenous backgrounds, who may have unique cultural circumstances. The term Indigenous is used in this document to refer to peoples who may identify as Aboriginal, First Nations (North American Indian), Inuit, or Métis, and/or identify as a Treaty Indian or Registered Indian; specificity will be provided where available. Manitoba Indigenous peoples are primarily from the Cree (mid-north and north Manitoba), Dakota (southwest Manitoba), Dene (far northwest Manitoba), Ojibway (south Manitoba), and Oji-Cree (mid northeast Manitoba) First Nations, and the Métis nation (MacKinnon, 2005). Individual cultural and historical considerations must be explored to better understand the sample and the impact these circumstances may have had on the mother-infant dyads in my study.

Winnipeg has the largest proportion of urban Indigenous people and Indigenous women in Canada (Statistics Canada, 2011). Winnipeg is home to 26% of status Indians residing in Manitoba (reported as the census metropolitan area of Winnipeg) and 52% of the Métis people residing in Manitoba (reported as the economic region of Winnipeg; Manitoba Government, 2012). The following Statistics Canada data centres on the Aboriginal identity population. They define Aboriginal identity as peoples who report identifying with one or more Aboriginal groups, including First Nations (North American Indian), Inuit, or Métis, and/or identify as a Treaty Indian or Registered Indian (Statistics Canada, 2011).

Indigenous women make up 10% of the total female population in Winnipeg; in 2006, 35,905 Indigenous women were living in Winnipeg (Statistics Canada, 2011). Indigenous women are overrepresented in the young mother population in Manitoba (Statistics Canada, 2011). Within Manitoba, rates of adolescent parenting amongst the Indigenous population of women are 125 per 1,000 (Statistics Canada, 2011). Manitoba has the country's highest number of young Indigenous women and the greatest number of adolescent mothers (Statistics Canada, 2011).

Young Indigenous mothers in Canada may conceptualize language development and language environments differently than those represented in most research literature cited previously. For example, within Indigenous cultures, language is often a gathering and dissemination tool to pass history and cultural practices on from generation to generation (Assembly of First Nations, 2022). Also, Indigenous Canadian children often take on the listener and observer role, which is perceived as a display of respect to adults (Ball & Lewis, 2005).

Within Manitoba, Indigenous peoples reported English as the most common language used and understood (75%), followed by Cree (11%), Ojibway (5%), and French (5%; Manitoba

Government, 2012). Indigenous peoples of Manitoba typically speak English within the home environment, with 86% reporting English as the sole language spoken at home (Manitoba Government, 2012). Indigenous people are more likely to speak their native language if residing on a reserve or in Northern Canada (Statistics Canada, 2011). Information on the proportion of Indigenous children living in unilingual or bilingual households in Winnipeg is not readily available.

Within North American IDS, further cultural variation likely exists. The literature on Canadian Indigenous language acquisition and the importance of IDS has been limited, with the only previous research for this literature review conducted through the University of Manitoba. Jonk (2009) completed her Master's thesis on Indigenous mother's views on language acquisition, comparing a group of Indigenous mothers in La Brochet, Manitoba, with a sample of non-Indigenous mothers from Winnipeg, Manitoba. Thirty mothers were recruited from each population and administered a survey. Jonk found that Indigenous mothers viewed the role of the grandparent as central in their child's upbringing, favoured the use of instructions during moments of teaching, used language facilitation techniques more, considered spirituality a vital component of language learning, and viewed "baby talk" as more beneficial for language acquisition when compared with the urban non-Indigenous sample. She also found that the Indigenous mother sample considered preserving their native language vital. She concluded that education and language providers might be able to apply Western techniques when aiding language acquisition in an Indigenous population, yet they must be aware that dual-language acquisition is likely occurring in the homes. She argued that support for native language acquisition should be offered as a child develops. While these findings may help us understand the unique perspectives and circumstances of Indigenous Manitobans, it is essential to note that

our samples differ, with the current study comprised of a largely Indigenous urban sample and households that report their primary language as English who may have different perspectives from those studied by Jonk.

Indigenous peoples in Canada have cultural histories that may impact various factors, including parenting and language. The colonization of European settlers in the seventeenth century (Boksa et al., 2015), the eradication of the political independence brought forth by the Indian Act in 1876 (Boksa et al., 2015), and the implementation of Indian Residential Schools on the First Nations peoples from 1880-1996 (Royal Commission on Aboriginal Peoples, 1996), exemplify such historical events. The historical treatment of Indigenous peoples in Canada impacted and continues to impact Indigenous people (Brave Heart & DeBruyn, 1998). For example, the assimilation attempts on First Nations people through the Indian Residential Schools resulted in individual and community-wide distress (Bombay et al., 2014). The children who attended residential schools were exposed to prolonged physical, mental, and sexual abuse and neglect (Royal Commission on Aboriginal Peoples, 1996) and many died (Smith, 2015; Tasker, 2015). Indian Residential School survivors are at an increased risk for physical and mental health difficulties compared to First Nations peoples who did not have this experience (First Nations Centre, 2005). It has been found that children of Indian Residential School survivors' well-being were also impacted (Bombay et al., 2014). Children whose parents are Indian Residential School survivors are at an increased risk for learning difficulties at school, lower school success, and are more likely to have to repeat a year of school (Bougie & Sene'cal, 2010). Furthermore, the children who attended Indian Residential Schools could not remain at home with positive parental role models (Evans-Campbell, 2008). Due to the historical differences between many Indigenous peoples when compared to non-Indigenous peoples in

Canada (Brave Heart & DeBruyn, 1998), these populations should not be treated as homogeneous in research, including the current study. I must be sensitive to the possibility that the history of Canadian Indigenous people likely plays a role in the information collected in the present study, and I aimed to interpret the findings in a sensitive, considerate manner.

Indigenous culture and language were repressed under colonization. The course of Indigenous people was disrupted, which has prevented many Indigenous people from living in alignment with their historical, cultural practices and traditional way of life. Some Indigenous cultures and languages have been lost permanently. Before colonization, Indigenous people were thriving; there were unique nations, populations estimated within the millions, and great diversity amongst Indigenous people (Dobyns, 1966; Waldram et al., 2006). There were an estimated 50-60 Indigenous languages of great diversity and complexity in the 1400s (Waldram et al., 2006). Statistics Canada (2017) reports the following information on Indigenous Language in Manitoba:

Indigenous Language Groups in Manitoba:

- First Nations: Cree, Ojibway, Dakota, Oji-Cree, Dene, and Swampy Cree
    - 24% of First Nations people report an Indigenous language as their first language, while 30% can have a conversation in an Indigenous language
- Metis: Michif, French, English Cree, Ojibway, Bungee, and others
    - <1% of Metis people report an Indigenous language as their first language
- Inuit: Inuktitut, Inuinnaqtun, and Inuvialuktun
    - 12.3% report an Indigenous Language as their first language, and 14.8% can have a conversation in an Indigenous Language

By narrowing my sample to include only English-speaking young mothers, I likely missed out on the rich languages of Indigenous people. Science is and should continue to move in the direction

of documenting, researching, and reflecting the linguistic diversity of all people. Although not the focus of the present study, efforts are being made to document and revive Indigenous languages and culture (Waldram et al., 2006).

Indigenous young mothers were a part of my sample because they mirror the population of young mothers living in Winnipeg. I hoped to explore the language practices of young mothers through a lens of curiosity and to describe instead of through categorization or an attempt to determine or assume "best practices." Winnipeg is a diverse city with strong Indigenous representation. The young mothers in the present sample had unique characteristics concerning cultural status. These mothers were also experiencing motherhood while navigating significant developmental changes in adolescence and emerging adulthood and were a vital part of the population researched for the current project.

Emergent Ideas Regarding Language Input

Two dominant conceptualizations of language input are often debated. The two sides of the debate often refer to the 30-Million Word Gap findings of Hart and Risley (1995) discussed earlier. Hart and Risley concluded that in the first four years of life, low SES children hear 30 million fewer words when compared with high SES children. Their methodological choices, claims, and dissemination strategies are now highly debated and critiqued (e.g., Sperry et al., 2019). The research study now serves as a foundation or launching point for a contemporary discussion on the best practice of defining and measuring infant language input.

One dominant definition of infant language input (based on current research precedence) focuses on language directed from the primary caregiver to the child in one-on-one interactions as comprising the language environment (e.g., Golinkoff et al., 2018; Hart & Risley, 1995). The other dominant definition describes a language environment as broad, comprehensive, and

inclusive, focusing on all language input within an infant's environment as capable of contributing to language learning (Sperry et al., 2019). This stance highlights the lack of prior research adequately accounting for cross-cultural differences. The latter group advocates for an in-depth examination of how language is utilized in unique, culturally diverse populations where children may be learning language (in ways not previously understood or adequately researched). An example of this being the measurable way bilingual (Spanish-English bicultural) infants but not monolingual (English) infants learned language from group settings in Ramirez-Esparza et al.'s study mentioned earlier (2017). Although the two groups conceptualize an ideal language environment differently, they also have different perspectives on historical language research and ideal research methodology practices. The first group, in support of the 30-Million Word Gap, views historical language research as the building blocks needed to ultimately conclude that the ideal form of language input has been found. The second group views historical language research as informative but narrow due to the overrepresentation of certain populations. The two different stances on conceptualizing a child's language experience have brought to the forefront the need to examine research practices with a critical lens.

Although research design and methodology have come a long way to aid the understanding of infant language environments, they often lack representation, statistical power, and large enough sample sizes (Purpura, 2019). This pitfall limits the generalizability of the relationship between language environment, language input, and other contributing factors (e.g., SES, culture; Hoff & Tian, 2005). Researchers up to this point must caution against making "blanket statements" regarding child language environments/development, which may be unintentionally detrimental to populations (Purpura, 2019, p. 1844). However, ignoring language variability or language gaps would be equally detrimental (Golinkoff et al., 2018). Therefore,

there may be a middle ground in this debate, with a focus on clear definitions, ambitious study designs, and the examination of population variability as a necessity. We must explore the language environments of various populations (e.g., different cultures and SES) in much greater detail without looking to fit under-researched populations into an assumptive mould (Purpura, 2019; Sperry et al., 2019).

Another important consideration is the ethical implications of overgeneralizing findings or applying methodological approaches and interventions to understudied populations. There must be caution against theoretical emphasis and clinical intervention driven by a one-size-fits-all approach to infant language learning because language researchers can potentially disrupt the cultural and language ecology of understudied populations (Ochs & Kremer-Sadl, 2020). It is important to emphasize that children from various populations and cultures grow up to be functioning, contributing members of their society, regardless of differences in the type, quantity, and quality, of early language exposure. Those in support of the 30 – Million Word Gap perspective may ignore the cycles of poverty and social inequality and the impact these factors have on children's language development instead oversimplifying maternal input as the cause (Ochs & Kremer-Sadl, 2020). We must be cautious against viewing infants and their mothers from non-mainstream, ‘different’ or ‘other’ populations as needing ‘saving’ by ‘humanitarian’ scientists who wish to impose their understanding of necessary components of language learning (Ochs & Kremer-Sadl, 2020). Too much weight is given to the child’s ability to *display* language knowledge as the prominent language development measure, which may not be the best form of measurement in many populations (Ochs & Kremer-Sadl, 2020). Researchers must seek knowledge and expertise from populations instead of viewing populations as needing help. Scholars from various disciplines, including cultural psychology, education, anthropology,

sociology, and sociolinguistics, have shared that they see the 30-Million Word Gap as detrimental by devaluing, delegitimizing, and misrecognizing the unique language, childcare, culture, and family system of understudied populations in order to "blame the victim" and promote the agenda of the "dominant group" (Avineri et al., 2015; Bourdieu, 1991; Dudley-Marling & Lucas, 2009; Johnson & Johnson, 2015; Miller & Sperry, 2012; Sperry et al., 2020).

Another important distinction in language research is the difference between quantity and quality of speech. When language researchers refer to the quantity of speech, they are typically referring to quantifiable measures of language, such as the amount of adult words spoken to a child. When language researchers refer to the quality of speech, they are typically referring to more qualitative aspects of speech, such as the acoustic or affective properties of speech or linguistic characteristics, such as the diversity of vocabulary (Golinkoff et al., 2015). However, these definitions become blurred when language researchers take the more qualitative aspects of speech and quantify them (e.g., counting the frequency of IDS). This concept is further complicated by the typical reference of psychologists to qualitative *methods* (compared to quantitative methods), meaning open-ended non-numerical data collection and analysis. Sperry et al. (2020) note that scholars interested in child development and culture are moving toward combining qualitative and quantitative methods, the result being a mixed-method approach (e.g., Weisner, 2005; Yoshikawa et al., 2008). I focused on quantitative methods only for the current project.

The emergent ideas discussed above on how to define, measure, and understand infant language helped guide my current project and infant language research moving forward. We are responsible for staying up to date and formally discussing the complexities of designing, carrying out, and disseminating findings on language development (and how IDS is defined and measured

more generally and study-specific). Accomplishing this involves being mindful of and applying these principles at each stage of a research project; from (a) study design (e.g., who is involved in designing the study, how much knowledge do they have on the population of interest, what do we know about the appropriateness of our methodology and measuring tools for this specific population, what consultation with the population has taken place?), to (b) the study implementation (e.g., how are we monitoring the appropriateness of our methods while the study takes place, what protocol is in place when the need to modify study design based off information collected or response to the study design are identified?), to (c) the study writing process and final document and dissemination (e.g., what are the limitations of the study, how can we avoid making overgeneralizations or bold claims and conclusions based on our study, what role do we have in ensuring others do not make such claims or conclusions based on our study, how does the population of study differ from other populations studied, how may our findings impact the population of study, what variables were not researched which may also impact or more adequately recognize the abilities and strengths of the population of study, how does one use a strength-based reporting stance while also communicating important findings which may be helpful to the population studied?).

The research and measurement methodologies of infant language development have predictably become more sophisticated over time. IDS has emerged as a variable of great interest within infant language learning. How children learn language, the input from caregivers, and the variables which impact a caregiver's input, represent complex phenomena. Researchers are becoming increasingly more aware of the need to apply multi-method, tailored, and targeted approaches when exploring these phenomena.

Chapter 3 – Maternal Characteristics

People who become mothers through birthing or raising children embark on a life phase unlike any other. Women may enter motherhood at different developmental stages, including adolescence, emerging adulthood, or adulthood. In Manitoba specifically, birth rates are 64 per 1,000 adolescent women and 190 per 1,000 emerging adulthood women (Manitoba Health, 2017). Women who enter motherhood during adolescence or emerging adulthood face a dual developmental circumstance: transitioning to adulthood and entering motherhood concurrently.

The present study focused on young mothers within the adolescent and emerging adulthood stages of development, as they are seen as similar stages involving identity exploration, brain development, and increased independence (Lewin et al., 2013). Adolescence includes mothers 18 years of age and under, and emerging adulthood includes mothers aged 19 – 25. Much of the research on young mothers has focused on adolescent mothers (although definitions of this age group vary dramatically, e.g., Gibbs & Forste, 2014; Hawkes & Joshi, 2012), with a small, notable, and growing focus on the emerging adulthood stage of development (e.g., Addo et al., 2016; Aitken et al., 2016).

The stage of development known as adolescence was first discussed in the literature over 100 years ago (Hall, 1916) while the term emerging adulthood was introduced much more recently (Arnett, 2000). There are many similarities between the two developmental stages, including biological (growth, maturation), social (academic and work performance, peer relationship, separation from parents), and psychological (brain development, cognitive abilities, identity exploration, moral and value exploration, emphasis on self-focus) development (Story & Stang, 2005; Tanner & Arnett, 2016). Both stages represent a feeling of in-between (for adolescence, of not being a child but not yet an adult, and for emerging adulthood, of not being

an adolescent but not altogether an adult; Arnett, 2004). Adolescence and emerging adulthood are not, however, interchangeable. Adolescence is a stage of childhood while emerging adulthood is conceptualized as a stage of adulthood. Adolescents living in Canada are typically attending secondary school, while emerging adults may be finishing secondary school, working, unemployed, and/or completing post-secondary education. Maternal education is an important variable to consider when working with a young mother population that includes adolescent and emerging adulthood mothers' the youngest mothers are likely to have less education due solely to their age and corresponding school level. Also, any physiological changes to the body or mind would be more advanced in emerging adulthood than in adolescence.

The characteristics that make up these two stages are impacted by the societal, economic, and social climates the individual lives within (Arnett, 2000, 2011). Also, chronological age is not the only method to index age (e.g., biological age, cognitive age, and psychological age; Bornstein et al., 2006). The cross-cultural generalizability of the characteristics comprising each stage (adolescence and emerging adulthood) is limited due to the current focus on industrialized populations when defining these stages. Individuals within these two age categorizations from different populations or cultures may have different norms, societal structures, and activities of focus such as work responsibilities at a young age or the inability to attend school (Arnett, 2011). Neither developmental stage is universally accepted, in fact, some cultures, such as the Navajo Indigenous people of the United States, do not find labelling life stages necessary at all, but both are used widely for theoretical, clinical, and practical purposes (Arnett, 2011; Chen et al., 2006; Schlegel & Barry, 1991). Maternal chronological age at study enrollment was used for the purpose of this study as is commonly practiced when researching this population (e.g., Erfina et al., 2019).

Historically, research on maternal age and motherhood have conceptualized young mothers as an at-risk population (e.g., Brooks-Gunn & Chase-Lansdale, 1995; Coley & Chase-Lansdale, 1998; Culp et al., 1998; Moore & Waite, 1977). It cannot be denied that adolescent and emerging adulthood developmental periods are stages of significant physical and psychological transition and present unique life stressors (Arnett, 2011; Bunting & McAuley, 2004; Gilmore et al., 2006; Owen-Jones et al., 2013). Research also finds that becoming a mother at a young age can affect a child's learning opportunities and how the mother interacts with the child (e.g., Burgess, 2005; Giardino et al., 2008; Lewin et al., 2013; Westerlund & Lagerberg, 2008). More recent longitudinal studies on young motherhood have focused on the external environmental circumstances and their impact on this population (e.g., health inequalities, social resources; Morinis et al., 2013; Patel & Sen, 2012; Shaw et al., 2006). An integrative review of the literature points to populations of young mothers studied often being confounded with other variables such as SES and access to healthcare (Erfina et al., 2019). Ultimately, research is beginning to highlight the importance of exploring the maternal age variable *and* individual parental/child characteristics to avoid overgeneralizations about young motherhood and a deficit-based lens (Bornstein et al., 2006).

Bornstein et al. (2006) examined the role of maternal age on parenting practices (including social interactions, physical encouragement, nurturing, conversational exchange, and speech) while controlling for mediating variables related to the mother (e.g., education and employment) and child (e.g., infant age was set to 5 months). They found that some parenting practices shifted for those first-time mothers who were 27 years of age and older (up to 42). The older mothers used language that was more frequent and of longer duration, and they were more sensitive to their child's needs. Other parenting practices did not shift in relation to mother age

such as nurturing behaviour including meeting the child's physical needs, and social practices including engaging in one-on-one interactions with their baby with emotionally positive characteristics. Further research is needed to better understand characteristics related to young motherhood which may impact parenting behaviour and infant language learning, such as exploring their knowledge of infant development, and a more in-dept look at the type of language used (e.g., is the one-on-one language interactions with positive affect best described as IDS?).

Research on parenting norms and expectations and what comprises optimal parenting practices is currently viewed through a narrow perspective (Coll & Pachter, 2002; Fulco et al., 2020). Less is known about these factors in more understudied populations and cultures. Population and cultural differences likely exist regarding parenting practices and ideal maternal traits and characteristics. For this reason, one should be cautious about drawing concrete conclusions when researching new young mother populations and intervening in parenting practices that differ from one's own, even when functioning through an expert lens.

Young mothers who do not identify with the dominant culture or ethnicity may experience systemic risks and disadvantages (Fulco et al., 2020). It is unethical and unproductive to place blame on the individual for systemic barriers beyond one's control. Removing blame from the individual, considering the role of society, and focusing on applied solutions are necessary and the only way forward. Also, maternal age, parenting, and child outcomes are linked to "pre-existing circumstances" and experiences (p. 1539, Fulco et al., 2020). Many factors impact a mother's ability to enrich her child's functioning, and many were in place before the woman entered motherhood (e.g., the mother's developmental timeline and skillset, trauma, family dynamics, and attachment; Kearney & Levine, 2007). Therefore, researchers must not

discount the impact of such pre-existing variables when researching populations. Researchers need to be aware of the inter-generational impact of parenting on child development and future parenting applications (e.g., Lomanowska et al., 2017).

The maternal characteristics included in the present study design included maternal age, maternal age status (adolescent or emerging adulthood), ethnicity, education, household structure, and a measure of their knowledge of infant development. Given the complex interrelationship of variables affecting young motherhood and their parenting described above, great consideration was given regarding the description of this central Canadian sample of mother-infant dyads.

Maternal Characteristics and Infant Development Knowledge

Research historically supports the finding that young mothers are less knowledgeable in terms of infant development and parenting practices. Specifically, samples of young mothers have been described as less aware of appropriate parent-child roles (Culp et al., 1998), display underdeveloped parenting knowledge (Burgess, 2005), and have unrealistic expectations of their children based on their developmental capacity (Brooks-Gunn & Chase-Lansdale, 1995; Field, et al., 1980; Zuckerman et al., 1979), when compared with adult mothers. The young mother population is different today than it was decades ago when much of the research on this population was completed (e.g., Culp et al., 1996; Luster & Dubow, 1990). For example, teenage pregnancies continue to drop in Manitoba (Manitoba Centre for Health Policy, 2022) and targeted interventions of different modalities, such as web-based are being utilized (Wu et al., 2021). However, there is a lack of contemporary research on this area limiting one's ability to make meaningful interpretations regarding the link between becoming a mother at a young age and infant development knowledge. It is possible that older mothers have more general

knowledge or experience with children, or for mothers with older infants of their own to have gained more knowledge due to first-hand experience (Huang et al., 2005). I explored the relationship between knowledge of infant development and maternal age in my sample of young mothers and how this may be impacting the language environments of infants in my sample. I also explored whether the age of the child participating in the study impacts the mother's knowledge of infant development.

Maternal Characteristics and Infant Cognitive Development

An infant's environment is a major contributor to cognitive development and future capabilities (Duncan et al., 2007). Certain factors, such as maternal-child interactions, play a crucial role in enriching a child's mind (and the likelihood of an infant reaching their full cognitive, including language, potential- something that the individual best evaluates in adulthood; Golinkoff et al., 2018; Lemelin et al., 2006). How an infant's language develops depends on the factors within their immediate, proximal environment. How a mother converses with her infant (conversational turns between mother and child) results in neural language processing critical for language formation (at least amongst English speakers living in a North American city; Romeo et al., 2018).

Research on maternal age and the relationship with child development outcomes is limited. Generally, as maternal age increases, favourable parenting practices and child development outcomes also increase (Fulco et al., 2020). However, outcomes for mother and child peak around the maternal age of 30 (Bornstein et al., 2006; Fulco et al., 2020). In contrast, children of adolescent mothers receive lower scores on well-established measures of infant cognitive development compared to older mothers (Fagan & Lee, 2013; Lemelin et al., 2006; Miller et al., 1996; Ryan-Krause et al., 2009; Spieker et al., 1997). Children of emerging

adulthood mothers also score significantly lower on cognitive assessments than children of older mothers (Pomerleau et al., 2003).

Many risk factors associated with being a mother at a young age are also associated with poor infant development outcomes (e.g., mental health problems, low SES, lower educational achievement; Boden et al., 2008). Less is known about the protective factors or strength-based interventions (e.g., supportive family members, support groups, mental health support, school accommodations) that may be capable of improving or safeguarding young motherhood circumstances and subsequent infant development outcomes. Despite knowledge of risk, many protective factors or strength-based interventions available to new mothers do not target young mothers and fail to address maternal age in their demographic information or statistical analyses (e.g., Ramírez et al., 2020). Until adequate societal support and intervention (focused on the unique needs of the young mother population) are available, we should be cautious in making conclusions or comparisons between young and older mothers. Young mothers are at a societal disadvantage regarding available support due to the lack of targeted services available to them, simply for entering motherhood during the adolescence and emerging adulthood developmental stages.

Maternal Age and Infant Language Development

Available information on maternal age and infant language development follows the trend described above regarding general cognitive development. On language measures specifically, infants of young mothers are at risk for poor outcomes. Infants of adolescent mothers historically score lower on measures of expressive language, language comprehension, and vocabulary (Barratt & Roach, 1995; Culp et al., 1996; Keown et al., 2001; Luster & Dubow, 1990; Luster & Vandenbelt, 1999; Oxford & Speiker, 2006). No research is readily available on

the relationship between emerging adulthood mothers and infant language development, although, since language is a component of overall cognitive development (Madaschi et al., 2016; Sharkins et al., 2017; Siegel, 1981), one can predict a similar pattern to infants born of adolescent mothers on such measures. I explored the relationship between infant language development and maternal age in my sample of young mothers and how this may be impacted by the mother's general knowledge of infant development.

Living Arrangements of Young Mothers

Young mothers and their infants are more likely to live in intergenerational homes (Pilkauskas & Cross, 2018). Young mothers who live with their parents are more likely to succeed in their education and employment goals (Gordon et al., 2004; Hao & Brinton, 1997; Unger & Cooley, 1992). However, young mothers' parenting skills may be negatively impacted if the grandparents take over most of the parenting duties for their grandchildren (Gordon et al., 2004; Pittman & Boswell, 2008). More recent research supports the finding that family and social support, along with the development of a positive maternal identity, positively influence a young mother's transition to motherhood (Erfina et al., 2019). Intergenerational family systems have been shown to have positive impacts on a child's cognitive development (Mollborn, Fomby, & Dennis, 2011). Children of young mothers who live in intergenerational homes are more likely to develop similarly compared to their peers from other family structures (DeLeire & Kalil, 2002). Research is starting to shed light on the role of multiple caregivers and how this is related to infant language input. Homes with multiple caregivers (including intergenerational homes) produce more IDS (Sperry et al., 2019). I explored the role of the number of adults living in the household with the young mother, its relationship with mother's use of IDS, infant language development, and maternal knowledge of infant development.

The characteristics described above provide evidence for exploring the young mother population in isolation. Although previous research points to the young mother population as being destined to face increased difficulty and shortcomings, I argue that there is more to know, uncover, and understand about this population. I aimed to describe a young mother population residing in a central Canadian city, their maternal language input, their knowledge on infant development, their infant's language abilities, and the role of adults residing in their homes. The central goal was to better understand this population and communicate findings about this population in an accurate and respectful manner.

Chapter 4 – Current Study

Aims

How a mother linguistically interacts with her infant has lasting consequences on the infant's language development (Goldstein & Schwade, 2008). Less is known about the role of maternal age on an infant's language development, especially with the current, advanced, naturalistic research methods that exist today (e.g., Barratt & Roach, 1995; Culp et al., 1991; Garcia et al., 1987), and given that previous studies lack the strength-based approach now favoured when researching a population group (e.g., Hammond & Zimmerman, 2012). To my knowledge, no project has explored the effect of maternal age on the specific speech type, IDS, even though many other maternal variables have been examined (e.g., Bergelson et al., 2019; Ramírez-Esparza et al., 2017; Weisleder & Fernald, 2013).

The aims for my dissertation research were to explore the type and quantity of speech infants of young mothers are exposed to, focusing on maternal IDS. Specifically, I examined the influence of maternal age on the amount of maternal IDS spoken to their infant and infant language development while also considering the role of knowledge of infant development on this question. I examined these variables by developing a unique labelling system (ConvoLabel) to aid in identifying IDS in the day-long naturalistic recordings provided by the Canadian young mother population that comprised my sample.

Research Questions

1. Descriptive Information:
    a. How much maternal IDS occurs per 60 minutes of AWC speech in the infant's language environment?

   b. How much maternal directive IDS occurs within 60 minutes of AWC speech in the infant's language environment?
   c. How much maternal non-directive IDS occurs within 60 minutes of AWC speech in the infant's language environment?

2. Maternal Age:
   a. Is there a relationship between maternal age and the quantity (AWC over time) of IDS the mother produces for her infant?
      i. Is there a relationship between the mother's age status (whether the mother fits into the adolescent or emerging adulthood age group) and the quantity (AWC over time) of IDS the mother produces for her infant? (If so, the category-based version of this question will be applied to all maternal age questions below).
   b. Is there a relationship between maternal age and the quantity (AWC over time) of directive IDS the mother produces for her infant?
   c. Is there a relationship between maternal age and quantity (AWC over time) of non-directive IDS the mother produces for her infant?

3. Child Age:
   a. Is there a relationship between child age and the quantity (AWC over time) of IDS the mother produces for her infant?
   b. Is there a relationship between child age and the quantity (AWC over time) of directive IDS the mother produces for her infant?
   c. Is there a relationship between child age and the quantity (AWC over time) of non-directive IDS the mother produces for her infant?

4. Knowledge of Infant Development:
    a. Is there a relationship between the quantity (AWC over time) of IDS the mother produces for her infant and their score on a knowledge of infant development measure?
    b. Is there a relationship between the quantity (AWC over time) of directive IDS the mother produces for her infant and their score on a knowledge of infant development measure?
    c. Is there a relationship between the quantity (AWC over time) of non-directive IDS the mother produces for her infant and their score on a knowledge of infant development measure?
5. Infant's Vocabulary:
    a. Is there a relationship between the quantity (AWC over time) of IDS the mother produces for her infant and infant language development as measured by the MCDI (percentile)?
    b. Is there a relationship between the quantity (AWC over time) of directive IDS the mother produces for her infant and infant language development as measured by the MCDI (percentile)?
    c. Is there a relationship between the quantity (AWC over time) of non-directive IDS the mother produces for her infant and infant language development as measured by the MCDI (percentile)?
6. Adults in Household:
    a. Is there a relationship between the number of adults in the infant's home and the quantity (AWC over time) of IDS the mother produces for her infant?

b. Is there a relationship between the number of adults in the infant's home and infant language development scores (percentile)?

7. Pitch Analysis:
    a. Is there a statistically significant difference between maternal IDS average pitch and maternal ADS average pitch?
    b. Is there a statistically significant difference between maternal IDS average maximum pitch and maternal ADS average maximum pitch?
    c. Is there a statistically significant difference between maternal IDS average minimum pitch and maternal ADS average minimum pitch?
    d. Is there a statistically significant difference between maternal IDS standard deviation of average pitch and maternal ADS standard deviation of average pitch?

Method

Master's Thesis Findings

The current research project is an expansion of the research I completed for my Master's thesis. My Master's thesis examined the influence of maternal age on infant home language environment, focusing on the environments of children born to young mothers and the quantity of overall adult speech their children heard. The differences between my Master's thesis and Ph.D. thesis are that my Master's thesis focused on LENA automatically generated estimates of the quantity of all adult words heard by the infant. In contrast, my Ph.D. thesis focused on maternal IDS, manually coded (by collaborating on the development of a computer program to code and quantify speech, ConvoLabel) the total number of spoken by the mother to her infant. Both projects included maternal age, KIDI scores, and MCDI scores as central variables. For a

comprehensive update on my Master's thesis findings, with the new data gathered to support my Ph.D. thesis, please see Appendix B.

Participants

This research project involved the recruitment of 11 English-speaking mothers and their children in my Master's thesis (2014-2016) and an additional 12 mothers from 2016-2017, for a total of 23 mothers over three years (sample size for individual analyses ranged from 15-20 due to exclusions, see below for details). Four additional mother and infant dyads participated in the study but are not included in this sample size as there was not enough data collected on our key variables of interest to warrant inclusion. Mothers were selected over fathers because it has been shown that adult females provide larger quantities of speech input and are also more likely to spend their day with their child (Bergelson et al., 2019; Greenwood et al., 2011); this is particularly true for the young mother population (Daryanani et al., 2016). The sampling procedure employed was convenience sampling (Gravetter & Wallnau, 2009). These families must have had a typically developing child (defined by no known hearing impairments or disorders in development, language, or speech) between zero and 24 months old at the time of study enrollment. The child's age was set at 24 months or younger; the child age range was not smaller as it would have significantly reduced the number of mothers eligible to participate.

The mother must have been 25 years of age or younger at the time they gave birth, be able to provide informed consent (18 years old or older or a mature minor) or assent (15 years old or younger), as appropriate, for themselves and their infant (consent from a legal guardian was also collected if assent was obtained from mother, assent from the infant was assessed based on their willingness to wear the LENA device), and be home with their child for at least two days of the week. A mature minor is considered a mother who is the decision-maker for their child

(e.g., if the child were in the hospital, they would decide on their care) and provides unsupervised care for their child. These questions were included in the consent form (see Appendix C). Throughout the review of the consent form between researcher and participant, the participant was asked to paraphrase essential components. This method assured the researchers that the participant understood the study details and the risk associated with participating in the study. The participant was also made aware that it was their duty to inform any other individuals who may be present during the recordings to ensure they know they are being recorded. These mature minor criteria and procedures were developed in consultation with the University of Manitoba's Psychology-Sociology Research Ethics Board. They were implemented formally partway through the study due to feedback from the young mothers participating in the study that the 18+ criterion for consent was not appropriate. As mentioned earlier, the mother age group of 25 years or younger at study enrollment was chosen after special consideration to the population available and willing to participate in my study. I have labelled this group of mothers "young mothers," including adolescent and emerging adulthood young mother (i.e., 25 years of age and under) populations.

Recruitment

Recruitment took place over three years and included postings and talks given to local high schools and community centres. The small sample size and large infant age range are partly due to considerable difficulties in identifying, recruiting, and overseeing this vulnerable population throughout the data collection process (similar to other research projects recruiting young Canadian mothers; e.g., Catherine et al., 2021). A local high school specializing in educating young mothers, the Adolescent Parent Centre, was a dominant source of recruitment. The principal at the Adolescent Parent Centre also served as an Indigenous Elder consult for the

recruitment through the school. Ethics approval was obtained through the River East Transcona School Division and the Winnipeg School Division, in addition to the approval by the University of Manitoba's Psychology-Sociology Research Ethics Board.

The sample consisted of mothers from a Western style of parenting who are primarily of White and/or Indigenous ethnicity and primarily English speaking. Many young mothers in my sample attended a school specifically designed for young mothers (the Adolescent Parent Centre). This school involved educational opportunities on motherhood, parenting, and child development and provided free childcare for the children while mothers attended class. School attendance may increase the likelihood of school staffers connecting young mothers with appropriate resources (Martin et al., 2013). This alleviation in childcare stress and exposure to education surrounding the variables researched in this study is worth noting. There may be certain differences between the mothers who participated in my sample compared to the young mother population in Winnipeg as a whole (e.g., since much of the recruitment was through community organizations, the mothers must have been motivated to participate in such organizational activities).

Instrumentation and Measures

Demographic Information. The mothers were asked to complete a short demographic questionnaire. The demographic questionnaire (see Appendix D) included information on the date of birth (of mother and child), education, income, siblings, and adult members in the household, childcare arrangements, child background (birth, hearing status, language, and cognitive developmental status), language background, and ethnicity. Included in the demographic questionnaire was a socio-economic measure that asks mothers to indicate where they would place themselves on the ladder compared to other people in Canada, with the top of

the ladder being the people who are "best off" in Canada, and the bottom of the ladder the "worst off" (the MacArthur Scales of Subjective Social Status; Adler et al., 2000). The mothers were also asked to do this for their community specifically, with the mothers interpreting "community" how they saw fit. This socio-economic measure was implemented partway through the study after researchers noticed the young mothers were unable to (due to being unaware of their total household income) or uncomfortable with providing their yearly income on the demographic questionnaire. Therefore, the household income question was removed in favour of the SES ladder measure. This personal information sheet was created by the Baby Language Lab at the University of Manitoba and adapted for this study.

Child Development Measure. The MCDI (Fenson et al., 1993) was developed to evaluate the language and communication skills of infants and children aged 8-30 months, such as emerging and observed language. This measure is a self-report assessment completed by a child's primary caregiver, reporting on behalf of their child's communication functioning. There are two main versions of the MCDI, the CDI-Words and Gestures (designed to evaluate children aged eight-18 months) and the CDI- Words and Sentences (designed to evaluate children aged 16-30 months). This commonly used measure is designed to evaluate a child's language development, with moderately high concurrent validity with observational settings (Caskey & Vohr, 2013; Charman, 2004; Fenson et al., 1993; Stone & Yoder, 2001).

Maternal Knowledge of Infant Development Measure. The KIDI (MacPhee, 1981, 2002) is a questionnaire the mothers completed to assess their understanding of infant development. The KIDI is a 58-item parent-report designed to test parental knowledge of child development, parenting, and child norms. It was designed to be accessible to those of low education (seventh-grade reading level; MacPhee, 2002) and claims to be culturally neutral. The

KIDI takes 20 minutes to administer, and each item is scored as right (+1), wrong (-1), or not sure (0). The KIDI produces Accuracy and Total Correct outcome scores. Accuracy tests how accurately the mothers answer the items (#Right / (#Right + #Wrong). Total Correct is the total number of items the mother answered correctly on the inventory (#Right / 58). The KIDI has an internal consistency reliability of $\alpha = .82$ and a 2-week test-retest reliability of $r = 91$. The KIDI provides normative data for a variety of mother populations, including two which were used to help understand the current sample in relation to other samples (a diverse sample of mothers from the United States and a sample of adolescent mothers from the United States).

Adult Word Count Measure. The audio recording device that was used in this study is the LENA DLP. As mentioned earlier, the LENA system includes an audio recording device and accompanying computer software including an automated speech analysis system. First, the participant used the LENA device to record their child's naturalistic language environment. Once the LENA DLP recording was complete, the researcher connected the device to the LENA computer software. The LENA language environment analysis software was designed to analyze audio data captured by the LENA DLP into quantitative data for interpretation.

LENA software has several essential tasks when analyzing audio data; one of the main tasks involves identifying and labelling meaningful audio (human speech sounds), non-speech (electronic media, noise, silence), and interfering speech signals. The basic steps carried out by the LENA system are (adapted from Gilkerson et al., 2017; Xu et al., 2009; see Appendix E for visual image):

1. The recording device records the naturalistic language (audio) environment.
2. The recording device audio data is transferred from the LENA device to the LENA computer software.

3. LENA segments the audio into sound categories using algorithms created for recognition and speech signal processing (sound categories include human speech vs other environmental audio).
4. The sound categories generate a segment map outlining the acoustic characteristics of the language environment (e.g., the adult speech segments are used to generate estimates of the AWC heard by the infant throughout the recording period).
5. The LENA software displays the audio data in a user-friendly format for interpretation and future analysis.

In addition to the LENA device and software, a software package called the Advanced Data Extractor (ADEX; LENA Research Foundation, 2011) allows for quantitative interpretation of the data, and a key variable used for this study, AWC. ADEX allows the user to export the data from the LENA system processed audio recordings to an Excel formatted document for analysis. ADEX allows one to examine the type of speech occurring in the recording in segmented-level data. ADEX can produce data in segment intervals of human vocalizations (the most detailed output available through ADEX). ADEX generated segment level data of AWC estimates were used for the present study. These AWC estimates helped quantify the amount of IDS spoken to infants in my sample. Specifically, the AWC estimates, combined with IDS estimates (explained below), produce an IDS word count LENA and ADEX are incapable of producing independently.

Recent reports find LENA to be an accurate estimate of language environments on the key variables used in this study. A systemic review on the accuracy of LENA segmentation and metrics completed by Cristia et al. (2020) found LENA to be precise (meaning agreement between LENA identified speech and human annotator identified speech) 68% of the time, with

a correlation of $r = .79$ for AWC and $r = .77$ for CVC. A 2019 study by Cristia et al., using language clips of North American English learners, British English learners, and Tsimane learners from Bolivia, found high agreement accuracy of AWC and CVC between LENA and human annotators. Research has found that the LENA software best estimates female adult speech (Soderstrom et al., 2021).

Caskey and Vohr (2013) highlight many benefits of the LENA recording system: LENA allows researchers to examine the language environments of children of different ages and with varying cognitive, language, and behavioural functioning. Researchers can use LENA's day-long recording capabilities to see how language input varies throughout the day. Moreover, the LENA DLP is a simple, easy-to-use device which allows researchers to quickly explain to caregivers how to turn on the device in the morning and reduces errors or missing data due to administration or compliance errors. LENA requires minimal research involvement during recordings and data organization, which allows for shorter project completion times and a larger quantity of data to be collected. LENA also provides a vast amount of data, allowing researchers to examine many research questions. Since data collection is simple, multiple days of recordings are easily acquired, allowing researchers to look at the child's language environment comprehensively. The use of LENA for language researchers has permitted language environments to be studied in a much more natural, efficient, and comprehensive way.

Despite the advantages mentioned, there are also notable limitations with the LENA system. LENA cannot differentiate adult speakers beyond gender (Caskey & Vohr, 2013). Moreover, when LENA software and human transcriber data were compared for a predominantly noisy environment, LENA software and human transcriber's labelling did not correlate strongly (when there was less noise, the correlation was stronger; Soderstrom & Franz, 2016; Xu et al.,

2009). Also, there may be hardware differences amongst the LENA DLP's, contributing to variability (Xu et al., 2009). Xu et al. (2009) acknowledge that LENA software is designed to exclude overlapping speech to reduce misclassification of the audio. They state that human transcribers would likely, in many cases, be able to understand and accurately code overlapping speech. However, it is not well known how helpful overlapping speech input is to an infant's language development. Also, LENA misses out on the nonverbal language and cues in one's environment (e.g., pointing, nodding; Caskey & Vohr, 2013).

A central limitation of LENA remedied by the present study is the LENA software's inability to identify and analyze the different types of speech children automatically hear, such as IDS, (explored in greater detail later; Bergelson et al., 2018; Inoue et al., 2011; Schuster et al., 2014; Vosoughi & Roy, 2012). Other methods of investigating day-long naturalistic language recordings exist (e.g., the Automatic LInguistic Unit Count Estimator (ALICE) software which relies on existing wav. recordings [Räsänen et al., 2020]).

Procedure

Study Procedure.

The study procedure described here included young mother participants from my Master's thesis research that are included in the sample described here as well. After learning about my study from the recruitment methods, interested mothers were invited to meet with a researcher at their chosen location (typically their home or school). During this first meeting, a consent form and demographic questionnaire were completed. The mothers were then provided with a LENA recording device, LENA-designed clothing, a handout with instructions on how to use the device, a brief verbal tutorial, and a record log to complete throughout the recording day. The mothers contacted the research assistant once the first daylong recording was completed

(approximately one or two weeks later) to meet the research assistant to submit the recording device and accompanying recording log and obtain new materials for subsequent entries.

Each participant was asked to submit between four to six recordings over their time enrolled in the study, and they received a small honorarium after each recording. Although I requested the recordings be 10 hours in length, any recordings over four hours in length were included in my analyses. During the recording period, it was requested that the mother pick a day they were spending with their child (i.e., not a day when the child would be attending childcare or away from their mother). Mothers were encouraged to go about their typical daily routines with their child (e.g., grocery store, bus rides, playground visits) to fully capture a typical day and the language their infant is hearing. To start the recording, the mother would place the LENA device in the LENA-designed clothing hidden pouch in the front chest pocket. During their enrollment in the study, mothers would complete the MCDI (Fenson et al., 1993) and Knowledge of Infant Development Inventory (KIDI; MacPhee, 1981, 2002) typically on the second visit, with a research assistant present.

After study completion, the participants were provided with a Parental Report Form (see Appendix F for an example). This report form included informative data from LENA, child language development scores, maternal knowledge of infant development scores, and helpful suggestions on creating a high-quality language environment for their infant.

Labelling Procedure. I developed a labelling system called ConvoLabel, implemented in code by Roman Belenya (see Appendix G for a visual representation), to identify and quantify the amount of maternal IDS taking place in each daylong recording. The labelling system can be installed by visiting https://github.com/babylanguagelab/. This program was created to bridge the gap identified above between the AWC estimates produced by ADEX and the desire of this

project to produce maternal IDS estimates. This labelling system allowed me to answer my research questions, exploring the relationship between maternal age and the amount of maternal IDS present in their infant's typical day-long language environment. The labelling process involved human "labellers" listening to speech from the day-long recordings and estimating how much IDS is present in that speech.

Due to the required accuracy with labelling and a large amount of data to process, a sizeable research team was required to complete this project phase. I created a manual to assist with using ConvoLabel and orient the user to the current project's objectives (see Appendix H or the public access link on Open Science Framework, project title Examining the Language Environments of Children Born to Young Mothers https://osf.io/xmu6t/?view_only=426cc7d06855453ba09b0fc24947396f). The manual includes detailed information on the step-by-step process for labelling, example situations for ambiguous labelling decisions, identifying and reporting sensitive information, and actions and considerations to be taken throughout the labelling process. I also created a document called the Young Mother Labeling Team Orientation Checklist (see Appendix I) to streamline the orientation process. To graduate from orientation, the research assistant labelled one participant recording (which had been previously labeled and vetted by senior researchers on the team) allowing us to assess inter-rater agreement using Krippendorff's Alpha (Krippendorff, 2007). An acceptable level of agreement between labelers is an alpha score of 0.75 or higher on the key variables of interest (Krippendorff, 2007). Therefore, each member of the research team had to meet the inter-rater agreement standard of alpha = 0.75 on the key variables of interest before officially graduating from orientation and contributing to the data collection process independently.

Before labelling the recordings in ConvoLabel, the day-long language recordings went through several processing steps.

1. The recordings collected from the participants were uploaded to the LENA software on a secure lab computer.
2. The LENA system completes the automated analysis of the audio files (as described above), allowing for file analysis and exportation.
3. The Interpreted Time Segment file (.its) and Waveform Audio File (.wav) for each recording were exported from the LENA system.
4. The .its files were then converted into Chat Configuration files (.cha) using the Computerized Language Analysis (CLAN) software.
5. The .cha and .wav files from each recording were then processed using ConvoLabel, creating the "conversation blocks" in a user-friendly format ready for data labelling (for complete instructions, see Appendix J).
    a. A conversation block, as defined by LENA, is a portion of speech bounded by five seconds of silence on either end (i.e., when a "child vocalizes, and some adult responds, or vice versa, within five seconds" p. 556; Zimmerman et al., 2009) determined by the LENA software. Simply, it is what LENA determines is a conversation or collection of speech segments.
    b. If the conversation blocks were longer than 15 seconds, they were further divided into conversation block parts; each part comprised 15 seconds of conversation or less. For example, if participant C001 completed four recordings, each would have its own identifiable recording name, such as C001_recording1, C001_recording2, C001_recording3, and C001_recording4. Then, each recording would be broken

down into conversation blocks so that C001_recording1 may have 385 conversation blocks. Each block 1-385 would be individually labelled, and each block (if large enough) could have several segments/parts (e.g., C001_recording 1, block 1, part 1).

Once the processing steps were completed, the ConvoLabel program was ready for data labelling. The labeller (research assistant) opened the ConvoLabel program and could easily select the participant, recording, and speech segment (either conversation block or part) they wished to listen to. Once they listened to the audio, they could identify or "label" the type of speech they were hearing; all within the ConvoLabel program. Each recording was labeled in its entirety by one labeller.

Before starting the labelling process, the labellers were asked to review the participant file for the recording they would label. Within the participant file, they found information on the mother's age, age of the child, living circumstances, number of family members, and activities completed during the recording day. This information is found on the Demographic Questionnaire (Appendix D) and the Recording Sheet (Appendix K; each recording should have an accompanying recording sheet). This information helped provide the labeller with some context regarding the recording and the audio they would be hearing, as well as the people's voices they may be labelling.

At each decision level, the labelers had the options of labeling speech as a) 0 = None or 0%, b) 1 = Some or 1-33%, c) 2 = Half or 34-66%, d) 3 = Most or 67-99%, or e) 4 = All or 100%. The 0% or None option equating to no quantity of that speech type present in the conversation block while 100% or All option equating to the entire conversation block contains solely that speech type. Initially, I had decided that the labellers would code the percentage of speech present at percentage intervals of 10% (e.g., 10%, 20%, 30%); however, the labellers

were finding this to be a very time-consuming process which resulted in them relying on math and timing to figure out the percentage of speech types present in the conversation blocks. This method was also producing data which did not show good inter-rater agreement. The goal of the labelling process was to determine the main speech types a child is likely attending to in their language environment. Therefore, I decided to move to a more intuitively instinctual process where the labellers were encouraged to focus more on the None, Some, Half, Most, or All categorical options to produce more efficient labelling and more reliable inter-rater agreement.

With each conversation block, the labellers were tasked with labelling the speech in the following sequence (see Appendix L for a visual representation flow chart of this sequence):

1. The labellers were tasked with judging the amount of speech that sounds like adult speech, maternal IDS, other child speech, and junk (e.g., overlapping speech, noise, crying), with IDS being the variable of interest. Labellers designated the IDS label to any speech from the mother which they judged was directed at children aged eight years of age or younger. The labellers used the available context, recording information, and participant information to judge to whom the speech was directed.
2. If the labellers deemed the conversation block as comprised of 'junk,' they did not label it any further and moved on to the next block.
3. If the conversation block had any amount of IDS, the labellers then judge the amount of IDS spoken by the target child's mother, another female, a male, or unsure.
4. If at least some of the IDS was from the target child's mother, the labellers then judged the amount of speech directed towards the target child and the amount of speech directed towards another child.

5. If at least some of the mother's IDS was directed at the target child, the labellers lastly judged the amount of directive and the amount of speech that is non-directive. The directive versus non-directive IDS designation is one of two ways I examined the qualitative components of IDS.

The labellers were also instructed to bring sensitive information (including information regarding the safety [immediate harm, abuse, or neglect] of individuals and illegal activity) heard on the recordings to Dr. Soderstrom and myself. There were two occasions where sensitive information was reported, and one occasion where the information reported resulted in consultation with the research ethics board. No reporting to participants or appropriate authorities was required for either case. Once the entire dataset was labelled in ConvoLabel, the data was exported to Excel, where a spreadsheet was generated with the completed data on key variables of interest.

Infant Directed Speech Pitch Analysis Procedure

A pitch analysis was completed to confirm that the speech labelled as maternal IDS for the current research project included characteristics commonly found in this speech type. A senior research assistant in the Baby Language Lab, Sarah MacEwan, created a data processing pipeline to complete an acoustic analysis of language samples automatically. This process was created to streamline how pitch is analyzed. Please visit https://github.com/babylanguagelab to review the relevant documentation of this analysis. In summary, Sarah and her research assistants took a sample of conversation blocks from seven young mother participants- labelled as maternal IDS or ADS- and compared their pitch quality averages. Paired Samples *t*-tests were used to compare the means of the two measurements (IDS and ADS) taken from the mothers.

Procedure Summary

I aimed to describe the language environments of children born to young mothers (with a focus on maternal IDS measured using LENA data further quantified through ConvoLabel), the language development of children born to young mothers (measured using the MCDI), and maternal characteristics related to young motherhood including maternal knowledge of infant development (KIDI) and demographic information (e.g., number of adults residing in the mother-infant dyad's home environment). The procedure included in the current study involved the study procedure (recruiting mother-infant dyads, gathering demographic information, collecting naturalistic language data using LENA, gathering infant language development scores using the MCDI, and assessing maternal knowledge of infant development using the KIDI) and the labeling procedure (applying LENA collected naturalistic language environment data to ConvoLabel to quantify IDS). The purpose of this methodology was to answer research questions that help us understand a Central Canadian sample of young mothers and their infants, with a focus on language learning.

Chapter 5 – Analysis and Results

Analysis

Since the data collected for this study included data of multiple formats and data from multiple programs, great care was taken to meticulously prepare the data for analysis, using the following steps:

1. Separate Excel data generated from ADEX, ConvoLabel, and a file containing demographic information, KIDI, and MCDI scores were merged into one master file.
    a. Recordings under four hours of length, recordings that took place over multiple days, and some recordings containing sensitive information were excluded from the master Excel file and formal analysis.
2. The Microsoft Excel master file was imported to Statistical Package for the Social Sciences (SPSS) version 23.0 for formal analysis of data related to descriptive statistics including:
    a. Descriptive statistics: Demographics information including education, ethnicity, child gender, child siblings, and adult household members.
    b. Descriptive statistics: MCDI percentile scores (child age dependent measure- either Words and Gestures or Words and Sentences).
    c. Descriptive statistics: KIDI responses including Total Correct, Accuracy, Attempted percentage scores.
    d. Descriptive statistics: LENA automated data including length of recording, recording noise type, quantity of adult words (AWC) percentile score, quantity of child vocalisations (CVC) percentile score.

e. Descriptive statistics: Maternal pitch estimates including IDS and ADS duration, average IDS and ADS pitch, minimum IDS and ADS pitch, maximum IDS and ADS pitch, and standard deviation of IDS and ADS pitch.

f. Bivariate correlational analyses: Including maternal average pitch- IDS versus ADS, maternal maximum pitch- IDS versus ADS, and maternal standard deviation of pitch- IDS versus ADS (research question 7 a, b, c, and d).

3. The Microsoft Excel master file was then imported to R-Studio for formal analysis of ConvoLabel data due to the complex nature of the data.

   a. RStudio was used to combine the master Excel file with an Excel file containing information on LENA recording lengths. This step created a condensed dataset with one row per recording, summing across variables of interest (necessary for descriptive statistics and the linear model analyses).

   b. The descriptive statistics completed in R-Studio included: Quantity of maternal IDS and all ADS, quantity of maternal directive IDS, quantity of non-directive IDS (research question 1 a, b, and c).

   c. The Multilevel Linear Models analyzed in R-Studio answered research questions 2-6 which targeted:

      i. Maternal age and the relationship with quantity of maternal IDS, directive IDS, and non-directive IDS (research question 2 a, b, and c).

         1. Maternal age status (whether the mother fell within the adolescent or emerging adulthood developmental stage designation) and the relationship with quantity of IDS (research question 2 ai).

   ii. Child age and the relationship with quantity of maternal IDS, directive IDS, and non-directive IDS (research question 3 a, b, and c).
   iii. KIDI percentage score and the relationship with quantity of maternal IDS, directive IDS, and non-directive IDS (research question 4 a, b, and c).
   iv. MCDI percentile scores and the relationship with quantity of IDS, directive IDS, and non-directive IDS (research question 5 a, b, and c).
   v. Number of adults in the infant's home and the relationship with quantity of maternal IDS and MCDI percentile scores (research questions 6 a and b).

4. The effect of child age on the research questions was considered for questions that did not directly examine child age. Child age may impact the frequency of adult speech; it is also likely to influence knowledge of infant development (as an infant gets older, the mother likely becomes more knowledgeable about their development; Huang et al., 2005). This step was essential due to the large child age range in the sample, an unfortunate necessary limitation due to difficulties in recruiting this population. Each analysis was tested by adding child age as a covariate to reduce potential confounding or interactive effects of this variable; it was found not to have a significant effect on any of the research questions, and the findings reported below did not include the impact of child age in the analysis.
5. There were four data subgroups collected for analysis: LENA generated data, ConvoLabel estimate data, MCDI scores, and KIDI scores. Please see Appendix M for information on the data that was excluded from analysis, missing, or altered for analysis. In total, there were five participants that required alterations to their LENA data (from one recording each) due to the recording being paused during recording days. One participant's recordings contained sensitive information which resulted in this participant being excluded from the Convolabel

estimate data. Two participants did not follow the recording instructions and let the recording run overnight/over multiple days and were excluded from contributing to LENA generated data and ConvoLabel estimate data. One participant had a recording that was excluded from contributing to LENA generated data and ConvoLabel estimate data due to a computer software related error. One participant had a recording excluded from ConvoLabel estimate data due to a research assistant error. Two participants did not complete the KIDI, and five did not complete the MCDI resulting in missing data for these scores. Due to these factors, no analyses included all 23 participants total, and instead varied from 15-20 participants.

R Analyses

R (version 3.6.2, 2019-12-12; R Core Team, 2019) and R-Studio (version 1.2.5033) were used to examine the influence of maternal age on the amount of maternal IDS spoken to their infant, and the role of infant language development and maternal knowledge of infant development on IDS usage (research questions 1, 2, 3, 4, 5, and 6). The tidyverse (Wickham et al., 2019), lubridate (Grolemund & Wickham, 2011), lmerTest (Kuznetsova et al., 2017), and hablar (Sjoberg, 2022) packages were used to organize and analyze the data. Figures were created using ggplot2 (Wickham, 2016). A detailed breakdown of variables and their definitions used in the R analyses can be found in Table 2.

Multilevel Linear Models were selected as the appropriate model to analyze the dataset. This model accounts for hierarchical data such as this dataset, where variables are nested within other variables (Field et al., 2012). This model is also appropriate for long-format data with multiple participant measurements (Field et al., 2012). The code used for these analyses can be found in the following repository: https://github.com/kmcdivitt/YoungMomLanguage.

Table 2

Analysis Variables and Definitions

Variable	Dataset Form	Definition	Unit	Varies By	Continuous or Categorical
Participant	Participant	The mother-infant dyad participant number (C1_ _)	Participant Number	Participant	Categorical
Mother Age	MotherAge	The mother's age (in years) during the time of study enrollment *Equivalent to Mother Age Status	Age in Years	Participant	Continuous
Mother Age Status	MotherAgeStatus	Adolescent[5] or Emerging Adulthood[6] designation based on mother age at study enrollment (this variable is included to add to the very limited research on the emerging adulthood mother population separate from the adolescent mother population) *Equivalent to Mother Age	Category (Adolescent or Emerging Adult)	Participant	Categorical
ID Speech	IDS_AWC	Number of infant-directed words spoken by an adult[1] per-second occurring within a conversation block[2]. This study focused on Maternal IDS.	Number of IDS Words/Second	Conversation Block (one number per block)	Continuous
Directive Speech	Directive_IDS_AWC	The percent of infant-directed words that are directive[3] spoken by an adult[1] occurring within a conversation block[2]	Number of directive IDS Words/IDS_AWC	Conversation Block (one number per block)	Continuous
Non-Directive Speech	NonDirective_IDS_AWC	The percent of infant-directed words that are non-directive[4] spoken by an adult[1] occurring within a conversation block[2]	Number of non-directive IDS Words/IDS_AWC	Conversation Block (one number per block)	Continuous
Peak ID Adult Word Count	PeakAWC	The quantity of infant-directed words (spoken by an adult[1] per-second) averaged across the top 10 5-minute time periods within each recording where	Peak Number of IDS Words/IDS_AWC	5-Minute Average (one number)	Continuous

		the greatest number of words are occurring (the highest frequency of words)			
Knowledge of Infant Development Inventory (KIDI)	KIDItotalcorrect	A measure of the mother's knowledge of infant development – Total Correct is the total number of items the mother answered correctly on the inventory converted to a percentage point ranging from 0-100%	Percentage	Participant	Continuous
MacArthur Bates Communicative Development Inventory (MCDI)	MCDIcombined	A measure of the infant's vocabulary – there are two main versions of the MCDI: 1. CDI Words and Gestures (designed to evaluate children aged 8-18 months) 2. CDI Words and Sentences (designed to evaluate children aged 16-30 months Depending on the age of the child, the Words Understood (Words and Gestures) or Words Produced (Words and Sentences) scores were obtained, converted to percentile scores	Percentile	Participant	Continuous
Adult Household Members	AdultHouseholdMembers	The total number of adults living in the home with the target child as reported by participant at time of study enrollment[7]	Number of People/Household	Participant	Binomial

1. *Adult:* IDS is deemed any speech that is directed at the target child (research participant) or another child present during the recording who is approximately under eight years of age.
2. *Conversation Block:* A conversation block, as defined by LENA, is a portion of speech bounded by five seconds of silence on either end (i.e. when a "child vocalizes, and some adult responds, or vice versa, within five seconds" p. 556; Zimmerman et al., 2009) determined by the LENA software. Simply, it is what LENA determines is a conversation or collection of speech segments.
3. *Directive:* Directive-IDS is defined as speech from an individual to a child which is a command, recommendation, or request, that communicates to the child that they should act, speak, or focus on something in their environment (McCathren et al., 1995). Directive-IDS, as defined for this study, includes both directive (e.g., "wave goodbye") and prohibitive (e.g., "don't eat that") utterances, and questions (Kitamura & Burnham, 2003).
4. *Non-Directive:* For this research project, all other speech (e.g., comforting, approving, questioning, narrating) should be considered non-directive-IDS.
5. *Adolescent:* includes mothers 18 years of age and under.
6. *Emerging Adulthood:* includes mothers aged 19 – 25 years of age.
7. *Adult Household Members:* Detailed information regarding who was living in the home with the participant was not included in the present study.

Results

The results from the current project are outlined below. The results show that significant variation amongst participants exists for most variables of interest. The substantial variation in the language experience of infants born to young mothers has been found in other studies (e.g., Sperry et al., 2019; Weisleder & Fernald, 2013) and suggests that the group mean is not representative of individual functioning or performance.

SPSS Descriptive Statistics

The sample consisted of $N = 23$ young mothers. The age range of the young mothers in my sample was from 15-25 years old at the time of their child's birth ($M = 19.83$, $SD = 2.59$) and 17 – 25 years old at the time of study enrollment ($M = 20.65$, $SD = 2.60$). Ages of the children participating in the study ranged from 1 to 20 months old at the time of study enrollment ($M = 10.78$, $SD = 4.95$). Participant demographic characteristics are presented in Table 3. The highest level of education completed by most of the mothers in the sample was less than high school, as most were currently enrolled in high school at the time of study participation. Most mothers in the sample were of Indigenous or White ethnicity, mirroring the larger population of young mothers in Winnipeg. The children in the sample were most likely to be only children with no siblings. The average age of the children during study participation was eleven months. The language environments were most likely to be two adult household homes, followed by single-mother homes and homes containing four or more adults (typically multigenerational homes).

Table 3

Sample Characteristics of Young Mother Sample including Percentages

Characteristic	*n*	%
Education		
High School in Progress	13	56.5
Completed High School	8	34.8
College	1	4.3
Unreported	1	4.3
Ethnicity		
Indigenous	11	47.8
White	10	43.5
Indigenous & White	1	4.3
Black	1	4.3
Child Gender		
Male	12	52.2
Female	11	47.8
Child Siblings		
Yes (one)	2	8.7
Yes (two)	3	13.0
No	16	69.6
Unreported	2	8.7
Adult Household Members		
1	6	26.1
2	8	34.8
3	4	17.4
4 or more	5	21.7

Descriptive statistics of LENA recording characteristics, including the number of recordings completed and recording lengths, are presented in Table 4. Participants completed an average of three recordings throughout their study enrollment, typically around eight or nine hours in length. A total of 71 recordings from 23 mother-child dyads were included for analysis, with over 600 hours of naturalistic LENA recordings entered.

Table 4

Naturalistic Language Recording Information

Participant Number	Recording	Child Age at Recording (in months)	Length of Recording (hh:mm:ss)
C167	1	11	12:13:35
	2	12	8:40:02
	3	12	4:52:32
	4	12	7:28:08
C168	1	7	13:45:33
	2	8	14:46:05
	3	8	12:49:07
	4	8	13:44:03
C169	1	6	10:53:16
	2	7	9:52:23
	3	7	10:27:45
	4	8	8:23:56
C170	1	1	10:50:06
	2	2	6:22:45
	3	2	8:37:46
	4	4	5:12:32
C173	1	17	10:36:48
	2	19	7:06:49
	3	19	11:44:58
	4	19	9:46:09
	5	20	4:43:33
C174	1	19	11:59:53
C175	1	8	8:19:51
	2	11	6:15:69
C176	1	10	8:53:18
	2	10	4:59:19
	3	11	11:23:14
	4	11	7:03:38
C177	1	5	10:11:03
	2	5	12:55:13
C181	1	10	10:46:36
	2	10	9:40:31
C183	1	10	7:25:58
	2	11	7:24:54
	3	11	8:05:23
	4	11	6:28:19
C184	1	9	4:07:56
	2	9	9:33:54
C185	1	20	7:00:06
C186	1	15	4:38:55
	2	16	5:09:25

	3	16	5:55:57
C187	1	8	11:54:45
	2	8	12:12:41
	3	9	11:07:21
	4	9	12:41:18
C188	1	9	10:47:25
C189	1	14	11:02:19
	2	15	10:47:31
	3	15	13:38:54
	4	15	11:05:55
	5	15	13:46:27
C190	1	9	5:26:23
	2	10	5:05:47
	3	10	5:05:40
C191	1	5	11:28:46
	2	5	10:00:22
	3	5	10:13:53
	4	5	7:07:24
C192	1	12	6:25:09
	2	12	8:47:26
C193	1	10	6:13:39
	2	10	5:23:07
	3	10	7:30:14
	4	10	5:01:29
C195	1	20	5:03:53
	2	20	4:47:34
	3	20	5:00:03
C196	1	13	5:03:41
	2	14	4:43:14
	3	14	6:31:54
23 participants	71 recordings	11-month average age at recording	600:45:37 total recording time

LENA software provides an overview of the type of audio the children were exposed to within hearing range throughout the recording day. This information is presented in Table 5. The "Meaningful speech" categorization (speech identified by the system as clear and near to the target child) comprised 13% of the children's days. The noise, media, and other audio categorization comprised 47%, and the silence categorization accounted for 40%.

Table 5
LENA Recording Total Detailed Information (N = 23)

Noise Type	Time (hours)	Percentage
Total Recording Time	600.76	100%
Total Meaningful Speech	78.57	13%
Total Noise/Media/Other	282.73	47%
Total Silence	239.46	40%

Descriptive statistics for LENA, MCDI, and KIDI variables are presented in Table 6. Using the information collected by the LENA recording device, generated by LENA software, and normative data collected by the LENA (of a sample of diverse children from the United States; LENA Research Foundation, 2011), I could look at percentiles on key language variables. The infants in my study were exposed to a quantity of adult words averaging the 56th percentile and produced vocalizations averaging the 50th percentile. On the MCDI, younger infants scored on average at the 61st percentile, while older children scored on average at the 66th percentile, compared to normative data. On the KIDI, on average, mothers obtained a score of 72%, similar to a sample of diverse mothers from the United States (72%; McPhee, 1983) and outperforming a sample of teenaged mothers from the United States (55%; Ruchala & James, 1997).

Table 6
Means (M) and Standard Deviations (SD) of LENA, MCDI, and KIDI Variables

Variable	*n*	*M*	SD	Range
LENA: Adult Word Count Percentile	23	56th percentile	37.36	1st – 99th percentile
LENA: Child Vocalizations Percentile	23	50h percentile	34.34	4th – 93rd percentile
MCDI: Words and Gestures	15	61st percentile	31.61	7th – 99th percentile
MCDI: Words and Sentences	15	66th percentile	25.94	38th – 98th percentile
KIDI: Total Correct	18	71.81%	9.71	53% - 91%
KIDI: Accuracy	18	80.44%	7.66	66% - 95%
KIDI: Attempted	18	88.39%	8.67	72% - 100%

It is important to note that ranges on the three measures varied substantially, indicating a wide range of variation in the language environment, child language development, and knowledge of infant development amongst the sample of young mothers and their children. For example, the amount of AWC ranged from the 10th to the 99th percentile depending on the mother-child dyad.

R Descriptive Statistics

Descriptive statistics generated from the ConvoLabel program in R studio are presented in Tables 7 and 8 (different iterations of the same data found in Table 8 at per second and 5-minute time intervals can be found in Appendix N). The quantity of maternal IDS global mean per 60-minutes of AWC speech (research question 1a) was 213 words (range 36-452). The quantity of maternal ADS global mean per 60-minutes of AWC speech was 400 words (range 19-1024). The quantity of maternal directive-IDS global mean per 60-minutes of AWC speech (research

question 1b) was 38 words (range 4-126). The quantity of maternal non-directive-IDS global mean per 60-minutes of AWC speech (research question 1c) was 97 words (range 16-313). There was great variation amongst the sample related to this proportion (one infant heard 7% maternal IDS while another heard 100% maternal IDS). When examining the type of IDS used by the mothers in the sample, 27% of the speech infants heard was directive IDS (range 3-61%) while 73% was non-directive IDS (range 12-90%).

Table 7

ConvoLabel Language Descriptive Statistics (occurring over recordings ranging in length from 4-14 hours in length; N = 20)

Participant Number	Recording	Quantity of Maternal Infant Directed Speech	Quantity of All Adult Directed Speech	Quantity of Maternal Directive-Infant Directed Speech	Quantity of Maternal Non-Directive-Infant Directed Speech
C167	1	194	81	26	47
	2	492	272	56	129
	3	622	279	24	226
	Mean:	436	210.67	35.33	134
C168	1	4421	5220	202	613
	2	5338	6062	181	626
	3	5347	3458	191	798
	Mean:	5035.33	4913.33	191.33	679
C169	1	826	0.52	243	573
	2	3656	6119	339	735
	3	2353	8127	219	930
	Mean:	2278.33	4748.84	267	746
C170	1	3243	13294	102	1334
	2	1487	9241	73	1185
	3	3126	3424	155	2346
	Mean:	2618.67	8653	110	1621.67
C173	1	1075	2223	180	331
	2	532	308	70	268
	3	1761	1523	774	435
	Mean:	1122.67	1351.33	341.33	344.67
C174	1	5423	226	1511	3755
C176	1	1489	708	152	789
	2	1309	594	99	678
	3	1393	3221	213	796
	Mean:	2403.5	1187.25	493.75	1504.5
C177	1	2888	3202	227	2086
	2	2782	799	458	2152
	Mean:	2835	2000.5	342.5	2119
C181	1	2711	5822	528	1135
	2	2717	8391	558	1142
	Mean:	2714	7106.5	543	1138.5
C183	1	1137	6943	242	693
	2	944	3473	200	298

	Mean:	1040.5	5208	221	495.5
C185	1	452	2351	199	212
C186	1	1932	2771	891	871
	2	675	1180	252	310
	3	1286	3138	556	626
	Mean:	1297.67	2363	566.33	602.33
C187	1	4549	3975	1632	1334
	2	4888	6283	628	1458
	Mean:	4718.5	5129	1130	1396
C189	1	525	580	212	275
	2	313	1944	192	105
	Mean:	419	1262	202	190
C190	1	339	4293	20	221
	2	1348	4624	94	274
	Mean:	843.5	4458.5	57	247.5
C191	1	2280	6705	333	1294
	2	3808	7897	514	1603
	3	1491	0	149	1342
	Mean:	2526.33	4867.33	332	1413
C192	1	1211	3308	293	277
C193	1	2665	4230	359	1363
	2	1743	2008	217	787
	3	4310	7217	624	2713
	Mean:	2906	4485	400	1621
C195	1	108	260	17	73
	2	376	1432	33	225
	3	532	518	93	268
	Mean:	338.67	736.67	47.67	188.67
C196	1	40	425	3	29
	2	587	3425	135	291
	3	370	732	64	91
	Mean:	332.33	1527.33	67.33	137
Mean Across all Participants/Recordings:		1939.46	3381.39	302.77	836.29
Range Across all Participants/Recordings:		40-5423	0-13294	3-1632	29-3755

Table 8

ConvoLabel Language Descriptive Statistics Per 60-Minutes (Global means by participant (i.e., unweighted by N of recordings of each participant) N=20)

Participant Number	Quantity of Maternal Infant Directed Speech (in AWC per 60-minutes)	Quantity of All Adult Directed Speech (in AWC per 60-minutes)	Quantity of Maternal Directive-Infant Directed Speech (in AWC per 60-minutes)	Quantity of Maternal Non-Directive-Infant Directed Speech (in AWC per 60-minutes)
C167	51.99	25.12	3.91	16.34
C168	366.64	353.23	13.96	49.75
C169	223.71	465.53	25.88	71.98
C170	298.24	1024.14	12.92	193.59
C173	108.63	127.42	30.85	35.28
C174	451.96	18.81	125.94	312.96
C176	184.1	160.53	18.52	98.14
C177	249.45	188.14	28.89	185.69
C181	266.2	703.77	53.35	111.71
C183	134.81	681.69	28.64	65.07
C185	64.67	335.81	28.45	30.22
C186	254.42	451.35	111.43	117.71
C187	410.66	449.29	96.72	121.56
C189	35.77	98.06	16.84	16.58
C190	165.54	874.97	11.16	48.6
C191	241.6	457.77	31.62	134.73
C192	188.65	515.28	45.58	43.08
C193	442	671.27	60.38	242.21
C195	68.85	151.27	9.6	38.28
C196	58.71	254.46	11.57	23.18
Mean Across all Participants:	213.33	400.4	38.31	97.83
Standard Deviation Across all Participants:	131.97	283.7	35	81.71
Range Across all Participants:	35.77-451.96	18.81-1024.14	3.91-125.94	16.34-312.96

R Linear Mixed Effect Models

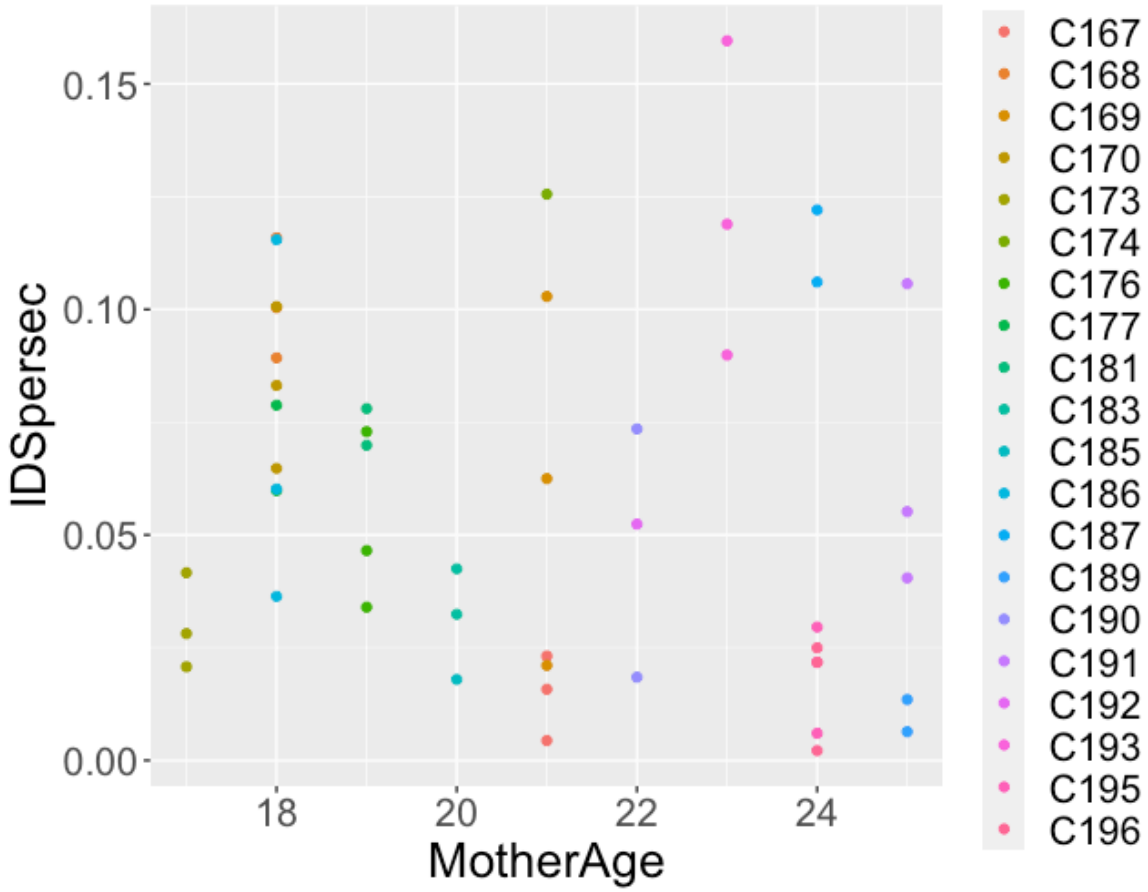
Each analysis involved a linear regression model with the *lmer()* function from the *lmerTest* package. A *p*-value was calculated for each model using the ANOVA() function. Both the *maternal age* and *child age* variables were centred on the mean to allow for a more meaningful interpretation of the results (Hofer, 2017). For all analyses, *the participant* was treated as a random effect.

The first analysis (research question 2a, $N = 20$) asked the following question: Is there a relationship between the mother's age (as a continuous variable) and the quantity (AWC over time) of IDS the mother produces for her infant? The following model was used:

IDSpersec ~ MotherAge + (1|Participant)

In this model, the total number of infant-directed words spoken to the infant per-second time was the dependent variable mother age was the predictor variable and a continuous fixed effect. There was no significant effect of maternal age on quantity of IDS $f(1, 16.7) = 0.37$, $p = 0.55$. The effect of maternal age was -0.002/year (this number represents how much the effect would change by year); the intercept was 0.06 (this means that the average IDS output per second is 0.06 when maternal age is the mean sample age, 21 years). The model is displayed visually in Figure 1.

Figure 1
Mother Age and IDS Per Second (N = 20)



The second analysis (research question 2ai, $N = 20$) asked: Is there a relationship between the mother's age status (as a categorical variable) and the quantity (AWC over time) of IDS the mother produces for her infant? The following model was used:

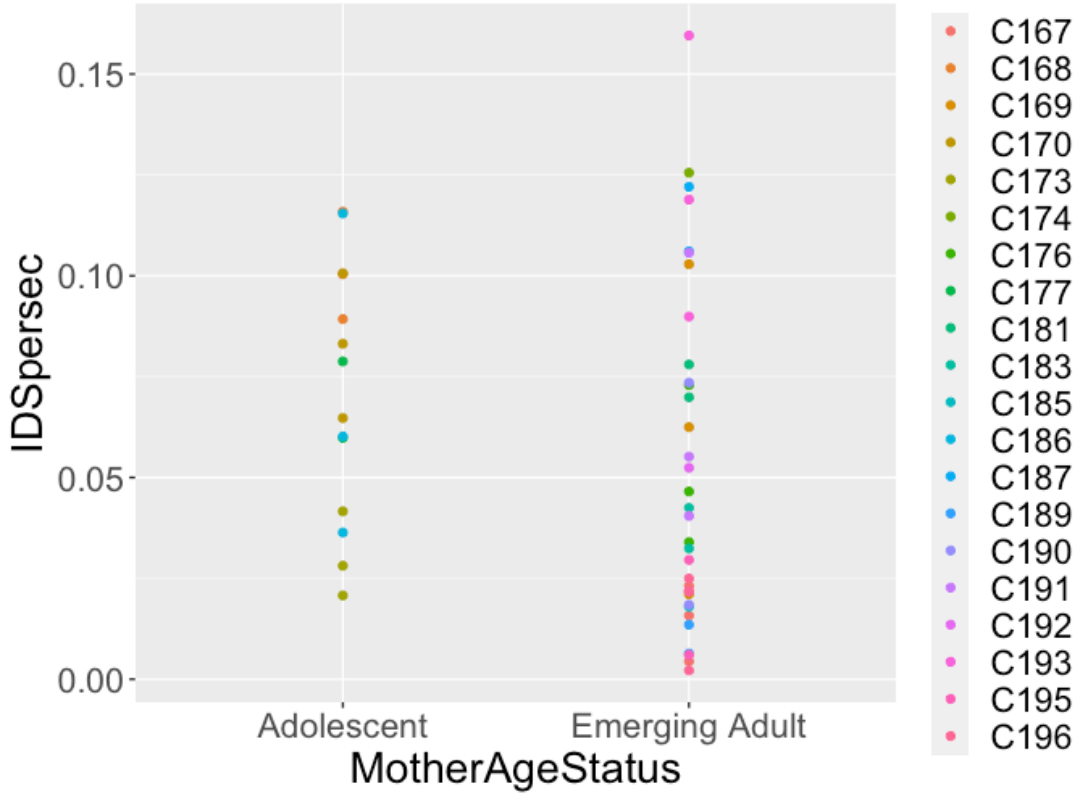
IDSpersec ~ MotherAgeStatus + (1|Participant)

In this model, the total number of infant-directed words spoken to the infant per-second time was the dependent variable, and mother age status (a categorical variable with two groups: Adolescence and Emerging Adulthood) was the predictor variable and fixed effect. There was a significant effect of maternal age status on quantity of IDS $f(2, 17) = 26.78$, $p < 0.001$. The fixed effect (mean) of maternal age status-adolescent was 0.07, while the fixed effect (mean) of maternal age status-emerging adult was 0.05. The model is displayed visually in Figure 2. Of

note, given that a significant effect using the categorical maternal age variable was found (but not as a continuous variable), each subsequent analysis examining the effect of maternal age was also tested by replacing the continuous maternal age variable with the categorical maternal age status variable. However, this did not change any of the findings, so only the continuous analyses are reported.

Figure 2

Mother Age Status and IDS Per Second (N = 20)



The third analysis (research question 2b, $N = 20$) asked: Is there a relationship between mother's age and the quantity (AWC over time) of directive IDS the mother produces for her infant? The following model was used:

directiveIDSpersec ~ MotherAge + (1|Participant)

In this model, the total number of directive infant-directed words spoken to the infant per-second time was the dependent variable, mother age was the predictor variable and a

continuous fixed effect. There was no significant effect of maternal age on quantity of directive IDS f (1, 15.7) = 0.04, p = 0.84. The effect of maternal age was -0.0002/year; the intercept was 0.01 (the average directive IDS output per second is 0.01 when maternal age is the mean sample age, 21 years).

The fourth analysis (research question 2c, N = 20) asked: Is there a relationship between the mother's age and the quantity (AWC over time) of non-directive IDS the mother produces for her infant? The following model was used:

nondirectiveIDSpersec ~ MotherAge + (1|Participant)

In this model, the total number of non-directive infant-directed words spoken to the infant per-second time was the dependent variable, mother age was the predictor variable and a continuous fixed effect. There was no significant effect of maternal age on quantity of nondirective IDS f (1,16.1) = 0.26, p = 0.62. The effect of maternal age was -0.001/year; the intercept was 0.03 (the average non-directive IDS output per second is 0.03 when maternal age is the mean sample age, 21 years).

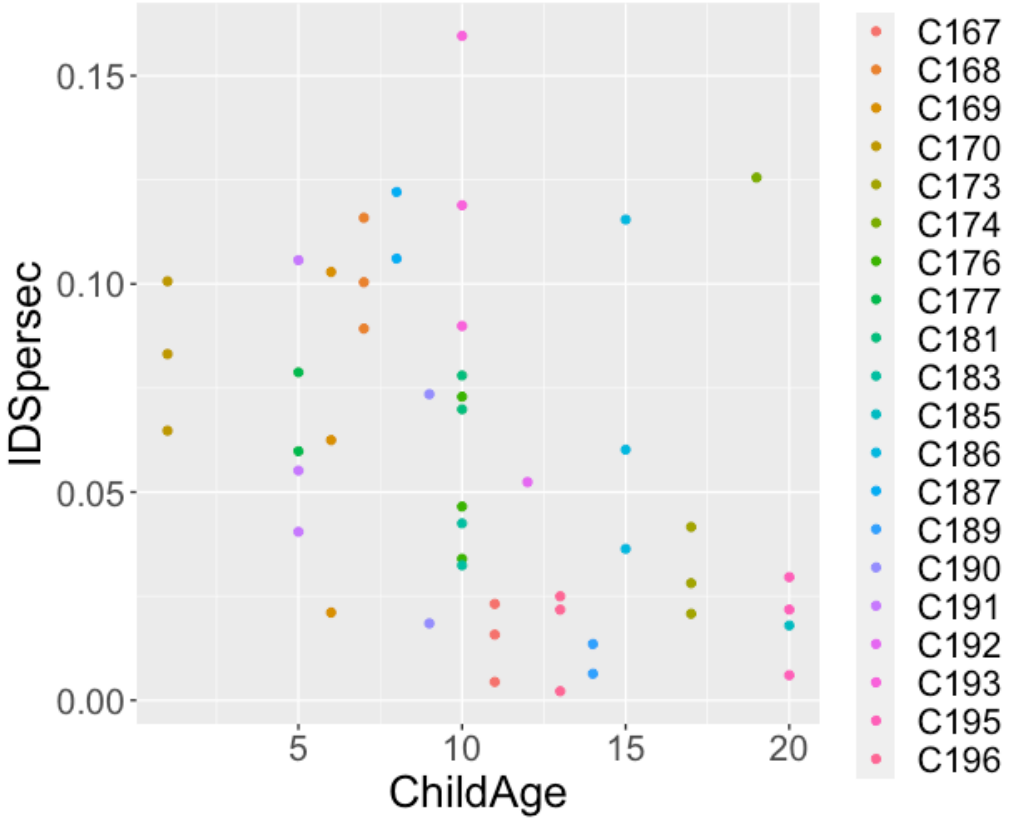
The fifth analysis (research question 3a, N = 20) asked the following question: Is there a relationship between infant's age (as a continuous variable) and the quantity (AWC over time) of IDS the mother produces for her infant? The following model was used:

IDSpersec ~ ChildAge + (1|Participant)

In this model, the total number of infant-directed words spoken to the infant per-second time was the dependent variable, infant age was the predictor variable and a continuous fixed effect. There was no significant effect of child age on the quantity of IDS f (1,17.2) = 3.34, p = 0.08, however this effect is approaching significance. The effect of child age was -0.003/month (if the child's age was the mean sample age, 11 months, this number represents how much the

effect would change by year); the intercept was 0.06 (the average maternal IDS output per second is 0.06 when the child's age is the mean sample age, 11 months). The model is displayed visually in Figure 3.

Figure 3
Child Age and IDS Per Second (N = 20)



The sixth analysis (research question 3b, $N = 20$) asked the following question: Is there a relationship between infant's age (as a continuous variable) and the quantity (AWC over time) of directive IDS the mother produces for her infant? The following model was used:

directive*IDSpersec ~ ChildAge + (1|Participant)*

In this model, the total number of directive infant-directed words spoken to the infant per-second time was the dependent variable, infant age was the predictor variable and a continuous fixed effect. There was no significant effect of child age on the quantity of directive IDS $f(1, 18) = 0.98$, $p = 0.34$. The effect of child age was 0.0004/year; the intercept was 0.01

(the average maternal directive IDS output per second is 0.01 when the child's age is the mean sample age, 11 months).

The seventh analysis (research question 3c, $N = 20$) asked the following question: Is there a relationship between infant's age (as a continuous variable) and the quantity (AWC over time) of non-directive IDS the mother produces for her infant? The following model was used:

nondirective*IDSpersec ~ ChildAge + (1|Participant)*

In this model, the total number of non-directive infant-directed words spoken to the infant per-second time was the dependent variable, infant age was the predictor variable and a continuous fixed effect. There was no significant effect of child age on the quantity of non-directive IDS $f(1, 16) = 1.16$, $p = 0.28$. The effect of child age was -0.001/year; the intercept was 0.03 (the average maternal non-directive IDS output per second is 0.03 when the child's age is the mean sample age, 11 months).

The eighth analysis (research question 4a, $N = 18$) asked: Is there a relationship between the quantity (AWC over time) of IDS the mother produces for her infant and their score on a knowledge of infant development measure (percentage point)? The following model was used:

IDSpersec ~ KIDItotalcorrect + (1|Participant)

In this model, the quantity (AWC over time) of IDS the mother produces for her infant was the dependent variable, their score on a knowledge of infant development measure (percentage point) was the predictor variable and continuous fixed effect. There was no significant effect of KIDI score on quantity of maternal IDS $f(1, 15.8) = 0.46$, $p = 0.51$. The effect of KIDI score was -0.08/percent (this represents how much the effect would change by percentage); the intercept was 0.12 (the average maternal IDS output per second is 0.12 when the mother's KIDI score is the mean score of 72%).

The ninth analysis (research question 4b, $N = 18$) asked: Is there a relationship between the quantity (AWC over time) of directive IDS the mother produces for her infant and their score on a knowledge of infant development measure (percentage point)? The following model was used:

directiveIDSpersec ~ KIDItotalcorrect + (1|Participant)

In this model, the quantity (AWC over time) of directive IDS the mother produces for her infant was the dependent variable, their score on a knowledge of infant development measure (percentage point) was the predictor variable and continuous fixed effect. There was no significant effect of KIDI score on quantity of maternal directive IDS $f(1, 14.9) = 1.45$, $p = 0.25$. The effect of KIDI score was -0.04/percent; the intercept was 0.04 (the average maternal directive IDS output per second is 0.04 when the mother's KIDI score is the mean score of 72%).

The tenth analysis (research question 4c, $N = 18$) asked: Is there a relationship between the quantity (AWC over time) of non-directive IDS the mother produces for her infant and their score on a knowledge of infant development measure (percentage point)? The following model was used:

nondirectiveIDSpersec ~ KIDItotalcorrect + (1|Participant)

In this model, the quantity (AWC over time) of non-directive IDS the mother produces for her infant was the dependent variable, their score on a knowledge of infant development measure (percentage point) was the predictor variable and continuous fixed effect. There was no significant effect of KIDI score on quantity of maternal non-directive IDS $f(1, 15) = 2.42$, $p = 0.14$. The effect of KIDI score was -0.10/percent; the intercept was 0.10 (the average maternal non-directive IDS output per second is 0.10 when the mother's KIDI score is the mean score of 72%).

The eleventh analysis (research question 5a, $N = 15$) asked: Is there a relationship between the quantity (AWC over time) of IDS the mother produces for her infant and infant language development as measured by the MCDI (percentile)? The following model was used:

IDSpersec ~ MCDIcombined + (1|Participant)

In this model, the quantity (AWC over time) of IDS the mother produces for her infant was the dependent variable, the score on the infant language development measure (percentile) was the predictor variable and continuous fixed effect. There was no significant effect of MCDI score on quantity of maternal IDS $f(1, 12) = 0.93$, $p = 0.35$. The effect of MCDI score was 0.0004/percentile (if the infant's MCDI score was 0, this number represents how much the effect would change by percentile); the intercept was 0.03 (the average maternal IDS output per second is 0.03 when the infant's MCDI score is the mean score of the 64th percentile).

The twelfth analysis (research question 5b, $N = 15$) asked: Is there a relationship between the quantity (AWC over time) of directive IDS the mother produces for her infant and infant language development as measured by the MCDI (percentile)? The following model was used:

directiveIDSpersec ~ MCDIcombined + (1|Participant)

In this model, the quantity (AWC over time) of directive IDS the mother produces for her infant was the dependent variable, the score on the infant language development measure (percentile) was the predictor variable and the continuous fixed effect. There was no significant effect of MCDI score on quantity of maternal directive IDS $f(1, 12) = 0.37$, $p = 0.56$. The effect of MCDI score was -0.00006/percentile; the intercept was 0.02 (the average maternal directive IDS output per second is 0.02 when the infant's MCDI score is the mean score of the 64th percentile).

The thirteenth analysis (research question 5c, $N = 15$) asked: Is there a relationship between the quantity (AWC over time) of non-directive IDS the mother produces for her infant and infant language development as measured by the MCDI (percentile)? The following model was used:

nondirectiveIDSpersec ~ MCDIcombined + (1|Participant)

In this model, the quantity (AWC over time) of non-directive IDS the mother produces for her infant was the dependent variable, the score on the infant language development measure (percentile) was the predictor variable and continuous fixed effect. There was no significant effect of MCDI score on quantity of maternal non-directive IDS $f(1, 11.6) = 0.10$, $p = 0.75$. The effect of MCDI score was -0.00007/percentile; the intercept was 0.03 (the average maternal non-directive IDS output per second is 0.03 when the infant's MCDI score is the mean score of the 64th percentile).

The fourteenth analysis (research question 6a, $N = 20$) asked: Is there a relationship between the quantity (AWC over time) of IDS the mother produces for her infant and the number of adults in the infant's home? The following model was used:

IDSpersec ~ AdultHouseholdMembers + (1|Participant)

In this model, the quantity (AWC over time) of IDS the mother produces for her infant was the dependent variable, the number of adults in the infant's home was the predictor variable and continuous fixed effect. There was no significant effect of a number of adult household members in the infant's home on the quantity of maternal IDS $f(1, 16.15) = 2.91$, $p = 0.11$. The effect of maternal IDS was 0.01/second (if the mother's IDS output was 0, this number represents how much the effect would change by second); the intercept was 0.04 (the average

maternal IDS output per second was 0.04 when the number of adults living in the home was the mean of two adults).

The fifteenth analysis (research question 6b, $N = 15$) asked: Is there a relationship between infant language development scores (percentile) and the number of adults in the infant's home? The following model was used:

MCDIcombined ~ AdultHouseholdMembers + (1|Participant)

In this model, the score on the infant language development measure (percentile) was the dependent variable, the number of adults in the infant's home was the predictor variable and continuous fixed effect. There was no significant effect of the number of adult household members in the infant's home on MCDI score $f(1, 36) = 0.56$, $p = 0.95$. The effect of MCDI score was 3.37/percentile; the intercept was 55.45 (the average MCDI percentile score was 55.45 when the number of adults living in the home was the mean of two adults).

Infant Directed Speech Pitch Analyses Results

Paired Samples *t*-tests were used to answer the pitch related research questions (please see Table 9 for descriptive statistics).

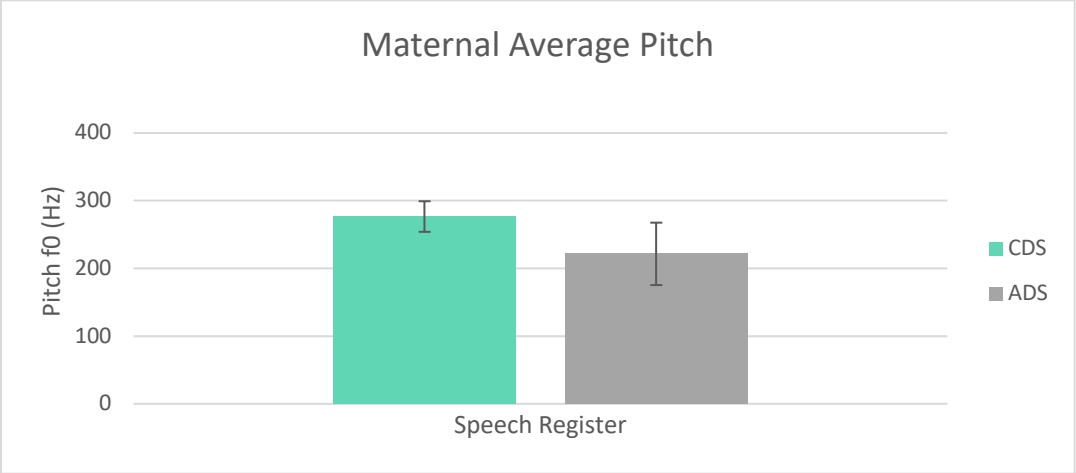
Table 9
Descriptive Statistics for Pitch Analysis of Maternal IDS and ADS (N = 7)

Pitch Measurement	Maternal IDS Mean	All ADS Mean	Maternal IDS Standard Deviation	All ADS Standard Deviation
Duration	0.87	0.88	0.25	0.31
Average Pitch	276.61	221.48	22.6	46.11
Minimum Pitch	181.07	167.17	32.25	19.12
Maximum Pitch	374.81	282.25	30.19	73.55
Standard Deviation of Pitch	52.09	30.06	7.96	14.66

The average pitch of mothers when speaking IDS was 276.61 hertz while the average pitch of the same mothers when speaking ADS was 221.48 hertz. There was a significant difference between maternal IDS pitch and maternal ADS pitch, t (6) = 2.59, $p < .05$. On average maternal IDS pitch was 55.13 hertz higher than maternal ADS pitch (95% CI [3.10, 107.16]). Figure 4 provides a visual representation of this *t*-test.

Figure 4

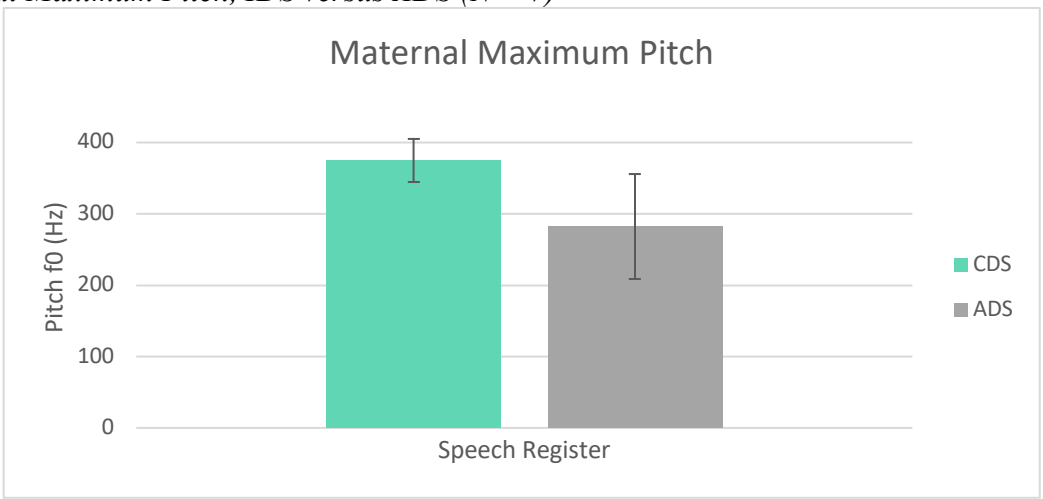
Maternal Average Pitch, IDS versus ADS (N = 7)



There was no significant average difference between maternal IDS minimum pitch and maternal ADS minimum pitch (t (6) = 1.15, p = .29). There was a significant average difference between maternal IDS maximum pitch and maternal ASD maximum pitch, t (6) = 3.53, p < .012. On average maternal IDS maximum pitch was 92.56 hertz higher than maternal ADS pitch (95%CI [28.32, 156.79]). Figure 5 provides a visual representation of this t-test.

Figure 5

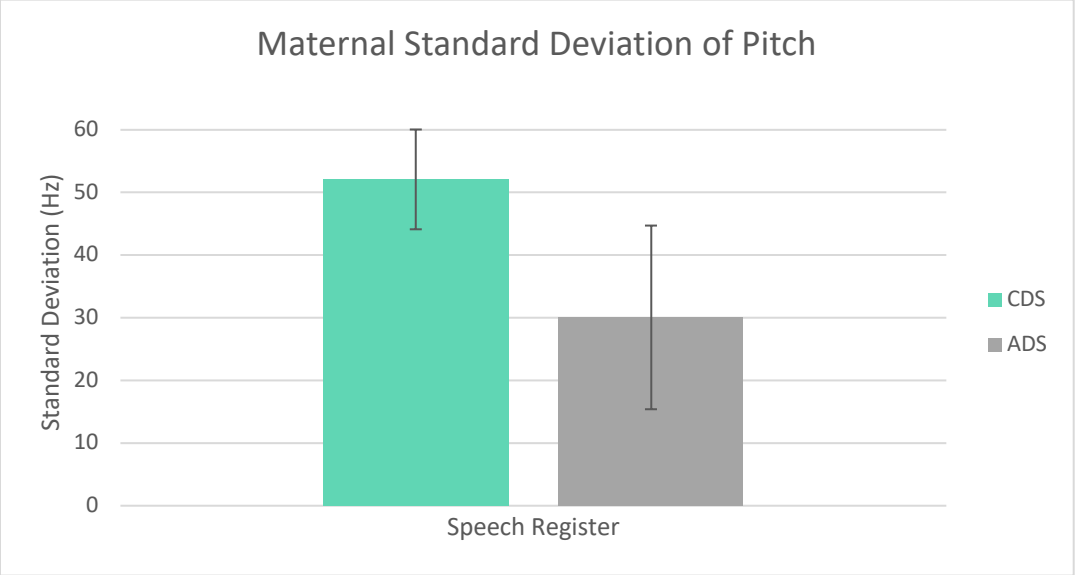
Maternal Maximum Pitch, IDS versus ADS (N = 7)



There was a significant average difference between maternal IDS standard deviation of pitch and maternal ADS standard deviation of pitch, t (6) = 4.77, p < .003. On average maternal IDS standard deviation of pitch was 22.03 hertz higher than maternal ADS standard deviation of pitch. Figure 6 provides a visual representation of this t-test.

Figure 6

Maternal Standard Deviation of Pitch, IDS versus ADS (N = 7)



I can conclude from this analysis that mother pitch does vary significantly based on speech type (IDS vs. ADS).

Chapter 6 – Conclusion

Research Summary

I examined the language environments of children born to adolescent and emerging adulthood mothers. To my knowledge, this is the first study to describe the day-long naturalistic language environments of a young mother population comprised of adolescent and emerging adulthood mothers and how this relates to infant language development. I gathered over 600 hours of rich naturalistic language data for this population of interest. The primary goal of this dissertation was to explore the language environments of children born to young mothers in a Canadian city using LENA technology. The literature on young motherhood and child developmental outcomes is dated in its methodology and conceptualization of this population. Infant language research has made tremendous advances theoretically and methodologically, but there is a notable gap in the literature on applying these advances to the young mother population. I aimed to shed light on the characteristics that comprise this population in the central Canadian city of Winnipeg in an exploratory nature.

The main findings from the current study are:

1. There was meaningful diversity within the young mother and infant dyads on the measures included in this study.
2. The young mothers' infants in my sample performed within the normative range on a parental self-report language development measure.
3. The young mothers in my sample have a strong foundational knowledge of infant development based on their performance on an inventory assessing these skills.
4. The young mothers in my sample are using IDS when speaking to their infants, with the majority being non-directive IDS.

5. The infants in my sample heard both IDS and ADS within their language environments.
6. The young mothers in my sample reported their infant's language and communication functioning as within the normative range.
7. Results of the correlation analysis indicate a significant relationship between maternal age and maternal knowledge of infant development information, indicating that the older mothers in the sample were more knowledgeable concerning infant development.
8. Results from the regression analysis indicate a significant relationship between maternal age status (as a categorical variable) and the quantity (AWC over time) of IDS the mother produces for her infant, indicating that there were significant differences between the two age groups in maternal IDS output. However, the finding suggests that emerging adulthood mothers produced less IDS for their infants when compared with adolescent mothers, contrary to my prediction.
9. Results from the regression analysis indicate a trend approaching significance for the relationship between infant age (as a continuous variable) and the quantity (AWC over time) of IDS the mother produces for her infant, indicating that the older infants in my study heard less IDS.
10. The statistical analyses comparing means indicate that samples of maternal IDS pitch were higher on average than maternal ADS pitch, the maximum maternal IDS pitch was higher on average than the maximum maternal ADS pitch, and maternal IDS pitch standard deviation was higher than maternal ADS pitch standard deviation.

Results from my analyses did not indicate a relationship between the mother's age (continuous) and variables related to the quantity of different types of speech she spoke to her infant (amount of maternal IDS, directive IDS, non-directive IDS). Results from the analyses

also did not indicate a relationship between the mother's knowledge of infant development and variables related to the quantity of different types of speech she spoke to her infant (amount of maternal IDS, directive IDS, non-directive IDS). Results from the analyses also did not indicate a relationship between an infant's reported vocabulary and variables related to the quantity of different types of speech young mothers spoke to their infant (amount of maternal IDS, directive IDS, non-directive IDS). Lastly, results from the analyses did not indicate a relationship between the number of adults living in the infant's home and variables related to the quantity of different types of speech she spoke to her infant (amount of maternal IDS, directive IDS, non-directive IDS), a mother's knowledge of infant development, or the infant's reported vocabulary.

Results from the present sample indicate great variability in the variables of interest across participants. The variability in this young mother sample may contribute to the lack of age-related effects found on the research questions. There are likely sub-samples within the young mother population which I could not identify due to the small sample size of the current study and the measures included in the study. For example, a Canadian study (Van Lieshout et al., 2020) found that of the young mothers (aged < 21 years) living in urban and rural Ontario, approximately two of three reported a recent or ongoing mental health concern. Maternal mental health functioning and an infant's language environment are correlated; maternal anxiety and depression are negatively associated with language use by both mother and child (Clifford et al., 2022). There may be a sub-sample of young mothers involved in the present study experiencing mental health challenges that impacted their language involvement and interactions with their child. Individual or sub-sample strengths, protective factors, and/or challenges are likely contributing to the variation found here.

Findings Contextualized

IDS Usage in a Young Mother Population

My greatest contribution to the literature is the quantifiable descriptive information on the use of maternal IDS within a young mother population. I found that the young mothers in the sample are using IDS both acoustically (McClay et al., 2022) and numerically, in a manner that is like non-young mother populations (of a Western context) reported in the literature (e.g., Bergelson et al., 2019; Bunce et al., 2020). The infants in the sample heard more maternal non-directive IDS, the IDS speech type hypothesized to be more favourable for language learning and infant engagement and responsiveness (Lacroix et al., 2002; McDonald & Pien, 1982; Pratt et al., 1992). Importantly, I also found that the infants in the study were hearing a significant amount of speech not directed to them, likely playing a role in their language learning process.

IDS Usage in Relation to Infant Age

I did not find a relationship between infant age and maternal IDS usage. This complements previous research by Bergelson et al. (2019) who found that North American children in their sample heard the same amount of IDS as child age increased in a cross-corpus sample of 61 children two years of age and under. In Bergelson et al.'s (2019) study the older infants in their study heard proportionally ~40% more IDS than ADS (due to ADS quantities decreasing with age and IDS quantities remaining the same). This indicates that IDS usage may be consistent from age 0-2 years.

Number of Adults Residing in the Home, IDS usage, and Infant Language Development

I did not find an effect between the number of adults in the infant's home and the mother's IDS usage. Previous research suggests that homes with multiple caregivers produce more IDS (Sperry et al., 2019), however less is known about trends regarding maternal IDS

usage specifically in homes with multiple caregivers. The findings from the current study do not suggest that mothers use less IDS when other adults are available to split language interaction duties with the infant. Nor does it suggest that young mothers living in an environment with other adults miss out on IDS interactions with their infant due to adult conversational demands. It also does not suggest that mothers living with fewer adults in the home spend more or less time engaging in IDS. In other words, young mothers from various family and home structures may be prioritizing IDS in similar quantities.

Maternal Age as a Variable of Interest

I found limited support for the importance of exploring the role of maternal age and how it relates to the different developmental stages included in one's sample, a research method not typically practiced within the young mother literature (e.g., Gibbs & Forste, 2014; Hawkes & Joshi, 2012). In fact, most of my questions related to maternal age (either as continuous or categorical variable structure) showed maternal age as a non-significant factor in my sample. In one case, the distinction between adolescence and emerging adulthood, was significant. As the emerging adulthood mothers in the sample produced less IDS for their infants- an unexpected finding. Research typically supports the hypothesis that parenting practices improve with maternal age (Fulco et al., 2020), although some literature reports similar parenting behaviours amongst adolescent and emerging adulthood mothers (Lewin et al., 2013). Many of the emerging adulthood mothers in the current sample were completing high school at an older age than is typically expected. There may be variables or circumstances related to this particular life course that may be impacting the amount of IDS they are producing for their infants (e.g., factors related to why they had to delay or revisit their educational goals later). These factors may include the influence of adverse childhood experiences, intergenerational trauma, or mental

health symptomatology unexplored in my study that is unique to emerging adulthood. Due to their older age, there may also be unique demands placed on these mothers (e.g., more responsibilities that limit the opportunity for IDS).

Young Mother's Knowledge of Infant Development

I was able to describe the infant development knowledge base of a sample of young mother's living in a central Canadian city. Despite previous research describing young mothers as less knowledgeable on infant development (e.g., Brooks-Gunn & Chase-Lansdale, 1995; Burgess, 2005; Culp et al., 1998; Field et al., 1980; Zuckerman et al., 1979) my sample of young mothers displayed similar knowledge bases on infant development to older moms from a diverse sample of mothers from the United States. The age of the children in the present sample did not have a significant effect on maternal infant development knowledge. This suggests that not all samples of young mothers, when examined as a group, are less knowledgeable on infant development information. Importantly, in the current sample, as maternal age increased, so did knowledge of infant development, indicating mothers who fell within the emerging adulthood age range did have greater foundational infant development knowledge. This provides evidence for the importance of exploring differences in maternal age and developmental stages, even amongst young mothers.

Young Motherhood and Infant Language Development

I was able to contribute descriptive information on the language and communication skills of infants born to young mothers. Despite previous research indicating infants of young mothers are at risk for poor language development outcomes when compared to older mothers (e.g., Barratt & Roach, 1995; Culp et al., 1996; Keown et al., 2001; Luster & Dubow, 1990; Luster & Vandenbelt, 1999; Madaschi et al., 2016; Oxford & Speiker, 2006; Sharkins et al.,

2017), the sample of Canadian young mothers in the present sample performed within the normative range.

There was no relationship found between maternal IDS usage and infant language development as measured by the MCDI. Previous research suggests IDS use leads to favourable language outcomes in young children (Ramírez-Esparza et al., 2017; Rowe, 2021). It is possible that the small sample size of the current study contributed to this finding. It is also possible that other language input is playing a role in the language acquisition of infants in the current sample. Another hypothesis is there could be a saturation effect of IDS, where a certain amount is needed to benefit language acquisition but once that threshold is reached, it no longer provides further benefits to language learning.

ConvoLabel's Contribution to the Literature

A major contribution is the creation of the ConvoLabel program in collaboration with researchers at the Baby Language Lab, particularly Roman Belenya. This program is one of the few methods currently available to researchers to manually label and quantify infant directed speech and related characteristics. The program was conceptualized, created, troubleshooted, and finalized using the young mother population described here, but is appropriate for use with other populations as well. The program is available to other researchers to use and apply to their data and may lead to future understanding of the ways various populations are using IDS.

Strengths of this Sample

The sample of young mothers and infants who participated in the present study are remarkable. Their willingness to share their personal information and personal lives for the benefit of this study, and the field of developmental psychology, is admirable. Great care was given to ensure the mothers were well informed on the details of the study, their data, and their

contribution to our laboratory. The mothers asked thoughtful questions, volunteered their time, and stepped out of classes to meet with the research team while navigating their academic, work, and personal lives and caring for a young child.

Most young mothers in my sample provided a language environment consistent with mothers who did not face the unique challenges associated with early parenthood. It is hypothesized that a primary reason for this success may be their access to information and support through the school or community organizations from which they were recruited. This finding is important as it shows the effectiveness of community support tailored for young mothers. However, it is also essential to recognize the individual young mother's role in connecting with and continuing to access resources that are proving beneficial to them. The young mothers in the sample showed dedication to themselves and their children through their commitment to accessing services. This collaboration between self and community would not be possible without the decades of young motherhood research such as that described above, inspiring community members and experts, and the willingness of adolescent and emerging adulthood women. For example, the Winnipeg School Division created the Adolescent Parent Centre, the school where most of the current sample was recruited, in 1971 (Quinsey, 2022) and has been a place of education and community ever since.

Limitations of the Study

Notable limitations exist in the current research study. My sample size is small as recruitment was challenging due to the relatively small size of this population and not all young mothers being comfortable with the commitment or the recording process. Because of the small sample size and the descriptive and exploratory nature of our research questions our sample is at greater risk for type 1 error. As mentioned, most of the sample was recruited through a school

specifically designed to help meet the needs of young mothers or community-based organizations with young mother parenting supports, which impacts the generalizability of the results. I also limited the sample to young mothers who were primarily English speaking, potentially excluding some possible interested mothers. This method contributes to the longstanding issue within infant language research of small sample size, limitation on generalizability, and potential lack of power (Button et al., 2013; Purpura, 2019).

There are also important considerations regarding the research materials. As mentioned previously, there may be reporting biases such as social desirability on the MCDI or help from external sources for the KIDI (although a research assistant was typically present during this task). Reporting biases on self-report and parent-report measures are unavoidable. If the current project had more resources, an independent assessment measure to corroborate the self-report scores would account for this limitation. Although LENA technology has many benefits, concerns regarding privacy and consent are warranted (Cychosz et al., 2020). I cannot guarantee that the participants are informing everyone within the hearing range of the infant that they were being recorded and were consenting to the study process. Because of this, I was selective on who could work with the data to ensure they have the proper training on ethical protocol and lab guidelines. Also, variation in language input throughout the day likely exists. Although the full-day language recording was requested, depending on the time of day when the recording started and ended, I may have collected data on various high or low patterns of different speech types, which may have impacted the quantity of IDS or ADS occurring within an infant's language environment during recording periods. Also, LENA misses out on the nonverbal language and cues in one’s environment (e.g., pointing, nodding; Caskey & Vohr, 2013); this is a notable limitation as these nonverbal communicative gestures are linked to early language learning

(Iverson & Goldin-Meadow, 2005). In a perfect world, research on young motherhood and infant language environments using various long-format data collection methods, not just audio, would be best.

A top priority of the present study was to accurately describe the research sample and include characteristics related to the sample in the descriptive information and analyses. There were study characteristics that were not collected or discussed in this paper which are likely contributing to the variables of interest (such as partnership status, role of siblings, maternal mental health, and specific information on who are the adults living in the home with the mother-infant dyads). Although attempts were made to be comprehensive in study design and data collection, including these variables would have enriched the data and findings further.

Another limitation of the present study is the applicability and appropriateness of the measurement tools used on a population they have not been normed or designed for. Tools to assess language development, the language environment, and maternal knowledge of infant development developed by individuals with intimate knowledge of the cultural norms of the specific populations tested would be appropriate if available. The sample had large Indigenous representation, and the measurement tools used would not have been normed for this type of distribution. Therefore, they may inaccurately represent Indigenous individuals or miss meaningful ways they contribute to these areas (e.g., different vocabulary not accounted for on the MCDI, traditional parenting practices not considered on the KIDI). Additionally, since the sample included data from multiple ethnicities, certain speech characteristics or speech differences may be present and more accurately labelled by an individual of the same ethnicity or background during the annotation process. The results may have missed out on the significance

or misunderstood certain speech characteristics or differences which may be important or even crucial to one's culture or population.

As mentioned above, IDS is defined and measured differently from study to study. My research focused on maternal speech directed to the infant; however, as touched on in my introduction, many other types of speech (Sperry et al., 2019) and nonverbal gestures (linked to early language learning; Iverson & Goldin-Meadow, 2005) are important in understanding an infant's comprehensive language environment. It is not as straightforward as focusing on one speech type or speaker. Although I hoped to convey my definition for this study and the methodology used systematically, direct comparison of the data to other IDS research may be challenging. Different methodology and definitions of IDS are likely to continue since a gold-standard approach is unavailable and may never be obtainable, which prevents researchers' ability to compare IDS data confidently. However, each contribution to understanding IDS and how it contributes to infant development adds a piece to the puzzle.

Future Directions

Research

Some variables not the focus of this research project likely contribute to infant language environments to varying degrees and would benefit from being included in future research on young motherhood, including maternal mental health (Clifford et al., 2022), the impact of intergenerational trauma (Howell et al., 2021), adverse childhood experiences experienced by mother and/or child (McDonald et al., 2019), sibling involvement (Laing & Bergelson, 2017), and other language environments such as childcare (Miser & Hupp, 2012). Relatedly, there may be protective factors present within the infant's environment which mediate the impact of low SES, young maternal age, or less knowledgeable infant development, such as favourable family

backgrounds, employment, fewer children, and community support (Chase-Landsdale et al., 1992; Luster & Brophy-Herb, 2000). Future research should also explore how interpersonal relationships may act as a protective factor for young mothers and their children. These relationships may include peer groups, friendships, romantic partners, immediate and extended family (Chung et al., 2018; Hymas & Girard, 2019), as well as the kinship between indigenous mothers, sisters, grandmothers, and aunties (St-Denis et al., 2022) The literature on young motherhood and infant language environments would benefit from thoroughly examining these additional variables.

Future research on infant language learning would benefit from research and analysis of other speech types, variables, and conceptualizations of language in various populations and cultures (e.g., how other factors, such as mother-child attachment, play into language learning). Children acquire language successfully in various cultures and populations worldwide; our goal should be to learn how this process takes place (Ochs & Kremer-Sadl, 2020). Also, there may be other variables of interest or uses for LENA technology not mentioned here. For example, LENA could be used to record naturalistic cultural and traditional practices of an Indigenous young mother sample in a non-intrusive manner to preserve cultural and linguistic information long-term (Cychosz et al., 2020).

The current research captures an infant's language environment over one month of the child's life. More comprehensive research focusing on longitudinal examinations of children's language environments over months or years is desirable, and amongst the many various language environments the child may be exposed to (e.g., preschool, grandparents' house; Purpura, 2019). Although this research project is a tremendous step forward in advancing infant language research within the young mother population, these next steps are also needed. There is

also a need to study young motherhood in a longitudinal format to understand the various factors impacting young mothers, their parenting skillset, and their child's development (Fulco et al., 2020).

Further conversation and exploration are needed on the type of information in audio recordings of sensitive nature, as well as procedures on how to proceed with such information. I identified more instances than expected of conversations containing what I have defined as "sensitive information" (e.g., talk of illegal activity or personal information). Upon discussion with the research team, unless the sensitive information was identified as urgent or safety-sensitive, the sensitive information, and the recording, remains in the data analysis phase for this study. This decision was made to prevent compromising the integrity of the naturalistic language recordings. Because the recordings contained a substantial amount of language and conversations I deemed sensitive information, I developed criteria and guidelines for managing this type of information and data.

Future research should explore the resources available to young mothers, what populations they are serving, recruitment strategies, their fit and effectiveness, and their areas needing improvement. Although the young mothers in my study had success in finding community organizations which provided the education, support, and routine they needed, where they could be amongst their peers, not all young mothers are accessing services. It would be interesting to know more about which variables impact service access and continuation. Ideally, most young mothers who are interested in and would benefit from services would have easy and prompt access. Future research should include focus groups, needs assessments, and program evaluations to identify the goals and needs of young mothers, identify subgroups of young

mothers with unique circumstances and needs, and assess the appropriateness of programs proposed or currently in place.

Research on how to best support young mothers shows promising results. If an adolescent mother is given the support and resources to continue her educational goals, her infant's environment and levels of stimulation improve, resulting in positive changes in infant cognitive development (Magnuson, 2007; Magnuson et al., 2009). One early intervention focused on improving language development outcomes in infants born to adolescent mothers found improvements when targeting interactional task quality and frequency between the duo (McGowan et al., 2008). A meta-analysis completed by Baudry et al. (2017) examined the impact of intervention strategies for adolescent mothers on early childhood development. They found intervention strategies targeting improving the quality of parent-child interactions to be the most effective at improving child development outcomes in children aged 0-4. They also found group-based interventions and interventions delivered by trained professionals to be the most successful.

Hoffman et al. (2020) completed a randomized control trial, using LENA (the recording device used to record and provide data on an infant's natural language environment) to assess infant language abilities and to provide individualized text message-based linguistic feedback for infants of adolescent mothers. Their study goals were based on previous evidence that young mothers speak less than older mothers to their infants (Culp et al., 1988; Flanagan et al., 1994). Their goal was to create a text message-based intervention (an approach previously used successfully with the adolescent population) to improve infant language outcomes. The mothers lived in the United States of America, and the majority were of Hispanic/Latino ethnicity, followed by White/Caucasian. The primary language spoken by the mothers was English (73%),

followed by Spanish (25%). Most participants lived with five other people, and over half resided with the infant's grandmother. Grade 11 was the mean level of education, although education level varied greatly. The authors found large variability in the LENA AWC, ranging from 3,363 to 29,529 per recording. On the second recording (post-curriculum), infants in the intervention group produced more vocalizations and engaged in more conversations when compared to their control group counterparts. Infants who resided in homes with more people were exposed to more words and obtained higher scores on the MCDI, a self-report measure of infant language development. Hoffman et al.'s intervention showed a significant positive impact in the short term; however, long-term changes based on study feedback did not persist.

Policy and Intervention

Although looking at the present study's sample of young mothers as a group is helpful, within-group differences are guaranteed. When exploring the language environments of infants of young mothers, one ultimately hopes the infants in this study get the language input they need to be successful and healthy in the future. One may wonder, are the mothers setting their children up for success? Will the infants be successful in the future? Although these are important questions, they lead to more questions such as: What is deemed successful? This answer may differ from person to person, culture to culture (for Indigenous people, this is complicated by the colonial disruption of their culture) and is dependent on the history and values of the family. Ultimately, the goal is to set a healthy foundation for the infant to be able to make future decisions and have autonomy over their future.

Both group-based and individualized services and interventions are available to young mothers living in Canada. Examples of group-based services available in Manitoba are the Adolescent Parent Centre (Quinsey, 2022) and the New Directions Resources for Adolescent

Parents Program (New Directions, 2022). Both services offer educational support while enhancing parenting skills, cultural heritage, and maternal mental health. The Adolescent Parent Interagency Network (APIN, 2022) is the Manitoba provincial hub for organizations and professionals working with young mothers funded by the provincial government. APIN offers events for both young mothers and the professionals who serve them. Young mothers can access APIN to be connect with services tailored to their needs. Individualized services in the province (not focused on young mothers specifically) include those run through Family Dynamics (2022) which offers in-home family support, parent coaching, and counselling to families. Even with these services available to young mothers, more can be done to help support them. Heaman et al. (2018) found that young mothers (aged 12-24 years) living in Manitoba are experiencing inadequate perinatal care compared with older mothers (25-34 years). Thompson (2016) discusses ways to meet the unique needs of young mothers to aid with breaking down barriers (lack of engagement with health care services and lack of focused young mother health services, fear of judgement from service providers, and concerns regarding privacy and confidentiality given the social perception of teen and emerging adulthood pregnancies). Thompson (2016) offers a recommended model of care which can be applied to young mothers and their children, in addition to offering appropriate screening tools, questions, and resources for various need areas, she emphasizes the need for care delivery to be community focused and individualized. An important consideration is the appropriateness of the intervention for the population involved. For example, initiatives focused on resilience (e.g., coping strategies, holistic health promotion, cultural identity, learning through personal narratives, focus on community, cultural values and beliefs, interconnection with the environment and others) and that address trauma and cultural loss have shown to be effective for Indigenous people living in Canada (Carrier et al., 2022).

Notably, none of these services offer specialized programing or interventions targeting the language environments of infants born to young mothers.

The great variability in the quality of language environments provided to the infants in my study suggests that while some young mothers may be providing strong language learning opportunities, some young mothers may benefit from language-specific interventions. A meta-analysis examining interventions for adolescent mothers targeting child cognitive development found that studies with interventions focused on the quality of parent child interactions resulted in optimal effect sizes even when compared to maternal education and support-based interventions (Baudry et al., 2017). Information on interventions and support targeting emerging adulthood mothers is not readily available and is most likely quite limited. To my knowledge, no interventions targeting young mothers, infant development, and the quality of infant language environments currently exist. Research on a general population of mothers has shown that parent coaching on language input and child development may improve child language outcomes (Ramírez et al., 2020). Other creative interventions, such as placing educational signs on language learning tips and tricks in supermarkets, are shown to improve mother-child language interactions (Ridge et al., 2015). Given the unique presentation and needs of young mothers and their infants, interventions to ensure the services meet these populations' unique needs.

Concluding Remarks

My research project has two main contributions to the literature: It provides rich data on the language environments of infants born to young mothers and a systematic approach to identifying and quantifying IDS through the development of ConvoLabel. The richness of the data collected is a strength of the study design. Although the sample size is relatively small, the quality of data collected (naturalistic, day-long, manually coded) is superior to many previous

studies exploring similar questions. My study provided feedback to young mothers on their skills and their child's language development. My study required community collaboration, strengthening my understanding of the population, and built relationships between researchers, our laboratory, and the community. Lastly, my study was mindful of applying research methods, principles, and findings to a young mother population in an ethical manner which stepped away from a deficit, one-size-fits-all lens towards a strength-based focus centred on curiosity, descriptive information, and representation (Ochs & Kremer-Sadl, 2020; Purpura, 2019; Sperry et al., 2020). Because this study is a first of its kind, many future directions of interest are necessary to understand better and encourage this population of mothers. Of most significant importance, young mothers and their children are best understood as a diverse population who would benefit from tailored research and intervention to help support and set a healthy foundation for themselves and their children.

References

Addo, F. R., Sassler, S., & Williams, K. (2016). Re-examining the association of maternal age and marital status at first birth with youth educational attainment. *Journal of Marriage and Family*, *78*(5), 1252-1268.

Adolescent Parent Interagency Network. (2022). *Supporting Families.* Adolescent Parent Interagency Network. https://apin.org/

Adler, N. E., Epel, E. S., Castellazzo, G., & Ickovics, J. R. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy, White women. *Health Psychology*, *19*(6), 586.

Aitken, Z., Hewitt, B., Keogh, L., LaMontagne, A. D., Bentley, R., & Kavanagh, A. M. (2016). Young maternal age at first birth and mental health later in life: Does the association vary by birth cohort? *Social Science & Medicine*, *157*, 9-17.

Akbar, M., & Parker, T. (2021). Equity, Diversity, and Inclusion Framework. American Psychological Association. https://www.apa.org/about/apa/equity-diversity-inclusion/framework

Amorim, M., Anikin, A., Mendes, A. J., Lima, C. F., Kotz, S. A., & Pinheiro, A. P. (2021). Changes in vocal emotion recognition across the life span. *Emotion, 21*(2), 315.

Arnett, J. J. (2000). Emerging adulthood: A theory of development from the late teens through the twenties. *American Psychologist*, *55*(5), 469.

Arnett, J. J. (2004). Emerging adulthood: The winding road from the late teens through the twenties. New York: Oxford University Press.

Arnett, J. J. (2011). Bridging cultural and developmental approaches to psychology: New synthesis in theory, research, and policy. Jensen, LA. Development Phases and Culture, 255-275.

Assembly of First Nations. (2022). *Declaration of Aboriginal languages*. AFN. https://www.afn.ca/policy-sectors/languages-and-culture/

Austerlitz, R. (1956). Gilyak nursery words. Word, *12*(2), 260-279.

Avineri, N., Johnson, E., Brice-Heath, S., McCarty, T., Ochs, E., Kremer-Sadlik, T., & Paris, D. (2015). Invited forum: Bridging the "language gap". *Journal of Linguistic Anthropology*, *25*(1), 66-86.

Ball, J. & Lewis, M. (2005 May 6). *First nation elders' and parents' views on supporting children's language development* [Paper presentation]. Canadian Association of Speech-Language Pathologists and Audiologists, Regina, SK.

Barratt, M. S., & Roach, M. A. (1995). Early interactive processes: Parenting by adolescent and adult single mothers. *Infant Behavior and Development, 18*(1), 97-109.

Baudry, C., Tarabulsy, G. M., Atkinson, L., Pearson, J., & St-Pierre, A. (2017). Intervention with adolescent mother–child dyads and cognitive development in early childhood: A meta-analysis. *Prevention Science*, *18*(1), 116-130.

Bayley, N. (2006). Bayley Scales of Infant and Toddler Development–Third Edition: Administration manual. San Antonio, TX: Harcourt Assessment.

Becker Razuri, E., Hiles Howard, A. R., Purvis, K. B., & Cross, D. R. (2017). Mental state language development: The longitudinal roles of attachment and maternal language. *Infant Mental Health Journal*, *38*(3), 329-342.

Bennis, W. M., & Medin, D. L. (2010). Weirdness is in the eye of the beholder. *Behavioral and Brain Sciences, 33*(2-3), 85.

Bergelson, E., Casillas, M., Soderstrom, M., Seidl, A., Warlaumont, A. S., & Amatuni, A. (2019). What do north American babies hear? A large-scale cross-corpus analysis. *Developmental Science*, *22*(1), e12724.

Berk, L. E. (2022). *Infants and children: Prenatal through middle childhood*. SAGE Publications.

Blount, B. G. (1972). Parental speech and language acquisition: Some Luo and Samoan examples. *Anthropological Linguistics*, 119-130.

Blount, B. G., & Padgug, E. J. (1976). *Mother and father speech: Distribution of parental speech features in English and Spanish*. Papers and Reports on Child Language Development; ERIC Clearinghouse.

Boden, J. M., Fergusson, D. M., & Horwood, L. J. (2008). Does adolescent self-esteem predict later life outcomes? A test of the causal role of self-esteem. *Development and Psychopathology*, *20*(1), 319-339.

Boksa, P., Joober, R., & Kirmayer, L. J. (2015). Mental wellness in Canada's aboriginal communities: Striving toward reconciliation. *Journal of Psychiatry and Neuroscience*, *40*(6).

Bombay, A., Matheson, K., & Anisman, H. (2014). The intergenerational effects of Indian Residential Schools: Implications for the concept of historical trauma. *Transcultural Psychiatry*, *51*(3), 320-338.

Bornstein, M. H., Putnick, D. L., Suwalsky, J. T., & Gini, M. (2006). Maternal chronological age, prenatal and perinatal history, social support, and parenting of infants. *Child Development*, *77*(4), 875-892.

Bougie, E., & Sene´cal, S. (2010). Registered Indian children's school success and intergenerational effects of Residential Schooling in Canada. *The International Indigenous Policy Journal*, *1*(1).

Bourdieu, P. (1991). Language and symbolic power. Harvard University Press.

Brave Heart, M. Y. H., & DeBruyn, L. M. (1998). The American Indian holocaust: Healing historical unresolved grief. *American Indian and Alaska Native Mental Health Research*, *8*, 56–78.

Bricker, D., & Squires, J. (1999). *Ages and stages questionnaires: A parent completed, child-monitoring system*. Brookes Publishing Co.

Broesch, T. L., & Bryant, G. A. (2015). Prosody in infant-directed speech is similar across western and traditional cultures. *Journal of Cognition and Development*, *16*(1), 31-43.

Brooks-Gunn, J., & Chase-Lansdale, P. (1995) *Handbook of parenting*: Vol. 3. *Adolescent parenthood*. Lawrence Erlbaum Associates Inc.

Brown, P., & Gaskins, S. (2014). *Language acquisition and language socialization*. Cambridge University Press.

Brown, P., & Casillas, M. (2020). *Child rearing through social interaction on Rossel Island*. PNG.

Brown, R. (1973). A first language: The early stages. Cambridge. MA: Harvard.

Bunce, J., Soderstrom, M., Bergelson, E., Rosemberg, C., Stein, A., Migdalek, M., & Casillas, M. (2020). *A cross-cultural examination of young children's everyday language experiences.* PsyArXiv. https://doi.org/10.31234/osf.io/723pr

Bunting, L., & McAuley, C. (2004). Research review: Teenage pregnancy and motherhood: The contribution of support. *Child & Family Social Work*, *9*(2), 207-215.

Burgess, S. (2005). The preschooler home literacy environment provided by teenage mothers. *Early Child Development and Care*, *175*, 249-258.

Button, K. S., Ioannidis, J. P. A., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S. J., & Munafo, M. R. (2013). Power failure: Why small sample size undermines the reliability of neuroscience. *Nature Reviews Neuroscience*, *14*, 365–376.

Bynon, J. (1968). Berber nursery language. *Transactions of the Philological Society*, *67*(1), 107-161.

Canadian Institutes of Health Research. (2022). *Equity, Diversity, and Inclusion Resources. Canadian Institutes of Health Research*. https://cihr-irsc.gc.ca/e/52553.html

Canadian Psychological Association. (2022). *Justice, Equity, Diversity, and Inclusion (JEDI) Resources.* Canadian Psychological Association. https://cpa.ca/students/jedi/

Carrier, L., Shin, H. D., Rothfus, M. A., & Curran, J. A. (2022). Protective and resilience factors to promote mental health among Indigenous youth in Canada: A scoping review protocol. *BMJ Open*, *12*(1), e049285.

Casagrande, J. B. (1948). Comanche baby language. *International Journal of Linguistics*, *14*(1), 11-14.

Casillas, M., & Cristia, A. (2019). A step-by-step guide to collecting and analyzing long-format speech environment (LFSE) recordings. *Collabra*, *5*(1).

Casillas, M., Brown, P., & Levinson, S. C. (2017). *Casillas HomeBank Corpus*. doi:10.21415/T51X12

Casillas, M., Brown, P., & Levinson, S. C. (2020). Early language experience in a Tseltal Mayan village. *Child Development*, *91*(5), 1819-1835.

Casillas, M., Brown, P., & Levinson, S. C. (2021). Early language experience in a Papuan community. *Journal of Child Language*, *48*(4), 792-814.

Caskey, M., & Vohr, B. (2013). Assessing language and language environment of high-risk infants and children: A new approach. *Acta Paediatrica*, *102*(5), 451-461.

Catherine, N., Hjertaas, K., Cullen, A., Zheng, Y., Amhaz, H., Lever, R., ... & Waddell, C. (2021). *Reaching Underserved Children and Families: Lessons from the British Columbia Healthy Connections Project*. Children's Health Policy Centre. https://childhealthpolicy.ca/wp-content/uploads/2021/12/RCY-Reaching-Underserved-Families-2021.12.11.pdf

Charman, T. (2004). Matching preschool children with autism spectrum disorders and comparison children for language ability methodological challenges. *Journal of Autism and Developmental Disorders*, *34*, 59-63.

Chase-Lansdale, P. L., Brooks-Gunn, J., & Paikoff, R. L. (1992). Research and programs for adolescent mothers: Missing links and future promises. *American Behavioral Scientist*, *35*(3), 290-312.

Chase-Lansdale, P. L., Brooks-Gunn, J., & Zamsky, E. S. (1994). Young African-American multigenerational families in poverty: Quality of mothering and grandmothering. *Child Development*, *65*(2), 373-393.

Chen, X., French, D. C., & Schneider, B. H. (2006). *Peer relationships in cultural context*. Cambridge University Press.

Chung, H. W., Kim, E. M., & Lee, J. E. (2018). Comprehensive understanding of risk and protective factors related to adolescent pregnancy in low-and middle-income countries: A systematic review. *Journal of Adolescence*, *69*, 180-188.

Clifford, B. N., Stockdale, L. A., Coyne, S. M., Rainey, V., & Benitez, V. L. (2022). Speaking of state of mind: Maternal mental health predicts children's home language environment and expressive language. *Journal of Child Language*, *49*(3), 469-485.

Coley, R. L., & Chase-Lansdale, P. L. (1998). Adolescent pregnancy and parenthood: recent evidence and future directions. *American Psychologist*, *53*(2), 152.

Coll, C. G., & Pachter, L. M. (2002). *Ethnic and minority parenting* (Vol. 4). Lawrence Erlbaum Associates Publishers

Cooper, R. P., & Aslin, R. N. (1990). Preference for infant-directed speech in the first month after birth. *Child Development, 61*(5), 1584-1595.

Coplan J. (1993). *Early language milestone scale* (2nd ed). Pro-ed.

Cristia, A., Bulgarelli, F., & Bergelson, E. (2020). Accuracy of the language environment analysis system segmentation and metrics: A systematic review. *Journal of Speech, Language, and Hearing Research, 63*(4), 1093-1105.

Cristia, A., Dupoux, E., Gurven, M., & Stieglitz, J. (2019). Child-directed speech is infrequent in a forager-farmer population: A time allocation study. *Child Development, 90*(3), 759-773.

Culp, A. M., Osofsky, J. D., & O'Brien, M. (1996). Language patterns of adolescent and older mothers and their one-year-old children: A comparison study. *First Language, 16*(46), 61-75.

Culp, A. M., Culp, R. E., Blankemeyer, M., & Passmark, L. (1998). Parent education home visitation program: Adolescent and non-adolescent mother comparison after six months of intervention. *Infant Mental Health Journal, 19*(2), 111-123.

Culp, R. E., Applebaum, M. I., Osofsky, D. D. & Levy, J. A. (1988). Adolescent and older mothers: comparison between parental maternal variables and newborn interaction measures. *Infant Behavior & Development, 11*, 353–362.

Culp, R. E., Culp, A. M., Osofsky, J. D. & Osofsky, H. J. (1991). Adolescent and older mothers' interaction patterns with their six-month-old infants. *Journal of Adolescence, 14*, 195-200.

Cummings, E. M. (1980). Caregiver stability and day care. *Developmental Psychology, 16*(1), 31.

Cychosz, M., Romeo, R., Soderstrom, M., Scaff, C., Ganek, H., Cristia, A., & Weisleder, A. (2020). Longform recordings of everyday life: Ethics for best practices. *Behavior Research Methods, 52*(5), 1951-1969.

Daryanani, I., Hamilton, J. L., Abramson, L. Y., & Alloy, L. B. (2016). Single mother parenting and adolescent psychopathology. *Journal of Abnormal Child Psychology, 44*(7), 1411-1423.

DeLeire, T., & Kalil, A. (2002). Good things come in threes: Single-parent multigenerational family structure and adolescent adjustment. *Demography*, *39*(2), 393-413.

Dobyns, H. F. (1966). An appraisal of techniques with a new hemispheric estimate. *Current Anthropology, 7*(4), 395-416.

Dudley-Marling, C., & Lucas, K. (2009). Pathologizing the language and culture of poor children. *Language Arts, 86*(5), 362-370.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology, 43*(6), 1428.

Dunn, L, M, & Dunn L. (2007). *Peabody picture vocabulary test* (4th ed.). American Guidance Service.

Dunn, J., & Kendrick, C. (1982). The speech of two-and three-year-olds to infant siblings: 'Baby talk 'and the context of communication. *Journal of Child Language, 9*(3), 579-595.

Dunst, C., Gorman, E., & Hamby, D. (2012). Preference for infant-directed speech in preverbal young children. *Center for Early Literacy Learning, 5*(1), 1-13.

Eimas, P. D., Siqueland, E. R., Juscyk, P., & Vigorito, J. (1971). Speech perception in infants. *Science, 171*(3968), 303-306.

ELAN. (2021). *ELAN* (Version 6.2) [Computer software]. Nijmegen: Max Planck Institute for Psycholinguistics, The Language Archive. https://archive.mpi.nl/tla/elan

Englund, K., & Behne, D. (2006). Changes in infant directed speech in the first six months. *Infant and Child Development: An International Journal of Research and Practice, 15*(2), 139-160.

Erfina, E., Widyawati, W., McKenna, L., Reisenhofer, S., & Ismail, D. (2019). Adolescent mothers' experiences of the transition to motherhood: An integrative review. *International Journal of Nursing Sciences, 6*(2), 221-228.

Evans-Campbell, T. (2008). Historical trauma in American Indian/Native Alaska communities: A multilevel framework for exploring impacts on individuals, families, and com-munities. *Journal of Interpersonal Violence, 23*(3), 316–338.

Fagan, J., & Lee, Y. (2013). Explaining the association between adolescent parenting and preschooler's school readiness: A risk perspective. *Journal of Community Psychology, 41*(6), 692-708.

Family Dynamics. (2022). *Our Services.* Family Dynamics. https://familydynamics.ca/

Farran, L. K., Lee, C.-C., Yoo, H., & Oller, D. K. (2016). Cross-cultural register differences in infant-directed speech: An initial study. *PLoS ONE, 11* (3): e0151518.

Fenson, L., Dale, P. S., Reznick, J. S., Thal, D., Bates, E., Hartung, J. P., & Reilly, J. (1993). *MacArthur Communicative Development Inventories: User's Guide and Technical Manual*. Paul H. Brookes.

Fenson, L., Bates, E., Dale, P., Goodman, J., Reznick, J. S., & Thal, D. (2000). Reply: Measuring variability in early child language: Don't shoot the messenger. *Child Development, 71*(2), 323-328.

Ferguson, B., & Waxman, S. (2017). Linking language and categorization in infancy. *Journal of Child Language, 44*(3), 527-552.

Ferguson, C. A. (1956). The emphatic l in Arabic. *Language, 32*(3), 446-452.

Ferguson, C. A. (1964). Baby talk in six languages. *American Anthropologist, 66*(6), 103-114.

Fernald, A. (1985). Four-month-old infants prefer to listen to motherese. *Infant Behavior and Development, 8*(2), 181-195.

Fernald, A., & Morikawa, H. (1993). Common themes and cultural variations in Japanese and American mothers' speech to infants. *Child Development, 64*(3), 637-656.

Fernald, A., & Simon, T. (1984). Expanded intonation contours in mothers' speech to newborns. *Developmental Psychology, 20*(1), 104.

Fernald, A., Taeschner, T., Dunn, J., Papousek, M., de Boysson-Bardies, B., & Fukui, I. (1989). A cross-language study of prosodic modifications in mothers' and fathers' speech to preverbal infants. *Journal of Child Language, 16*(3), 477-501.

Field, A., Miles, J., & Field, Z. (2012). *Discovering statistics using R*. Sage Publications.

Field, T. M., Widmayer, S. M., Stringer, S., & Ignatoff, E. (1980). Teenage, lower-class, black mothers and their preterm infants: An intervention and developmental follow-up. *Child Development, 51*, 426–436.

First Nations Centre. (2005). *First Nations Regional Longitudinal Health Survey (RHS) 2002/03: Results for adults, youth, and children living in First Nations communities*. First Nations Centre.

Flanagan, P. J., Coppa, D. F., Riggs, S. G., & Alario, A. J. (1994). Communication behaviors of infants of teen mothers: An exploratory study. *Journal of Adolescent Health, 15*(2), 169-175.

Floccia, C., Keren-Portnoy, T., DePaolis, R., Duffy, H., Delle Luche, C., Durrant, S., & Vihman, M. (2016). British English infants segment words only with exaggerated infant-directed speech stimuli. *Cognition, 148*, 1-9.

Foushee, R., Griffiths, T. L., & Srinivasan, M. (2016). Lexical complexity of child-directed and overheard speech: Implications for learning. *Proceedings of the 38th Annual Conference of the Cognitive Science Society.*

Fulco, C. J., Henry, K. L., Rickard, K. M., & Yuma, P. J. (2020). Time-varying outcomes associated with maternal age at first birth. *Journal of Child and Family Studies, 29*(6), 1537-1547.

Garcia Coll, C. T., Hoffman, J. & Oh, W. (1987). The social ecology and early parenting of Caucasian adolescent mothers. *Child Development*, *58*, 955-63.

Giardino, J., Gonzalez, A., Steiner, M., & Fleming, A. S. (2008). Effects of motherhood on physiological and subjective responses to infant cries in teenage mothers: A comparison with non-mothers and adult mothers. *Hormones and Behavior, 53*(1), 149-158.

Gibbs, B. G., & Forste, R. (2014). Breastfeeding, parenting, and early cognitive development. *The Journal of Pediatrics, 164*(3), 487-493.

Gilkerson, J., Richards, J. A., Warren, S. F., Montgomery, J. K., Greenwood, C. R., Oller, D.K., & Paul, T. D. (2017). Mapping the early language environment using all-day recordings and automated analysis. *American Journal of Speech-Language Pathology, 26*, 248–265.

Gillmore, M. R., Gilchrist, L., Lee, J., & Oxford, M. L. (2006). Women who gave birth as unmarried adolescents: Trends in substance use from adolescence to adulthood. *Journal of Adolescent Health, 39*(2), 237-243.

Goldstein, M. H., & Schwade, J. A. (2008). Social feedback to infants' babbling facilitates rapid phonological learning. *Psychological Science, 19*(5), 515-523.

Golinkoff, R. M., Hoff, E., Rowe, M., Tamis-LeMonda, C., & Hirsh-Pasek, K. (2018). *Talking with children matters: Defending the 30 million word gap*. Brookings: Education Plus Development.

Golinkoff, R. M., Can, D. D., Soderstrom, M., & Hirsh-Pasek, K. (2015). (Baby) talk to me: The social context of infant-directed speech and its effects on early language acquisition. *Current Directions in Psychological Science, 24*(5), 339-344.

Goodwin, C. J., & Goodwin, K. A. (2016). *Research in psychology methods and design*. John Wiley & Sons.

Gordon , R. A., Chase-Landsale , P. L., Matjasko , J. L., & Brooks-Gunn , J. (1997). Young mothers living with grandmothers and living apart: How neighborhood and household contexts relate to multigenerational coresidence in African American families. *Applied Developmental Science*, *1*, 89–106.

Gravetter, F. J., & Wallnau, L. B. (2009). Statistics for the behavioural sciences (8th ed.). Wadsworth.

Greenspan, S. I. (2002). The developmental basis of psychotherapeutic processes: Comprehensive handbook of psychotherapy. *Psychodynamic and Object Relations, 1*, 15-45.

Greenwood, C. R., Thiemann-Bourque, K., Walker, D., Buzhardt, J., & Gilkerson, J. (2011). Assessing children's home language environments using automatic speech recognition technology. *Communication Disorders Quarterly, 32*(2), 83-92.

Grieser, D. L., & Kuhl, P. K. (1988). Maternal speech to infants in a tonal language: Support for universal prosodic features in motherese. *Developmental Psychology, 24*(1), 14.

Grolemund, G., & Wickham, H., (2011). Dates and Times Made Easy with lubridate. *Journal of Statistical Software, 40*(3), 1-25.

Hall, G. S. (1916). Adolescence. Appleton.

Hammond, W., & Zimmerman, R. (2012). *A strengths-based perspective*. Resiliency Initiatives.

Hao, L., & Brinton, M. C. (1997). Productive activities and support systems of single mothers. *American Journal of Sociology*, *102*(5), 1305-1344.

Harrison, P., & Oakland, T. (2003). *Adaptive behavior assessment system-(ABAS-II).* The Psychological Corporation.

Hart, B., & Risley, T. R. (1989). The longitudinal study of interactive systems. *Education & Treatment of Children, 12*(4), 347-358.

Hart, B., & Risley, T. R. (1992). American parenting of language-learning children: Persisting differences in family-child interactions observed in natural home environments. *Developmental Psychology, 28*(6), 1096.

Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experience of young American children*. Paul H Brookes Publishing.

Hawkes, D., & Joshi, H. (2012). Age at motherhood and child development: Evidence from the UK Millennium Cohort. *National Institute Economic Review, 222*, R52-R66.

Hayashi, A., Tamekawa, Y., & Kiritani, S. (2001). Developmental change in auditory preferences for speech stimuli in Japanese infants. *Journal of Speech, Language, and Hearing Research, 44*(6), 1189-1200.

Heaman, M. I., Martens, P. J., Brownell, M. D., Chartier, M. J., Thiessen, K. R., Derksen, S. A., & Helewa, M. E. (2018). Inequities in utilization of prenatal care: a population-based study in the Canadian province of Manitoba. *BMC Pregnancy and Childbirth*, *18*(1), 1-18.

Henrich, J., Heine, S. J., & Norenzayan, A. (2010). Most people are not WEIRD. *Nature, 466*(7302), 29-29.

Hedrick, D. L., Prather, E. M., & Tobin, A. R. (1975). *Sequenced inventory of communication development (SICD)*. University of Washington Press.

Hedrick, D. L., Prather, E. M., & Tobin, A. R. (1984). *Sequenced inventory of communication development*. Seattle: University of Washington Press.

Hofer, M. (2017). Mean Centering. *The International Encyclopedia of Communication Research Methods*, 1-3.

Hoff, E., & Tian, C. (2005). Socioeconomic status and cultural influences on language. *Journal of Communication Disorders, 38*, 271–278.

Hoffman, L., Hersey, A., Tucker, R., & Vohr, B. (2020). Randomised control language intervention for infants of adolescent mothers. *Acta Paediatrica, 109*(12), 2604-2613.

Howell, K. H., Miller-Graff, L. E., Martinez-Torteya, C., Napier, T. R., & Carney, J. R. (2021). Charting a course towards resilience following adverse childhood experiences: Addressing intergenerational trauma via strengths-based intervention. *Children*, *8*(10), 844.

Huang, K. Y., Caughy, M. O. B., Genevro, J. L., & Miller, T. L. (2005). Maternal knowledge of child development and quality of parenting among White, African-American and Hispanic mothers. *Journal of Applied Developmental Psychology, 26*(2), 149-170.

Hymas, R., & Girard, L. C. (2019). Predicting postpartum depression among adolescent mothers: A systematic review of risk. *Journal of Affective Disorders*, *246*, 873-885.

Inoue, T., Nakagawa, R., Kondou, M., Koga, T., & Shinohara, K. (2011). Discrimination between mothers' infant-and adult-directed speech using hidden Markov models. *Neuroscience research, 70*(1), 62-70.

Iverson, J. M., & Goldin-Meadow, S. (2005). Gesture paves the way for language development. *Psychological Science, 16*, 367–371.

Johnson, D. C., & Johnson, E. J. (2015). Power and agency in language policy appropriation. *Language Policy, 14*(3), 221-243.

Jonk, L. (2009). Aboriginal and non-Aboriginal mothers' views on language acquisition. University of Manitoba. Winnipeg, MB.

Kearney, M. S., & Levine, P. B. (2007). *Socioeconomic disadvantage and early childbearing. In The problems of disadvantaged youth: An economic perspective*. University of Chicago Press.

Kelkar, A. R. (1964). Marathi baby talk. *Word, 20*(1), 40-54.

Keown, L. J., Woodward, L. J., & Field, J. (2001). Language development of pre-school children born to teenage mothers. *Infant and Child Development: An International Journal of Research and Practice, 10*(3), 129-145.

Kitamura, C., & Lam, C. (2009). Age-specific preferences for infant-directed affective intent. *Infancy, 14*(1), 77-100.

Kitamura, C., & Burnham, D. (2003). Pitch and communicative intent in mother's speech: Adjustments for age and sex in the first year. *Infancy, 4*(1), 85-110.

Kitamura, C., Thanavishuth, C., Burnham, D., & Luksaneeyanawin, S. (2001). Universality and specificity in infant-directed speech: Pitch modifications as a function of infant age and sex in a tonal and non-tonal language. *Infant Behavior and Development, 24*(4), 372-392.

Kline, M. A., Shamsudheen, R., & Broesch, T. (2018). Variation is the universal: Making cultural evolution work in developmental psychology. *Philosophical Transactions of the Royal Society B: Biological Sciences, 373*(1743), 20170059.

Krippendorff, K. (2007). *Computing Krippendorff's alpha-reliability*. Annenberg School for Communication Department.

Kuchirko, Y. (2019). On differences and deficits: A critique of the theoretical and methodological underpinnings of the word gap. *Journal of Early Childhood Literacy, 19*(4), 533-562.

Kuznetsova A., Brockhoff P. B., Christensen, R. H. B. (2017). lmerTest Package: Tests in Linear Mixed Effects Models. *Journal of Statistical Software, 82*(13), 1–26.

Lacroix, V., Pomerleau, A., & Malcuit, G. (2002). Properties of adult and adolescent mothers' speech, children's verbal performance and cognitive development in difference socioeconomic groups: A longitudinal study. *First Language, 22*(65), 173-196.

Laing, C. E., & Bergelson, E. (2017, November). *What did you say? Infants' early productions match caregiver* input [Paper presentation]. Boston University Conference on Language Development, Boston, MA, United States.

Lemelin, J. P., Tarabulsy, G. M., & Provost, M. A. (2006). Predicting preschool cognitive development from infant temperament, maternal sensitivity, and psychosocial risk. *Merrill-Palmer Quarterly* (1982), 779-806.

LENA Research Foundation. (2011). *LENA: Every word counts* [Computer Software, Equipment]. LENA Research Foundation. http://www.lenafoundation.org/Default.aspx

Levine, S. C., Suriyakham, L. W., Rowe, M. L., Huttenlocher, J., & Gunderson, E. A. (2010). What counts in the development of young children's number knowledge? *Developmental Science, 46*, 1309–1319.

Lewin, A., Mitchell, S. J., & Ronzio, C. R. (2013). Developmental differences in parenting behavior: Comparing adolescent, emerging adult, and adult mothers. *Merrill-Palmer Quarterly, 59*(1), 23-49.

Lomanowska, A. M., Boivin, M., Hertzman, C., & Fleming, A. S. (2017). Parenting begets parenting: A neurobiological perspective on early adversity and the transmission of parenting styles across generations. *Neuroscience, 342*, 120-139.

Lord, C. (1975). *Is talking to baby more than baby talk?* [Paper presentation]. Society for Research in Child Development, Denver, CO, United States.

Luster, T., & Vandenbelt, M. (1999). Caregiving by low-income adolescent mothers and the language abilities of their 30-month-old children. *Infant Mental Health Journal: Official Publication of The World Association for Infant Mental Health, 20*(2), 148-165.

Luster, T., & Brophy-Herb, H. (2000). Adolescent mothers and their children. *WAIMH Handbook of Infant Mental Health, 4*, 369-413.

Luster, T., & Dubow, E. (1990). Predictors of the quality of the home environment that adolescent mothers provide for their school-aged children. *Journal of Youth and Adolescence, 19*(5), 475-494.

Ma, W., Golinkoff, R., Houston, D., & Hirsh-Pasek, K. (2011). Word learning in infantand adult-directed speech. *Language Learning and Development, 7*, 185–201.

MacKinnon, M. (2005). A First Nations voice in the present creates healing in the future. *Canadian Journal of Public Health, 96*(1), S13-S16.

MacPhee, D. (2002). *Knowledge of Infant Development Inventory: Survey of childcare experiences & manual*. Colorado State University.

MacPhee, D. (1981). *Manual: Knowledge of Infant Development Inventory*. University of North Carolina-Chapel Hill.

MacPhee, D., (1983). *Manual: Knowledge of Infant Development*. University of North Carolina.

MacWhinney, B. (2000). *The CHILDES project: The database* (Vol. 2). Psychology Press.

MacWhinney, B. (1992). *The CH1LDES Database* (2nd ed.). Discovery Systems.

MacWhinney, B. (1996). The CHILDES system. *American Journal of Speech-Language Pathology, 5*(1), 5-14.

Madaschi, V., Mecca, T. P., Macedo, E. C., & Paula, C. S. (2016). Bayley-III scales of infant and toddler development: transcultural adaptation and psychometric properties. *Paidéia (Ribeirão Preto), 26*, 189-197.

Magnuson, K. A., Sexton, H. R., Davis-Kean, P. E., & Huston, A. C. (2009). Increases in maternal education and young children's language skills. *Merrill-Palmer Quarterly* (1982), 319-350.

Magnuson, K. (2007). Maternal education and children's academic achievement during middle childhood. *Developmental Psychology, 43*(6), 1497.

Majid, A., & Levinson, S. C. (2010). WEIRD languages have misled us too. *Behavioural and Brain Sciences, 33,* 103.

Manitoba Centre for Health Policy. (2022). *The Manitoba Population Research Data Repository.* https://umanitoba.ca/manitoba-centre-for-health-policy/data-repository

Manitoba Government. (2012). *Aboriginal People in Manitoba.* Government of Manitoba. http://www.gov.mb.ca/inr/pdf/pubs/abpeoplembweb.pdf

Manitoba Health. (2017). *Annual statistics 2015-2016*. Manitoba Health, Seniors, and Active Living. https://www.gov.mb.ca/health/annstats/as1516.pdf

ManyBabies Consortium, The. (2020). Quantifying sources of variability in infancy research using the infant-directed speech preference. *Advances in Methods and Practices in Psychological Science, 3*(1), 24-52.

Martin, A., Brazil, A., & Brooks-Gunn, J. (2013). The socioemotional outcomes of young children of teenage mothers by paternal co-residence. *Journal of Family Issues, 34*(9), 1217-1237.

Masataka, N. (1992). Motherese in a signed language. *Infant Behavior and Development, 15*(4), 453-460.

McCarney, R., Warner, J., Iliffe, S., Van Haselen, R., Griffin, M., & Fisher, P. (2007). The Hawthorne Effect: A randomised, controlled trial. *BMC Medical Research Methodology, 7*(1), 30.

McCathren, R. B., Yoder, P. J., & Warren, S. F. (1995). The role of directives in early language intervention. *Journal of Early Intervention, 19*(2), 91-101.

McClay, E. K., Cebioglu, S., Broesch, T., & Yeung, H. H. (2022). Rethinking the phonetics of baby-talk: Differences across Canada and Vanuatu in the articulation of mothers' speech to infants. *Developmental Science, 25*(2), e13180.

McDivitt, K., & Soderstrom, M. (2016). *McDivitt HomeBank Corpus*. doi:10.21415/T5KK6G

McDonald, L., & Pien, D. (1982). Mother conversational behaviour as a function of interactional intent. *Journal of Child Language, 9*(2), 337-358.

McDonald, S. W., Madigan, S., Racine, N., Benzies, K., Tomfohr, L., & Tough, S. (2019). Maternal adverse childhood experiences, mental health, and child behaviour at age 3: The all our families community cohort study. *Preventive medicine*, *118*, 286-294.

McGowan, M. W., Smith, L. E., Noria, C. W., Culpepper, C., Langhinrichsen-Rohling, J., Borkowski, J. G., & Turner, L. A. (2008). Intervening with at-risk mothers: Supporting infant language development. *Child and Adolescent Social Work Journal, 25*(4), 245-254.

Mehler, J., Jusczyk, P., Lambertz, G., Halsted, N., Bertoncini, J., & Amiel-Tison, C. (1988). A precursor of language acquisition in young infants. *Cognition, 29*(2), 143-178.

Miller, P. J., & Sperry, D. E. (2012). Déjà vu: The continuing misrecognition of low-income children's verbal abilities. In S. Fiske & H. Markus (Ed.), *Facing Social Class: How Societal Rank Influences Interaction*, Russell Sage Foundation.

Miller, C. L., Miceli, P. J., Whitman, T. L., & Borkowski, J. G. (1996). Cognitive readiness to parent and intellectual-emotional development in children of adolescent mothers. *Developmental Psychology, 32*(3), 533.

Miser, T. M., & Hupp, J. M. (2012). The influence of socioeconomic status, home environment, and childcare on child language abilities. *Current Psychology: A Journal for Diverse Perspectives on Diverse Psychological Issues, 31*(2), 144-159.

Mollborn, S., Fomby, P., & Dennis, J. A. (2011). Who matters for children's early development? race/ethnicity and extended household structures in the United States. *Child indicators research*, *4*(3), 389-411.

Moon, C., Lagercrantz, H., & Kuhl, P. K. (2013). Language experienced in utero affects vowel perception after birth: A two-country study. *Acta Paediatrica, 102*(2), 156-160.

Moore, K. A. & Waite, L. J. (1977). Early childbearing and educational attainment. *Family Planning Perspectives, 9*, 221–225.

Morikawa, H., Shand, N., & Kosawa, Y. (1988). Maternal speech to prelingual infants in Japan and the United States: Relationships among functions, forms, and referents. *Journal of Child Language, 15*(2), 237-256.

Morinis, J., Carson, C., & Quigley, M. A. (2013). Effect of teenage motherhood on cognitive outcomes in children: a population-based cohort study. *Archives of Disease in Childhood*, *98*(12), 959-964.

Naigles, L. R., Hoff, E., Vear, D., Tomasello, M., Brandt, S., Waxman, S. R., & Collins, W. A. (2009). Flexibility in early verb use: Evidence from a multiple-n diary study. *Monographs of the Society for Research in Child Development*, i-144.

New Directions. (2022). *Resources for Adolescent Parents*. New Directions. https://newdirections.mb.ca/resources-for-adolescent-parents/#1610993373185-781f3ac8-54db

Newman, R. S. (2003). Using links between speech perception and speech production to evaluate different acoustic metrics: A preliminary report. *The Journal of the Acoustical Society of America, 113*(5), 2850-2860.

Newman, R. S., & Hussain, I. (2006). Changes in Preference for Infant-Directed Speech in Low and Moderate Noise by 4.5 to 13-Month-Olds. *Infancy, 10*(1), 61-76.

Niwano, K., & Sugai, K. (2002). Intonation contour of Japanese maternal infant-directed speech and infant vocal response. *Japanese Journal of Special Education, 39*(6), 59-68.

Nunan, D., & Choi, J. (2010). *Language and culture: Reflective narratives and the emergence of identity*. Routledge.

Ochs, E., & Kremer-Sadl, T. (2020). Ethical Blind Spots in Ethnographic and Developmental Approaches to the Language Gap Debate. *Langage et societe,* (2), 39-67.

Owen-Jones, E., Bekkers, M. J., Butler, C. C., Cannings-John, R., Channon, S., Hood, K., & Montgomery, A. (2013). The effectiveness and cost-effectiveness of the Family Nurse

Partnership home visiting programme for first time teenage mothers in England: a protocol for the Building Blocks randomised controlled trial. *BMC Pediatrics, 13*(1), 114.

Owen-Jones, E., Bekkers, M. J., Butler, C. C., Cannings-John, R., Channon, S., Hood, K., & Montgomery, A. (2013). The effectiveness and cost-effectiveness of the Family Nurse Partnership home visiting programme for first time teenage mothers in England: A protocol for the buildingbBlocks randomised controlled trial. *BMC Pediatrics, 13*(1), 114.

Oxford, M., & Spieker, S. (2006). Preschool language development among children of adolescent mothers. *Applied Developmental Psychology, 27*, 165-182.

Papoušek, M., Papoušek, H., & Haekel, M. (1987). Didactic adjustments in fathers' and mothers' speech to their 3-month-old infants. *Journal of Psycholinguistic Research, 16*(5), 491-516.

Patel, P. H., & Sen, B. (2012). Teen motherhood and long-term health consequences. *Maternal and Child Health Journal*, *16*(5), 1063-1071.

Pegg, J. E., Werker, J. F., & McLeod, P. J. (1992). Preference for infant-directed over adult-directed speech: Evidence from 7-week-old infants. *Infant Behavior and Development, 15*(3), 325-345.

Pilkauskas, N. V., & Cross, C. (2018). Beyond the nuclear family: Trends in children living in shared households. *Demography, 55*(6), 2283-2297.

Pittman, L. D., & Boswell, M. K. (2008). Low-income multigenerational households: Variation in family functioning by mothers' age and race/ethnicity. *Journal of Family Issues*, *29*(7), 851-881.

Pomerleau, A., Scuccimarri, C., & Malcuit, G. (2003). Mother–infant behavioral interactions in teenage and adult mothers during the first six months postpartum: Relations with infant development. *Infant Mental Health Journal: Official Publication of The World Association for Infant Mental Health, 24*(5), 495-509.

Pratt, M. W., Kerig, P. K., Cowan, P. A., & Cowan, C. P. (1992). Family worlds: Couple satisfaction, parenting style, and mothers' and fathers' speech to young children. *Merrill-Palmer Quarterly,* (1982), 245-262.

Purpura, D. J. (2019). Language clearly matters; methods matter too. *Child Development, 90*(6), 1839-1846.

Quinsey, M. (2022). *History of the adolescent parent centre*. https://sbwsdstor.blob.core.windows.net/media/Default/medialib/history-of-the-adolescent-parent-centre-maureen-quinsey.847e0415418.pdf

R Core Team (2019). R: A language and environment for statistical computing Computer software]. R Foundation for Statistical Computing. https://www.R-project.org/.

Ramírez-Esparza, N., García-Sierra, A., & Kuhl, P. K. (2014). Look who's talking: speech style and social context in language input to infants are linked to concurrent and future speech development. *Developmental Science, 17*(6), 880-891.

Ramírez-Esparza, N., García-Sierra, A., & Kuhl, P. K. (2017). The impact of early social interactions on later language development in Spanish–English bilingual infants. *Child Development, 88*(4), 1216-1234.

Ramírez, N. F., Lytle, S. R., & Kuhl, P. K. (2020). Parent coaching increases conversational turns and advances infant language development. *Proceedings of the National Academy of Sciences, 117*(7), 3484-3491.

Räsänen, O., Seshadri, S., Lavechin, M., Cristia, A., & Casillas, M. (2021). ALICE: An open-source tool for automatic measurement of phoneme, syllable, and word counts from child-centered daylong recordings. *Behavior Research Methods, 53*(2), 818-835.

Reilly, J. S., & Bellugi, U. (1996). Competition on the face: Affect and language in ASL motherese. *Journal of Child Language, 23*(1), 219-239.

Ridge, K. E., Weisberg, D. S., Ilgaz, H., Hirsh-Pasek, K. A., & Golinkoff, R. M. (2015). Supermarket speak: Increasing talk among low-socioeconomic status families. *Mind, Brain, and Education, 9*(3), 127-135.

Romeo, R. R., Leonard, J. A., Robinson, S. T., West, M. R., Mackey, A. P., Rowe, M. L., & Gabrieli, J. D. (2018). Beyond the 30-million-word gap: Children's conversational exposure is associated with language-related brain function. *Psychological Science, 29*(5), 700-710.

Rowe, M. L. (2012). A longitudinal investigation of the role of quantity and quality of child-directed speech in vocabulary development. *Child Development, 83*(5), 1762-1774.

Royal Commission on Aboriginal Peoples, RCAP. (1996). *Looking forward, looking back: Report of the Royal Commission on Aboriginal Peoples* (Vol. 1). Communication Group.

Ruchala, P. L., & James, D. C. (1997). Social support, knowledge of infant development, and maternal confidence among adolescent and adult mothers. *Journal of Obstetric, Gynecologic, & Neonatal Nursing, 26*(6), 685-689.

Ryan-Krause, P., Meadows-Oliver, M., Sadler, L., & Swartz, M. K. (2009). Developmental status of children of teen mothers: Contrasting objective assessments with maternal reports. *Journal of Pediatric Health Care, 23*(5), 303-309.

Santesso, D. L., Schmidt, L. A., & Trainor, L. J. (2007). Frontal brain electrical activity (EEG) and heart rate in response to affective infant-directed (ID) speech in 9-month-old infants. *Brain and Cognition, 65*(1), 14-21.

Sarsour, K., Sheridan, M., Jutte, D., Nuru-Jeter, A., Hinshaw, S., & Boyce, W. T. (2011). Family socioeconomic status and child executive functions: The roles of language, home environment, and single parenthood. *Journal of the International Neuropsychological Society, 17*(1), 120-132.

Schlegel, A., & Barry, H. (1991). *Adolescence: An anthropological inquiry*. Free Press.

Schuster, S., Pancoast, S., Ganjoo, M., Frank, M. C., & Jurafsky, D. (2014). *Speaker-independent detection of child-directed speech* [Conference Workshop]..Spoken Language Technology Workshop.

Shankar, M. (2014). *Empowering our children by bridging the word gap*. White House. https://www.whitehouse.gov/blog/2014/06/ 25/empowering-our-children-bridging-word-gap.

Sharkins, K. A., Leger, S. E., & Ernest, J. M. (2017). Examining effects of poverty, maternal depression, and children's self-regulation abilities on the development of language and cognition in early childhood: An early head start perspective. *Early Childhood Education Journal, 45*(4), 493-498.

Shatz, M., & Gelman, R. (1973). The development of communication skills: Modifications in the speech of young children as a function of listener. *Monographs of the Society for Research in Child Development*, 1-38.

Shaw, M., Lawlor, D. A., & Najman, J. M. (2006). Teenage children of teenage mothers: psychological, behavioural and health outcomes from an Australian prospective longitudinal study. *Social Science & Medicine*, *62*(10), 2526-2539.

Shi, R., Morgan, J. L., & Allopenna, P. (1998). Phonological and acoustic bases for earliest grammatical category assignment: A cross-linguistic perspective. *Journal of Child Language, 25*(1), 169-201.

Shneidman, L. A., & Goldin-Meadow, S. (2012). Language input and acquisition in a Mayan village: How important is directed speech? *Developmental Science, 15*(5), 659-673.

Shute, B., & Wheldall, K. (2001). How do grandmothers speak to their grandchildren? Fundamental frequency and temporal modifications in the speech of British grandmothers to their grandchildren. *Educational Psychology, 21*(4), 493-503.

Siegel, L. S. (1981). Infant tests as predictors of cognitive and language development at two years. *Child Development*, 545-557.

Siegel, D. J. (2001). Toward an interpersonal neurobiology of the developing mind: Attachment relationships, “mindsight,” and neural integration. *Infant Mental Health Journal, 22*(1-2), 67-94.

Siegel, D. J., & Bryson, T. P. (2012). *The whole-brain child: 12 revolutionary strategies to nurture your child's developing mind*. Bantam.

Singh, L., Morgan, J. L., & Best, C. T. (2002). Infants' listening preferences: Baby talk or happy talk? *Infancy, 3*(3), 365-394.

Sjoberg, D. (2020). Hablar [Computer software]. https://github.com/davidsjoberg/hablar/blob/master/LICENSE

Smith, J. (2015). *Truth and reconciliation commission's report details deaths of 3,201 children in residential schools.* Toronto Star. https://www.thestar.com/news/canada/2015/12/15/truth-and-reconciliation-commissions-report-details-deaths-of-3201-children-in-residential-schools.html

Soderstrom, M. (2007). Beyond babytalk: Re-evaluating the nature and content of speech input to preverbal infants. *Developmental Review, 27*(4), 501-532.

Soderstrom, M. & Franz, W. (2016). Comparing Human and Machine Annotated Language Input Across Childcare Settings [PowerPoint slides].

Soderstrom, M., Casillas, M., Bergelson, E., Rosemberg, C., Alam, F., Warlaumont, A. S., & Bunce, J. (2021). Developing a Cross-Cultural Annotation System and MetaCorpus for Studying Infants' Real World Language Experience. *Collabra: Psychology, 7*(1), 23445.

Sperry, D. E., Miller, P. J., & Sperry, L. L. (2020). Hazardous intersections: Crossing disciplinary lines in developmental psychology. *European Journal of Social Theory, 23*(1), 93-112.

Sperry, D. E., Sperry, L. L., & Miller, P. J. (2019). Reexamining the verbal environments of children from different socioeconomic backgrounds. *Child Development, 90*(4), 1303-1318.

Spieker, S. J., Larson, N. C., Lewis, S. M., White, R. D., & Gilchrist, L. (1997). Children of adolescent mothers: Cognitive and behavioral status at age six. *Child and Adolescent Social Work Journal, 14*(5), 335-364.

Spinelli, M., Fasolo, M., & Mesman, J. (2017). Does prosody make the difference? A meta-analysis on relations between prosodic aspects of infant-directed speech and infant outcomes. *Developmental Review, 44*, 1-18.

St-Denis, N., Favel, J., Moore, J., & Walsh, C. (2022). ohpikhâwasiw: kiskeyihtamowin âcimowin: She Raises the Children: Sharing Our Knowledges from Stories. *Journal of the Motherhood Initiative for Research and Community Involvement*.

Story, M., & Stang, J. (2005). Nutrition needs of adolescents. *Guidelines for adolescent nutrition services, 3*(1), 21-34.

Statistics Canada. (2011). *The Canadian population in 2011: Age and sex.* Canadian Government. http://www12.statcan.gc.ca/census-recensement/2011/as-sa/98-311-x/98-311-x2011001-eng.cfm

Statistics Canada. (2017). *The Aboriginal languages of First Nations people, Métis and Inuit.* https://www12.statcan.gc.ca/census-recensement/2016/as-sa/98-200-x/2016022/98-200-x2016022-eng.cfm

Stern, C., & Stern, W. (1928). Die Kindersprache/The Speech of Children. Darmstadt: WissenschaftlicheBuchageseIlschaf.

Stone, W., & Yoder. (2001). Predicting spoken language level in children with autism spectrum disorders. *Autism, 5*, 341-361.

Sugden, N. A., & Moulson, M. C. (2019). These are the people in your neighbourhood: Consistency and persistence in infants' exposure to caregivers', relatives', and strangers' faces across contexts. *Vision Research, 157*, 230-241.

Tamis-LeMonda, C. S., Kuchirko, Y., Luo, R., Escobar, K., & Bornstein, M. H. (2017). Power in methods: Language to infants in structured and naturalistic contexts. *Developmental Science, 20*(6), e12456.

Tanner, J. L., & Arnett, J. J. (2016). The emergence of emerging adulthood: The new life stage between adolescence and young adulthood. In A. Furlong (Ed.), *Routledge handbook of youth and young adulthood* (2nd ed., pp. 50-56). Routledge.

Tasker, J. (2015). *Residential schools findings point to 'cultural genocide', commission chair says.* CBC News. http://www.cbc.ca/news/politics/residential-schools-findings-point-to-cultural-genocide-commission-chair-says-1.3093580

Thompson, G. (2016). Meeting the needs of adolescent parents and their children. *Paediatrics & Child Health*, *21*(5), 1.

Unger, D. G., & Cooley, M. (1992). Partner and grandmother contact in black and white teen parent families. *Journal of Adolescent Health*, *13*, 546–552.

Van Lieshout, R. J., Savoy, C. D., Boyle, M. H., Georgiades, K., Jack, S. M., Niccols, A., & Lipman, E. L. (2020). The mental health of young Canadian mothers. *Journal of Adolescent Health, 66*(4), 464-469.

VanDam, M., Warlaumont, A. S., Bergelson, E., Cristia, A., Soderstrom, M., De Palma, P., & MacWhinney, B. (2016, May). HomeBank: An online repository of daylong child-centered audio recordings. In *Seminars in Speech and Language* (Vol. 37, No. 2). NIH Public Access.

Vernon-Feagans, L., Bratsch-Hines, M., Reynolds, E., & Willoughby, M. (2020). How early maternal language input varies by race and education and predicts later child language. *Child Development, 91*(4), 1098-1115.

Voegelin, C. F., & Robinett, F. M. (1954). 'Mother Language in Hidatsa. *International Journal of American Linguistics, 20*(1), 65-70.

Vosoughi, S., & Roy, D. (2012, May). A longitudinal study of prosodic exaggeration in child-directed speech [Paper presentation]. Speech Prosody Special Interest Group.

Waldram, J. B., Herring, A., & Young, T. K. (2006). *Aboriginal health in Canada: Historical, cultural, and epidemiological perspectives.* University of Toronto Press.

Weber, A., Fernald, A., & Diop, Y. (2017). When cultural norms discourage talking to babies: Effectiveness of a parenting program in rural Senegal. *Child Development, 88*(5), 1513-1526.

Weimer, A. A., Warnell, K. R., Ettekal, I., Cartwright, K. B., Guajardo, N. R., & Liew, J. (2021). Correlates and antecedents of theory of mind development during middle childhood and adolescence: An integrated model. *Developmental Review*, *59*, 100945.

Weisleder, A., & Fernald, A. (2013). Talking to children matters: Early language experience strengthens processing and builds vocabulary. *Psychological Science, 24*(11), 2143-2152.

Weisner, T. S. (Ed.). (2005). *Discovering successful pathways in children's development: Mixed methods in the study of childhood and family life.* University of Chicago Press.

Werker, J. F., & McLeod, P. J. (1989). Infant preference for both male and female infant-directed talk: A developmental study of attentional and affective responsiveness. *Canadian Journal of Psychology/Revue Canadienne de Psychologie, 43(*2), 230.

Westerlund, M., & Lagerberg, D. (2008). Expressive vocabulary in 18-month-old children in relation to demographic factors, mother and child characteristics, communication style and shared reading. *Child: Care, Health, and Development, 34*(2), 257-266.

Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L. D. A., François, R., & Yutani, H. (2019). Welcome to the Tidyverse. *Journal of Open Source Software, 4*(43), 1686.

Wickham, H. (2016). *Data analysis: In ggplot2.* Springer, Cham.

Wu, J. J., Ahmad, N., Samuel, M., Logan, S., & Mattar, C. N. (2021). The influence of web-based tools on maternal and neonatal outcomes in pregnant adolescents or adolescent mothers: Mixed methods systematic review. *Journal of Medical Internet Research, 23*(8), e26786.

Xu, D., Yapanel, U., & Gray, S. (2009). Reliability of the LENA Language Environment Analysis System in young children's natural home environment. *Boulder, CO: Lena Foundation*, 1-16.

Yang, C., Crain, S., Berwick, R. C., Chomsky, N., & Bolhuis, J. J. (2017). The growth of language: Universal Grammar, experience, and principles of computation. *Neuroscience & Biobehavioral Reviews, 81*, 103-119.

Yoshikawa, H., Weisner, T. S., Kalil, A., & Way, N. (2008). Mixing qualitative and quantitative research in developmental science: Uses and methodological choices. *Developmental Psychology, 44*(2), 344.

Zeidner, M. (1983). 'Kitchie-koo'in modern Hebrew: The sociology of Hebrew baby talk. *International Journal of the Sociology of Language, 1983*(41), 93-114.

Zheng, Y., & Peng, J. E. (2022). ELAN (EUDICO Linguistic Annotator). *RELC Journal*, 00336882221089052.

Zimmerman I. L., Steiner V. G., & Pond R. E. (2011). Preschool language scale (5th ed.). The Psychological Corporation.

Zimmerman, F. J., Gilkerson, J., Richards, J. A., Christakis, D. A., Xu, D., Gray, S., & Yapanel, U. (2009). Teaching by listening: The importance of adult-child conversations to language development. *Pediatrics, 124*(1), 342-349.

Zuckerman, B., Winesmore, G., & Alpert, J. J. (1979). A study of attitudes and support systems of inner city adolescent mothers. *Journal of Pediatrics, 95,* 122–125.

Appendices

Appendix A: Definitions of Key LENA Variables

Definitions of Key LENA Variables

- Key Child Vocalization: An estimate of the words or vocalizations (e.g., babbles, growls) produced by the child that are at least 50 milliseconds in length
- Key Child Fixed Sounds: E.g., crying, giggling
- Key Child Vegetative Sounds: E.g., burping, coughing, breathing
- Adult Word Count: Total number of words spoken in proximity to the child, and can be divided into male and female speakers
- Conversational Turns: Joint speech exchanges between an adult and child bound by five seconds of silence on either end of the conversational exchange.
- Noise: E.g., bumps, other unidentifiable noise
- Electronic media: E.g., TV, radio, toys
- Silence and background: Silence and noise less than 32 decibles

Adapted from:

Caskey, M., & Vohr, B. (2013). Assessing language and language environment of high-risk infants and children: a new approach. *Acta Paediatrica*, *102*(5), 451-461.

Appendix B: Master's Thesis Findings

My Master's thesis sample consisted of 30 mother-child pairs between the ages of 15 and 21 years at time of study enrollment. The mothers who enrolled in the study were asked to complete between 4–6-day long recordings, once a week, over their study period (~1 month) on a day when they were with their child. To complete a recording, the mothers were instructed to turn on the LENA recording device, place the device in the LENA-designed clothing pocket, and leave the device on and close to the child from morning to bedtime. The mothers were instructed to go about their typical daily routines (e.g., taking the bus, going grocery shopping, etc.) on recording days if the child was with them for most of the day. I asked that the recording be 10 hours in length but accepted shorter recordings. The mothers also completed the paper version of the MCDI, the KIDI, and a demographic questionnaire during their time enrolled in the study.

This study used the LENA digital processor and software to record and analyze recordings from each parent. LENA's estimate of AWC, child language development, and maternal knowledge of infant development were analyzed. Pearson's correlations were completed to determine how the age of the young mothers (at time of target child's birth and at time of study enrollment) was associated with adult speech, child language development, and knowledge of infant development, and the relationship between knowledge of infant development and child language development. Welch *t*-tests were completed to determine if our sample of young mothers differed significantly from three normative samples, general, low SES mothers, and teen mothers collected on the KIDI Total Correct item.

I found that my sample of young mothers knew less about general infant knowledge compared to a sample of diverse mothers from the United States (t (24) = -1.78, $p < .05$). The normative sample had a mean score of 72.2 total correct, while the sample had a mean score of

67.3 total correct. I also found that the young mother sample performed better than a low SES American sample of mothers on general infant development knowledge (t (58) = 1.099, p > .05). The low SES sample had a mean score of 61.3 total correct, while the sample had a mean score of 67.3 total correct. However, I did not find that quantity of adult words was correlated with maternal age or infant development, as hypothesized (r (11) = -.073, p = .41).

A notable limitation of my Master's thesis was the small sample size. Of the 30 mothers in my sample, only 12 completed LENA recordings (the remaining 18 were enrolled in a "mini-study" designed to collect more information on the MCDI and KIDI from a larger number of willing young mothers). Therefore, I hoped to double my sample of young mother participants for my dissertation project. Another limitation was my inability to examine the qualitative characteristics of the language provided by this young mother population. As mentioned earlier, recent research suggests that the sheer quantity of adult speech, a key variable in my Master's thesis, may not be the best way to look at ideal child language input. However, the LENA device does not allow us to look at the more qualitative components of speech, such as IDS. Therefore, for my dissertation research, I used the audio data collected by LENA and my systematic method for labelling the amount of IDS the children in this young mother sample were hearing from their mothers.

In order to provide a comprehensive analysis of the data, I explored five research questions asked in my Master’s thesis with additional participants and data collected post-Master's defence (as I continued to recruit new participants for my Ph.D. studies). The research questions were analyzed using bivariate correlations using Pearson's correlation coefficient (r). The research questions are:

1. Does maternal age influence the total amount of adult words spoken to their child (LENA generated AWC)?
2. Does maternal age influence the total amount of child vocalizations made by the child (LENA generated child vocalization count)?
3. Does maternal age influence child language development (MCDI percentile scores)?
4. Does maternal age influence knowledge of infant development (KIDI total correct percentage scores)?
5. Does knowledge of infant development (KIDI total correct percentage scores) influence child language development (MCDI percentile scores)?

SPSS Bivariate Correlational Analyses

Bivariate correlations using Pearson's correlation coefficient (r) for the variables of interest are presented below. There were no significant correlations between maternal age and AWC, CV, or child language development. However, there was a significant moderate positive correlation that emerged post-Master's thesis (when more participants had submitted data) between maternal age and knowledge of infant development ($r = .49$, $p < 0.05$, $N = 23$). My young mother sample showed no significant correlation between knowledge of infant development and child language development.

Bivariate correlations among study variables using Pearson's r

Variables	Pearson's *r* Correlation (*r*)	Significance (*p*-value)	Correlation Coefficient Squared (r^2)	Variability Shared (%)
Maternal Age at Birth & Adult Word Count	-.186	.54	.035	3.5%
Maternal Age at Birth & Child Vocalizations	-.005	.99	.000	0.0%
Maternal Age at Birth & Child Language Development	.075	.77	.005	0.5%
Maternal Age at Birth & Knowledge of Infant Development	.49	.026*	.24	23.6%
Knowledge of Infant Development & Child Language Development	.026	.92	.001	0.1%

***** *significant at $p < 0.05$*

Appendix C: Participant Information and Consent Form

Participant Information and Consent Form

Research Project Title: Influence of Maternal Age on Infant Home Language Environment

Principal Investigator: Karmen McDivitt, 1st Year PhD in Clinical Psychology
Email: adolescent@babylanguagelab.org, 204-474-6579

Dr. Soderstrom, Associate Head (Graduate), Associate Professor, Department of Psychology
Email: M_Soderstrom@umanitoba.ca, 204-474-8777

This consent form should give you the basic idea of what the research is about and what you are being asked to do. 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.

Purpose: Karmen McDivitt is conducting this study as her PhD Dissertation, under the supervision of Dr. Soderstrom. The purpose of this research is to study the language environments of children aged 0-24 months born to young mothers. We hope to learn more about how young mothers can best support their child's language development.

Participating in the research: We will first ask you to complete a short questionnaire about your background and home life. We will also show you how to use the LENA device, which will be used for the home audio recordings. During a 1-month period, you will use the recording device during your daily activities, at least once a week (ideally 4-6 recordings total). Each recording should be at least 10 hours long (a full day). You will dress your child in clothing designed to hold the recording device. The device will be placed in a pouch hidden in the front chest pocket. Once a week, a research team member will meet with you at your home or another mutually agreed upon location to pick up the recordings. You will also be asked to complete a short self report assessment on your knowledge of infant development and your child's language development.

Risks and Benefits: You may gain a sense of accomplishment for your contribution as a mother, and/or may learn some things about how you can improve your language interactions with your child. ***Your participation is voluntary. You are free to stop participating at any time.*** The potential risk of harm is no greater than that one might experience in everyday life. We hope that you and your child find this to be an enjoyable and educational experience.

Confidentiality: Should you choose to participate in the study, we would protect the identities of mother, baby, and others exposed during the recording sessions. When presenting our research, if it is necessary to refer to a particular sentence or utterance that might identify a person, we will use pseudonyms and/or mask the identifying information. 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 recordings themselves. 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 an 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.***

Your consent form and any other written materials that might identify you will be kept indefinitely in a locked file drawer. 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. The information in them will not leave the lab. Any sensitive and/or identifying materials obtained during the study period (including recordings and transcripts of recordings) will be stored indefinitely on a password protected laboratory computer. Copies may also be stored on backup drives stored in the locked file cabinet and in a secure location in the study coordinator's home. We will also ask for your permission (on a separate form) to share the recordings with other researchers. You can participate in the study without giving this permission.

We recognize that parenting is a difficult task, and no parent is perfect. Because we are collecting recordings of real people going about their real lives, we expect that the recordings will contain examples of less-than-ideal parenting, and such examples will be kept confidential and treated non-judgmentally. Please note, however, that if a researcher has a significant concern regarding the ongoing safety of any adult and/or child based on our visits or the recordings, we may be obligated to report our concern to the appropriate authorities. Confidentiality is not guaranteed in a situation where it conflicts with our legal obligation to report suspected child abuse.

We plan to share the results in publications and presentations at research conferences, and in academic journals, as well as on the web, and other public forums We might occasionally show a small segment of a recording or transcript (up to 10 seconds maximum) to a group of people outside the lab (e.g. researchers at a conference where we are presenting our data) to illustrate a finding. However, in doing so we will not provide any information that could identify you or anyone else as a participant. Also, it may occasionally be necessary to allow remote access to our files to LENA technical support. This access would always be supervised by the lab Director (Dr. Soderstrom) to make sure your files remain confidential.

Your contact information will be kept in our database for up to ten years in case we need to contact you about your recordings, and you may be contacted for future studies in our lab. Should you at any time wish not to be contacted for future studies, please tell a study team member, and we will be happy to remove your name from our calling list.

We will do our best to preserve your confidentiality. All information discussed and collected during meetings with the researcher will be kept confidential, and your participation in the study will not be deliberately communicated to anyone outside of the laboratory. However, if we are meeting with you in a public location, including on school grounds, it may not be practically possible to keep your participation confidential. You can always request to meet outside of school grounds or in a private location of your choice if this concerns you. Below, please indicate if it is OK for us to enlist the help of a third party, like your school, to contact you if we are having trouble reaching you. (please circle).

I **DO/DO NOT** give the Baby Language Lab permission to contact a third party if they have having trouble reaching me.

School: ___ OR Family Member: ___ Third Party Contact Information:
_____

If at some point after your enrollment in our study, should we lose contact with a recording device, or should a device be misplaced, we may activate our GPS feature attached to the device in order to locate it. We will active the GPS feature after receiving your permission, or if we have not heard from you within 30 days of our request to collect the device. The GPS feature will only be used to locate the device, and will never be used to track you or your child.

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 young children, 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 or Facebook account “The Baby Language Lab at the University of Manitoba”, which has information on past and present study information. In addition, we send out a yearly newsletter in May that updates our participants on our latest projects.

Compensation: You will receive a $10 gift card for each 10-hour recording you complete. We request that you complete at least one recording a week during the 1-month recording period, however you are able to make up to 6 recordings total. In addition, for remembering to complete a recording on time (within a 1 week time period), you will receive an extra $10 cash bonus. Therefore you are able to obtain between $40 and $60 in gift cards, and up to $60 in cash bonuses. You will also be given a $10 gift card for completing and returning this consent form. The gift card will be for a local store in your community where you will be able to purchase necessary items such as food, clothing, etc. You will be given a choice among several local stores (e.g. Sears, the Bay, Superstore).

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 Psychology-Sociology Research Ethics Board (PSREB). If you have any concerns or complaints about this project you may contact Karmen McDivitt, Dr. Melanie Soderstrom, or the Human Ethics Coordinator (HEC) at 474-7122, or email humanethics@umanitoba.ca. A copy of this consent form will been given to you to keep for your records and reference.

1. I wish to receive reports form this study by ☐ email ☐ letter. *Yearly reports will be sent out in May with updates on study progress.*

Please provide address: _____

2. I **DO/DO NOT** give the Baby Language Lab permission to contact me for future studies (please circle).

3. Would you like to receive a summary of their LENA information via the above address? (please circle). **YES/NO**

4. Are you the decision maker for your child? For example, if your child were in the hospital, would you be the person making decisions about their care? (please circle). **YES/NO**

5. Do you provide unsupervised care for your child? (please circle). **YES/NO**

Signature of Participant: _____
Date: _____

Researcher and/or Delegates Signature: _____
Date: _____

Signature of Parent/Guardian (if needed): _____
Date: _____

Appendix D: Demographic Questionnaire

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Demographic Questionnaire

To be filled out by experimenter:

Data code: _____
Study: _____
Date: _____

Please note: Responses to these questions are *entirely voluntary*. The information you provide to use 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.

1. Parent Information

Parent 1 (you):

Age: _____

Gender: _____

Birthday (Day/Month/Year): ___/___/___

Do you consider yourself to be (please circle):

White Black Aboriginal Other: _____

What grade are you in (please circle)?

Grade 10 Grade 11 Grade 12 High School Completed College

Did you have experience with children before becoming a parent (please circle)?

Yes No

If yes, describe: _____

How often are you away from your child? _____

Parent 2 (leave blank if no second parent is involved in your child's care:

Age: _____

Gender: _____

Birthday (Day/Month/Year): ___/___/___

Are they (please circle):

White Black Aboriginal Other: _____

What grade are they in (please circle)?

Grade 10 Grade 11 Grade 12 High School Completed College

Did they have experience with children before becoming a parent (please circle)?

Yes No

If yes, describe: _____

How often is Parent 2 away from your child? _____

2. Children in your Family:

Child participating, Date of Birth (Day/Month/Year): ___/___/___ Male or Female (circle)

Does your child have siblings? Yes No

If yes,

Date of Birth (Day/Month/Year): ___/___/___ Male or Female (circle)

Date of Birth (Day/Month/Year): ___/___/___ Male or Female (circle)

Date of Birth (Day/Month/Year): ___/___/___ Male or Female (circle)

3. Household:

Who are the adult members in your household?

_____

_____

Are there grandparents or other family members involved in childcare? Yes No

If yes, please describe: _____

4. Formal Childcare:

Does your child attend daycare? Yes No

If yes, what type (please circle)?

In home (licensed) In home (unlicensed) Child care center

If yes, how often does your child attend daycare (please circle)?

1x a week 2x a week 3x a week 4x a week 5x a week 6x a week everyday

5. Language Background:

What percentage of the time are the following languages used in your (your child's) household (please circle)?

Canadian English:	0%	10%	25%	50%	75%	90%	100%
Canadian French:	0%	10%	25%	50%	75%	90%	100%
American Sign language (not baby sign):	0%	10%	25%	50%	75%	90%	100%
Other Languages: _____	0%	10%	25%	50%	75%	90%	100%

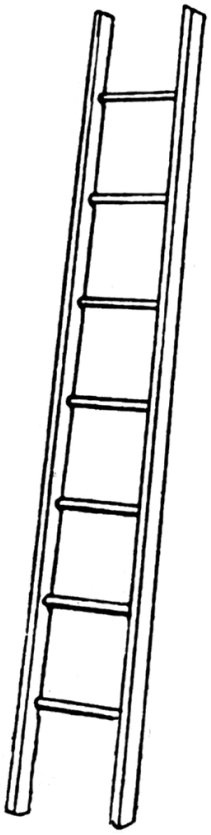
Do you use "Baby Sign" with your child? Yes No

6. Think of this ladder as representing where people stand in Canada.

At the **top** of the ladder are the people who are the best off – those who have the most money, the most education, and the most respected jobs. At the **bottom** are the people who are the worst off – who have the least money, least education, and the least respected jobs or no job. The higher up you are on this ladder, the closer you are to the people at the very top; the lower you are, the closer you are to the people at the very bottom.

Where would you place yourself on this ladder?

*Please place a large "**X**" on the rung where you think you stand, at this time in your life, relative to other people in Canada.*[1]



[2]

[1] Adapted from The MacArthur Scale of Subjective Social Status

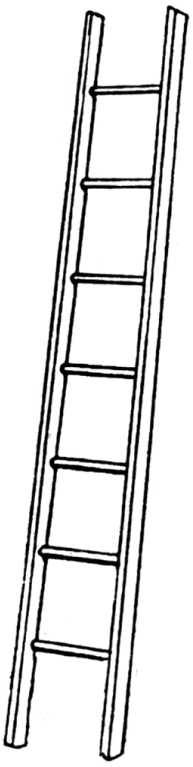
[2] Ladder retrieved from http://www.clipartkid.com/images/150/leaning-ladder-clipart-etc-njlG8N-clipart.gif

7. Think of this ladder as representing where people stand in their communities.

People define community in different ways; please define it whatever way is most meaningful to you. At the **top** of the ladder are the people who have the highest standing in their community. At the **bottom** are the people who have the lowest standing in their community.

Where would you place yourself on this ladder?

*Please place a large "**X**" on the rung where you think you stand at this time in your life, relative to other people in your community.*



Please describe what 'community' meant to you as you completed this task:

_____
_____
_____

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8. Child Background

Was your child born prematurely? Yes No

Child Due Date (Day/Month/Year): ___/___/___

Is your child from a multiple birth? Yes No

If yes (please circle): Identical Fraternal Not Sure

Are you aware of any hearing impairments or difficulties in your child? Yes No

If yes, please explain: _____

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

Yes No

If yes, please explain: _____

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

Yes No

If yes, please explain: _____

Appendix E: Overall Speech Processing Framework for LENA

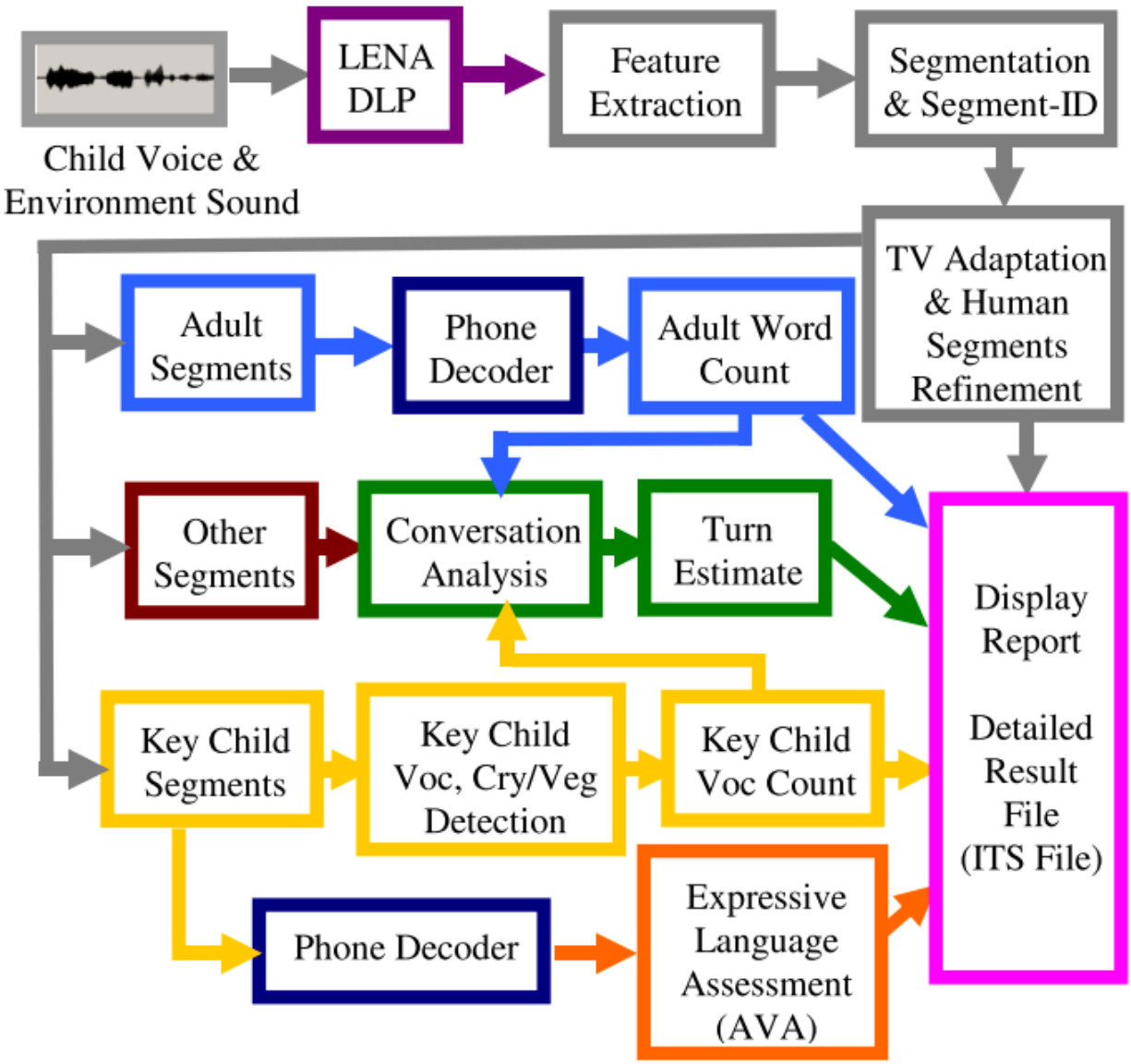


Figure 1: Overall speech processing framework for the LENA system.

Xu, D., Yapanel, U., & Gray, S. (2009). Reliability of the LENA Language Environment Analysis System in young children's natural home environment. *Retrieved online July*, *27*, 2009.

Appendix F: Parental Report Form Example

Baby Language Lab: Study Report

Dear

Thank you so much for your participation in our Adolescent Mother study! Your participation will help us understand how to address the unique needs of adolescent mothers and their babies. It is very much appreciated. Below is a report about your child's language environment and your child's development based on the information we collected during the study. We have included your child's scores on the Bayley Scales of Infant and Toddler Development (BSID-III), and the MacArthur-Bates Communicative Development Inventories (MCDI), as well as a brief summary of some of the information provided by the LENA system. We have also included your score on the Knowledge of Infant Development Inventory (KIDI) for your information.

A few important things to help you understand the report:

- ***We are not a diagnostic or medical laboratory.*** We are using these assessments for research purposes only. You should not take your child's performance in our lab as any kind of medical assessment. If you have concerns about your child's development, please consult your doctor.
- ***Children vary considerably in the timing of the milestones tested, so if your child is in the lower ranges of performances in our tests, this does not necessarily mean your child is at risk for developmental difficulties.*** These tests are NOT tests of child IQ. Children may perform very poorly but later catch up to, or even surpass, their peers. Also, sometimes children just perform poorly on the test on a given day because they are upset, hungry, or acting shy. However, if your child performed in the lower ranges AND you have other reasons for concern about your child's development, you may want to bring this report to show your doctor when you discuss those concerns.
- ***The scores are given in "percentile" form.*** So for example if your child is listed as "40-60%", that means that your child was in the middle range compared with other children of the same age, with approximately half of the children performing better and half performing not as good. If you child is listed as "80-100%", this means they performed among the most advanced for their age group during the test.

Bayley Scales of Infant Development (BSID-III)

- ***We report two measures from the BSID-III (motor and cognitive).*** The motor development score reports on your child's physical development (e.g. grasping, crawling, rolling over). The cognitive score reports on your child's developing ability to understand and respond to the world around them (e.g. interest in pictures, solving puzzles, remembering hidden objects).

Age	Motor	Cognitive

Knowledge of Infant Development Inventory (KIDI)

- ***This is the score given for parental knowledge on infant development.*** The KIDI tests the parent's knowledge of a variety of aspects of infant development.

MacArthur-Bates Communicative Development Inventory (MCDI)

- ***You may have been given either the Words & Gestures (8-16 months) OR the Words & Sentences MCDI (16+ months) booklet based on your child's age. Parents of infants younger than 8 months were not given this***

questionnaire. For either age groups e report 4 measures of language development based on the MCDI you completed. Each of the 4 components makes up an important aspect of language development, and is given a percentile score.

Words & Gestures (8-18 Months)

Phrases Understood	Words Understood	Words Produced	Gestures

Words & Sentences (16-30 Months)

Words Produced	Word Forms	Word Endings	Sentence Complexity

LENA

- ***This is a report based on the 4-6 LENA recordings you completed for the study.*** This gives us estimates of your child's vocalizations, the number of words spoken to your child per hour, and the conversational turns (number of verbal exchanges between the child and others). In addition, this report gives estimates of the percentage of time your child is exposed to several language and sound environment characteristics. Please keep in mind that all of these measures are estimates only. Based on certain acoustic characteristics of the recording, the LENA program analyzes the probability that a particular sound falls into one of these categories. In addition, the categories are somewhat broad, and the labels used by the system a little misleading. We have therefore provided some more detailed explanations of each of these categories below, so that you can better understand what they mean. Please feel free to call or email us if you have any questions or concerns about what any of this means.
- ***LENA Categories***
    - ***Meaningful Speech:*** This category is the one used by LENA to determine the estimates of child vocalizations, adult words, and conversational turns. Segments of time in this category are speech (either by an adult or child, including your infant) deemed to be clear, loud, and intelligible. They are typically produced within about 6-10 feet of the child and are assumed to provide the primary linguistic input from which the child is learning to speak.
    - ***Distant Speech:*** This is a catch-all category for segments that the system cannot easily classify. They are typically speech segments that are further than 10 feet from the child, but may also include other noises that the system doesn't recognize, or quiet speech that is close by. This is speech-like sounds that are unlikely to be helpful to your child in learning to speak.
    - ***TV:*** This is a category for TV, radio, and other electronic sounds, like music recordings. Note that if you play a music CD while the children are sleeping (for example), that will be included in this category. It is common to see about 1% TV input in your report even if there is no television.
    - ***Noise:*** This category is used for non-language noises, such as jostling, rattle, bumps, bangs, etc.
    - ***Silence:*** This category is reserved for time periods for which there is little or no noise or language taking place.

Adult Word Count: This is an estimate provided by LENA of the number of words your child hears. In general, about xxx words per hour is considered average. Hearing more words has been shown to help babies learn language.

Child Vocalizations: This is an estimate of how often your child babbles or talks. Vocalizing is how babies practice talking.

BABY LANGUAGE LAB

UNIVERSITY OF MANITOBA

Conversational Turns: This is a measure of how often you talk to your baby and they respond, or vice versa. In addition to just hearing you talk and vocalizing themselves, having the give-and-take of a conversational turn is important for learning about language.

AVA score: This is an estimate that LENA makes based on analyzing the sounds that your child makes. The AVA score tells us how far along your child is in producing speech sounds the way adults do.

Explanation of your scores:

NOW WHAT?

Now that you have learned a little bit about how your child is progressing, and how much they are being stimulated by your language, you may decide that you want to try to talk more (or better) with your child. Here are some tips for providing a good "language environment" for your child, to increase the amount, and the quality, of the language they hear.

Read with your child. A large number of studies have shown us that children who are read to from an early age (even young babies!) learn language better and faster. Reading gives your child one-on-one language attention, and also gets them in the habit of spending time with books, which will help them to have a love of reading when they are older. When reading with your child:

- Don't feel like you have to stick with the written words. Ask questions about the pictures or story, point out things that look interesting, respond to their cues if they seem interested in something specific.

Find a community with other moms and babies, or get out of the house. It can be hard to feel like talking with your baby if you're stuck at home all day. Other moms feel the same way and there are loads of moms' groups out there. Getting out of the house and spending time together with other moms and babies will help you talk more to your baby and is important for your mental health as well. If you're not sure where to find a local baby group, we can give you some suggestions. You can also just go to the library or other outings that are fun for you and your baby. Some moms even go to "baby rhyme" groups that have play-based singing and talking activities with moms and babies.

Make use of "everyday" moments. Even a simple trip to the grocery store can become a language teaching time. Talk with your child about what you are doing and get them involved in an age-appropriate way.

Avoid the TV and screen time. TV is not recommended for kids under 2 years. Even with older children, it's important to set boundaries about how much. You can set a good example by watching less TV yourself. Avoid using your phone (texting, Facebook, etc.) as much as possible when you are with your child. Every moment you are in front of the screen is one less moment for talking with your child. If you do turn on the TV for your child, pick high quality children's programming like Sesame Street, and try to sit with them and have it be an interactive time – ask them about the things they are seeing.

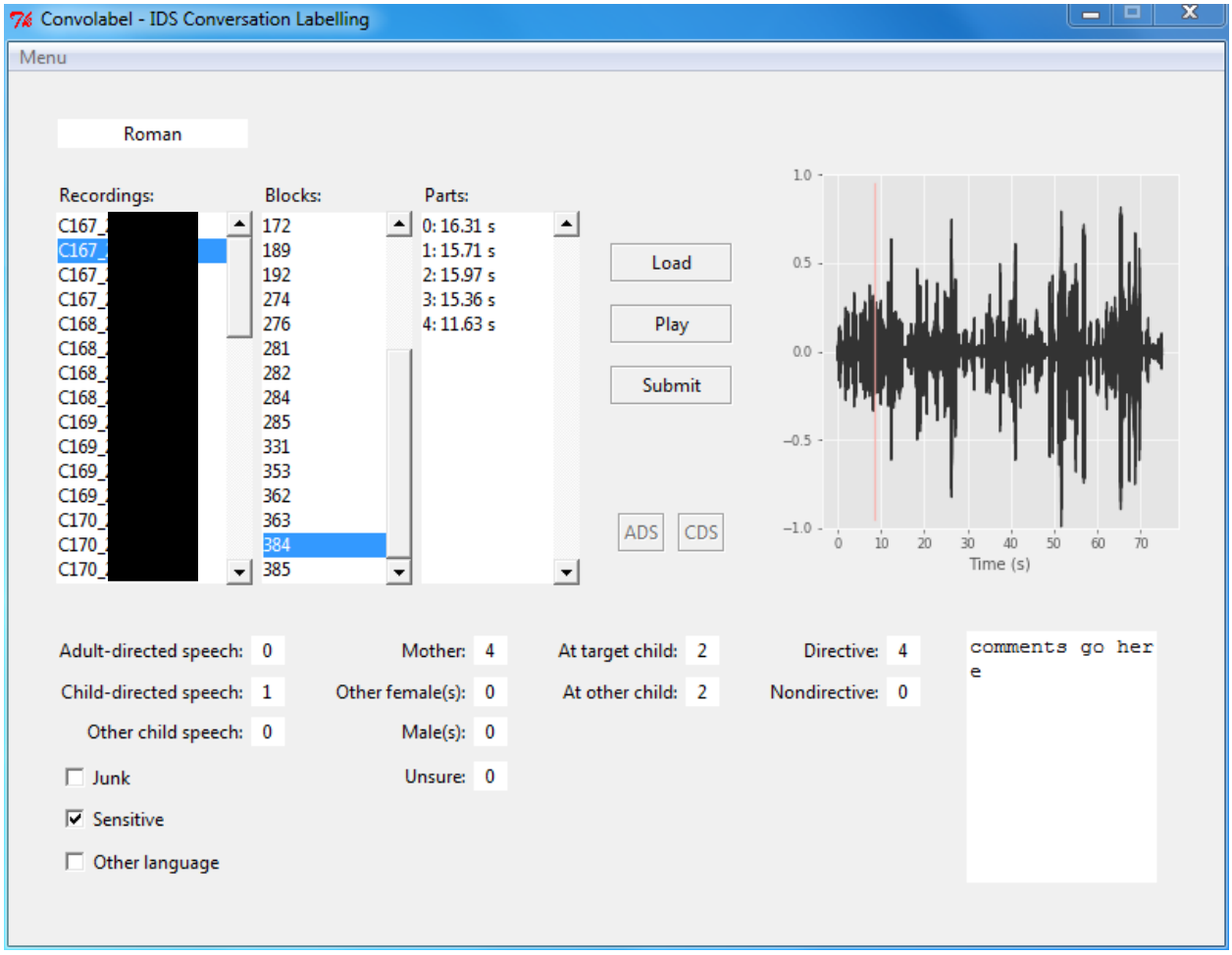
Ask questions and engage your child. Questions are a key part of language learning for children. Asking questions even if they can't answer back sets the stage for learning about conversations. Talk to your child about what you are doing, point things out that might interest them, and tell them the names for things.

Once again, thank you so much for participating in our study. Please do not hesitate to contact my supervisor, Melanie Soderstrom, or me if you have any questions or concerns about this report.

Sincerely,

Karmen McDivitt

Appendix G: Visual Representation of ConvoLabel



Appendix H: McDivitt Manual for Labelers – Young Mother Project

McDivitt Manual for Labelers –Young Mother Project

Adapted from https://osf.io/d9ac4/wiki/home/

Last Edited by: Karmen McDivitt, March 21, 2018

Introduction:

You will be given a set of conversational blocks to label. These blocks are chunks of speech that LENA has labeled as being a conversational exchange (a set of speech segments) from one or more speakers bounded by a silence of at least 5 seconds on each end – in other words, what LENA thinks is a conversation! You will find that LENA's chunking and labeling process is far from perfect. Just do the best you can to label these **conversational blocks**, following the instructions below.

Before Starting to Label:

1. Take a look at the participants corresponding file, located in the filing cabinet in the "Adolescent" drawer, focusing on the "Participant Information" sheets, which will give you information on child age, mother age, family environment, and the "Recording Sheet" which will give you information on the type of activities the mother and target child were exposed to on the day of the recording (e.g. bus rides, park, play dates).

2. Listen to the example clips provided for example speech segments of the mother speaking in both child-directed and adult-directed speech. These can be listened to by clicking the example ADS/CDS buttons on the main program screen.
    - To add in the ADS and CDS sample clips, go to Menu > Set ADS sample/Set CDS sample. Select convolabel > mother clips, then pick the desired clip.

3. First listen to the whole block from start to finish, but don't tag anything yet. Ask yourself:
    - How many participants are there?
    - Who are the participants (adult vs. child/infant)?
        - ➢ Outsiders, such as cashiers, can still be labeled.

4. Then listen to the conversational block again and ask yourself:
    - What type of speech is present?
    - Who is speaking? Is there a single speaker?
    - If not, is there a foregrounded speaker? This is a speaker who is easier to perceive than other talker(s) or noises in the block.
    - Who is the mother speaking to?

Helpful Info:

- Please reference the waveform diagram that appears with each block to assist with labeling/estimating input percentages.
- Please label block segments, if the block has been broken down into segments.
- Please select blocks IN ORDER presented in program and label block PARTS when available (not whole block).

For Step-By-Step instructions on Program Use/additional information, visit before labelling:

https://github.com/babylanguagelab/bll_app/blob/master/src/app/convolabel/README.md

Remember: The primary purpose is to estimate the amount of speech children are hearing that is ADS vs CDS. Pay attention to who you think the baby would be attending to.

Categories

Category	Meaning	Amount in %
0	None	0
1	Some	1 - 33
2	Half	34 - 66
3	Most	67 - 99
4	All	100

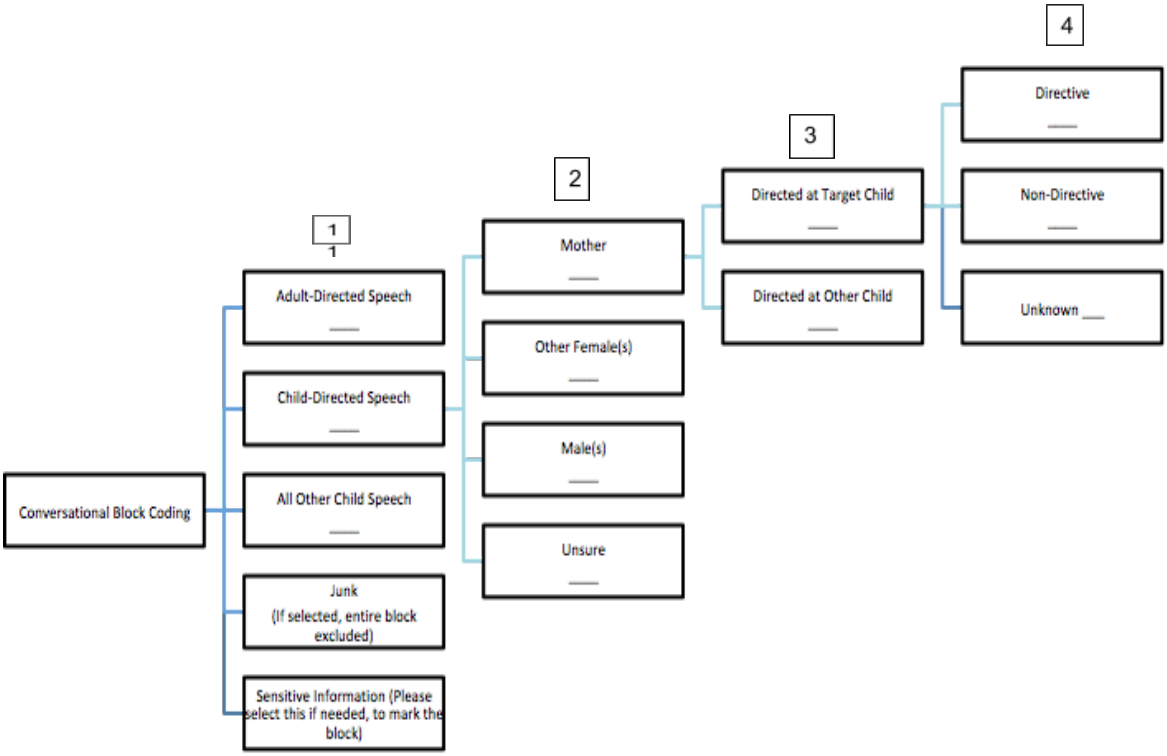
Categories Detail:

- **0 / None**
  - Select this category if NO speech of the type labeling is present
  - OR if the majority of the block is junk (e.g., 80-90% do not label the small amount as speech and just label the block as junk and move on).
- **1 / Some**
  - If A LITTLE BIT of the speech type is present in the block
  - This is basically flagging that a small proportion of the block is this speech type (i.e. it is present but not overly significant to the overall block)
- **2 / Half**
  - This includes a little less than half, half, and a little more than half
- **3 / Most**
  - If the majority of the block is of a specific speech type, select most
- **4 / All**
  - If the entire speech block is made up of one specific speech type

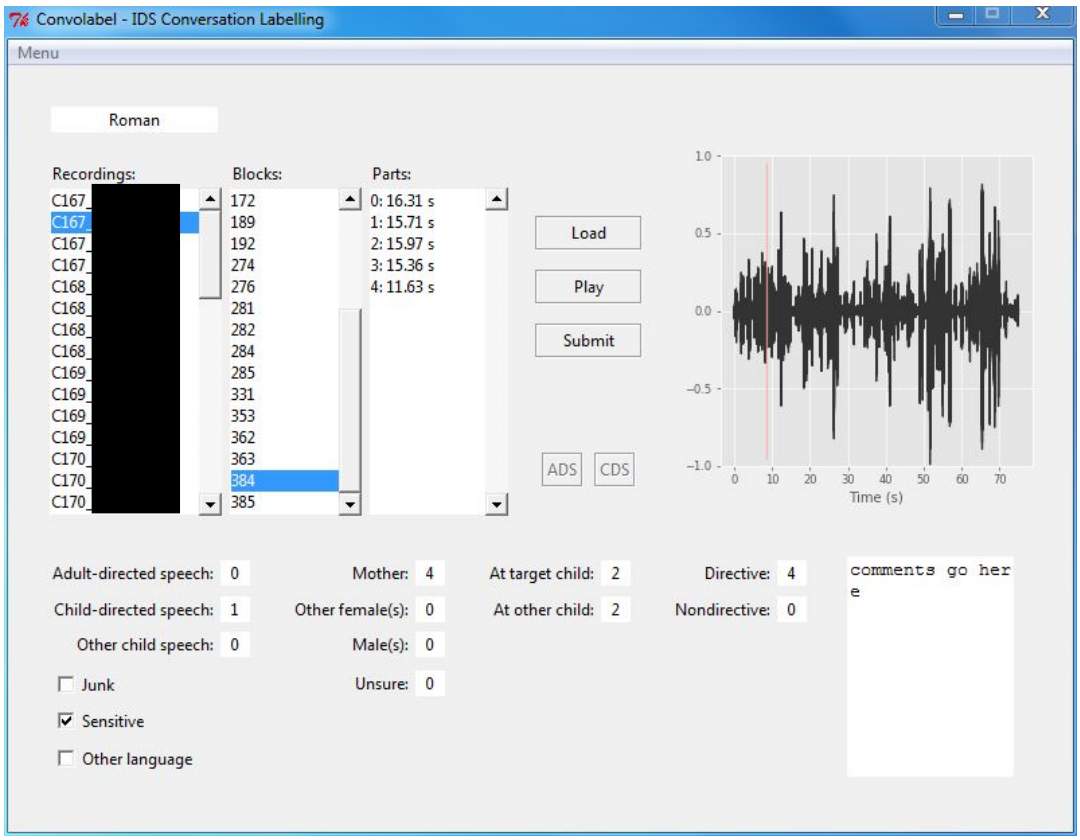
Special Considerations:

- The significance of an utterance (i.e. a statement) will vary depending on the length of the block.
  - For example: In a 5 second clip, a short utterance (2 seconds) would score a 2, whereas in a 30 second clip with a short utterance (2 seconds) would score a 1.
- We want to be labeling any MEANINGFUL speech/utterances (e.g., if a mother is calling her child “Amy” although this is only one word it would be labeled appropriately – unless it meets the JUNK cutoff range [see below])
- How to handle silences:
  - If there are silence/natural pauses (less than 5 seconds longs) within a sentence from the same speaker, include that in your percentage of speech.
  - Another important example: Say you are confident that you want to label ADS as a 3, but then you have a period of silence and a small amount of CDS, in this case, choose to label the CDS if it is meaningful speech.

Labeling Guide



Example of Labeling Program



When to use Comments Section:

- If another language other than English is spoken (please specify if you know the language)
  - ➢ It can be helpful to look at the participant's personal information sheet first to see if they mention using another language in the home.
- If you have reason to believe that the LENA device has been covered (so that speech is muffled), taken off, etc.
- If the conversation block is unique in any way

Your task as a labeler is to identify the amount of language INPUT the target child (24 months of age or younger) is exposed to by:

1. Judging the amount of speech that sounds like it is between adults (**ADS**), adult speech directed at any child (**CDS**), any child speech (**CS**), or noise but not speech (**JUNK;** NOTE that coding JUNK will exclude the full block). You are also in charge of identifying sensitive information (**SENS**) present in the block, or language other than English (**OL**) present in the block.

- **ADS**: Adult-Directed Speech
- **CDS**: Child-Directed Speech
  - ➢ This speech types includes ALL speech that is directed at the target child or another child present (it does not need to have the unique characteristics if "babytalk" in order to receive this designation). Use your best judgement to determine if the speaker is speaking to a child (under the age of 8 years of age).
    - If there is an adult talking to a child, but it sounds like ADS still label as CDS
  - ➢ Label using the context, then use acoustics as the secondary option if you cannot label based off of context alone
  - ➢ If a child over 8 years old is speaking:
    - Label their speech as CDS if they are talking to someone younger than 8.
    - Do not count their speech as child speech. Only a child younger than 8, can count as child speech.
- **CS**: Child Speech
  - ➢ When coding any child speech, the cut off for a child for the purposes of this manual is: **Younger than 8 years old**, but use your best judgement and the context/surrounding speech/how they are being talked to. In deciding if it is CDS or not, first check in their personal information to see if there are any older siblings around that age. If there are siblings older than 8 years old, any speech directed at the sibling would be ADS.
- **JUNK**: E.g., television, phone, computer, radio, iPad, iPhone, electronic toys, electronic 'reader' books, toy, PA system, silence, crying, distant speech, overlapping speech, other non-linguistic sounds (e.g., pianos, guitars)
  - ➢ Soothing/other sounds that are quasi-linguistic (e.g. 'shhhhhhh', "hm", "kissy sound") are labeled as junk without a vowel sound but are classifiable with a vowel sound
  - ➢ Distant speech is speech where you cannot understand what they are saying, and/or cannot tell what type of speech it is.
  - ➢ Overlapping speech is speech that is overlapping so you cannot hear what they are saying or cannot understand what type of speech it is, or speech that is overlapping and does not have a foreground speaker that is identifiable.
    - If it is only a small amount of overlap, where you can still understand what is being said, leave it in as speech.
    - If there are multiple conversations happening in the same room and it is impossible to understand, label block as junk.
    - If there is both background and foreground speech overlapping, label the foreground speech only, if the foreground speaker stops talking and the only speech present is the background speech, do not label the background speech.
  - ➢ Please label muffled or unclear speech appropriately if you can tell what kind of speech it is and DO NOT label as junk.
  - ➢ If you cannot tell what's happening because baby is on his/her belly where the mic is so there's rustling or dampening of the input label as junk.
  - ➢ If the conversation block is mostly of noise that is defined as junk, select the junk label, and move on to the next block. So, if the majority of the block is junk (e.g., 80-90% do not label the small amount as speech and just label the block as junk and move on).
  - ➢ If the speech clip is not one that would be useful to play to an outsider as an example of the speech type (i.e., if there is very limited meaningful speech) then label as junk.

- **SENS**: Sensitive Information
  - ➢ Please select whether the conversation block has sensitive information in it (see below for criteria), this will not exclude the block, but will simply mark the block for further consideration).
- **OL**: Other Language
  - ➢ If speech other than English is present, please also select the "Other Language" box, and leave a comment in the comment box stating "language other than English present". If you know the language, specify what it is, but still do not label.

Note: This does not need to add up to 4, but the sum should not be greater than 4.

Provide your estimate of how much of each type of speech there is in a block. Enter your estimates as categories:

- Adult-Directed Speech (**ADS**): ___
- Child-Directed Speech (**CDS**): ___
- Child Speech (**CS**): ___
- Noise (**JUNK**): ☐/☒
- Sensitive (**SENS**): ☐/☒
- Other Language (**OL**): ☐/☒

Special Considerations:

- If you hear an acoustic vowel, classify it as CDS/ADS (e.g., Oooh, uhh, umm, weee!)
- If you hear babbling, classify as child speech (e.g., dadada)
- Reading and singing are labeled as speech unless there are no vowel sounds (this excludes humming)

2. If the conversation block has any amount of Child-Directed Speech (CDS), judge the amount of this child-directed speech that is coming from the target child's mother (**MOTHER**), another female (**OTHFEM**), a male (**MALE**), or unsure (**UNSURE**).
    - **MOTHER:** Target Child's Mother
        - ➢ If you are labelling CDS, and most (category 3) of it is coming from a *Mother*, then some (category 1) of that speech must come from OTHFEM, MALE or from other folks who you're UNSURE about.
    - **OTHFEM:** Another Female
        - ➢ If you are having a hard time distinguishing between the target child's mother and another female within the same block, label as MOTHER (i.e. when in doubt, label as mother)
    - **MALE:** Male
    - **UNSURE:** Unsure

    Note: This needs to add up to 4.

Provide your estimate of how much of each type of speech there is in a block. Enter your estimates as categories:
- Target Child's Mother (**MOTHER**): ___
- Other Female: label as (**OTHFEM**): ___
- Male: label as (**MALE**): ___
- Unsure: label as (**UNSURE**): ___

Special Considerations:

- *Mother* speaks half (category 2) of *Child-directed speech* in a block, and the rest is divided (not necessarily equally) between *Another female* (category 1) and a *Male* (category 1). In total, there is 2 (half) + 1 (some) + 1 (some) = 4 (all).

3. If the Child-Directed Speech (CDS) is from the target child's mother (MOTHER) for at least any percentage of the time, judge the amount of this speech that is directed towards the target child (Directed at Target Child; **DTC**) and the amount of this speech that is directed towards another child (Directed at Other Child; **DOC**).
    - **DTC:** Directed at Target Child
        - ➢ If the mother is addressing multiple children including the target child, label as DTC.
        - ➢ If there are multiple children and you are unsure if the speaker is talking to the target child or another child, label as DTC.
    - **DOC:** Directed at Other Child

    Note: This needs to add up to 4.

Provide your estimate of how much of each type of speech there is in a block. Enter your estimates as categories:
- Directed at Target Child (**DTC**): ___
- Directed at Other Child (**DOC**): ___

4. If at least any percentage of the target child's mother's speech (MOTHER) is directed towards the target child (DTC), judge the amount of this speech that is directive (**DIR**) and the amount of this speech that is non-directive (**NONDIR**) or unknown speech (**UNKWN**) if you are unsure whether it is directive or non-directive.
    - **DIR:** Directive-Infant Directed Speech
        - ➢ This is defined as speech from mother to child, which is a command, recommendation, or request, which communicates to the child that they should act, speak, or focus on something in their environment (McCathren, Yoder, & Warren, 1995).
        - ➢ DIR includes both directive (e.g. "wave goodbye") and prohibitive (e.g. "don't eat that") utterances (Kitamura & Burnham, 2003). Essentially, it is the act of a mother having a baby do what is directed (Kitamura & Lam, 2009)
        - ➢ Included in DIR are need statements, imbedded imperatives, permission directives, and question directives (see examples below). Please use your best judgement and the available context in order to determine whether the mother's intent is to have their baby *do/act/speak/focus* on what is directed.
    - **NONDIR:** Non-Directive-Infant Directed Speech
        - ➢ All other speech (e.g. comforting, approving, questioning, narrating) should be considered (NONDIR) or (UNKWN).
    - **UNKWN**: Unknown Speech
        - ➢ If you are not able to decipher whether the speech is Directive vs. Non-Directive, select the "Unknown" option.
        - ➢ If the speech type is CDS and it is muffled or unclear, at the directive/non-directive level label as Unknown.

Directive Examples:	**Non-Directive Examples:**
- *"Get the blankie" (Directive)** - *"I need the blankie" (Need Statement)** - *"Could you get me the blankie?" (Imbedded Imperative)** - *"May I have the blankie?" (Permission Directive)** - *"Do you have the blankie?" (Question Directive)** - *Repeating a phrase/sound with the expectation that the child will repeat it* - *"You're going to have to wait one second." (i.e. please wait)* - *Saying child's name to direct attention* - *"You gotta get your foot straight."* - *"Another kiss?" (i.e. give another kiss)* - *"You don't have to try and reach." (i.e. do not reach)* - *"What's that cat doing?" (i.e. look at the cat)*	- "You'll be fine" - "Let's change your bum!" - "We've got to put your diaper on." - "Last bite!" - "Good job!" - "What do you have in your hand?" -" Ouch, ouch" (if the meaning is for the child to understand "that hurts")
**adapted from (Ervin-Tripp, 1976)*	

Note: This needs to add up to 4.

Provide your estimate of how much of each type of speech there is in a block. Enter your estimates as categories:

- Directive Speech (**DIR**): ___
- Non-Directive Speech (**NONDIR**): ___
- Unknown Speech (**UNKWN)**: ___

Special Considerations:

- Focus on intention and not explicit meaning when coding directive vs. non-directive. For example "we don't jump on the beds" would be labelled directive (given context) if the mother's intention was to have the child stop jumping on the bed.

Primary Criteria to Use to Decide if There is Sensitive Information Present

URGENT Sensitive information present in conversation blocks that must be labeled as "sensitive" (**SENS**):

1. If any individual that is at risk of immediate harm, or you believe are at risk of future harm.

    Examples:
    The individual is discussing suicide or a suicide plan.
    The individual fears for his or her life.
    The individual is in an abusive relationship.
    The individual is describing a situation currently happening or that is planned for the future, which is life threatening.
    The individual is negligent in caring for himself or herself, or purposely puts themselves in situations which have the potential to be life-threatening.

2. If you believe a child is at current or future risk for abuse or neglect, or there is mention of unreported abuse or neglect that occurred in the past.

    Examples:
    The child has been/is being physically, sexually, or emotionally abused
    The child has been/is being neglected, or not being provided with the means to sustain a healthy life (such as starvation).
    The child has not been/ is not being given the appropriate care for their level of development (such as missing a large proportion of school).

3. Illegal activity.

    Examples:
    Illegal drug use, sexual behaviour, stealing, homicide, carrying of illegal weapons
    Description or participation of illegal activities

Safety Sensitive Section:

1. Last/family names (first names, including uncommon ones, are okay)
2. Addresses or other contact information
3. Birthdates
4. Social security, credit card, etc. numbers

If you come across a conversation block that contains sensitive information, both urgent and safety sensitive, please mark the block as sensitive and explain the sensitive information in the comment box.
If URGENT, state it in all caps at the beginning of the comment and send an email to both Karmen McDivitt and Dr. Soderstrom, with information on how to locate the block.

If the recording is <u>less than 1-year old</u>: Dr. Soderstrom and Karmen will handle any situations that include this information, on a case-by-case basis, and will consult with the ethics board before coming to a decision on how to appropriately handle the information.

Appendix I: Young Mother Labeling Team Orientation Checklist

Young Mother Labeling Team Orientation Checklist

Check Mark	Date Completed (mmm/dd/yyyy)	Orientation Task
		Email Karmen copies of CORE and PHIA certification, and completed lab forms (2) -Note, if you have not completed these yet, complete at the following links: CORE: http://www.pre.ethics.gc.ca/eng/education/tutorial-didacticiel/ PHIA: http://umanitoba.ca/access_and_privacy/survey.html?audience=general_phia
		Email Karmen at mcdivitk@myumanitoba.ca and request reading materials
		Read Karmen's Master's Thesis
		Read Karmen's Dissertation Proposal
		Read the Labeling Manual https://docs.google.com/document/d/1siXSj7qQMYPI5CFwohfNT50H5sPsmpj55IQXm_hzhJQ/edit?usp=sharing
		Read the Lab Manual: https://drive.google.com/drive/folders/0B-CaLIot2GOBcWZlMmxtMHdyNFU?usp=sharing & email Karmen confirming you have read the manuals.
		Read and sign the Pledge of Confidentiality Lab Form and NSERC Lab Form and email them to Karmen
		Email Karmen to inform her you have completed the readings and forms and are in need of your in-person orientation with a senior labeling team member
		In-Person Orientation: Example file from filing cabinet, review of: .... Baby birth date, date of recording (calculate baby age - rough estimate) .... Review # of parents, and family members involved in recording context. .... Have other siblings etc. been indicated? .... Review parents' schedules of time with their baby .... Review the journal log for the corresponding file recording # (day-log/journal entry for correct recording number). .... Review the activities completed with the child for that recording (did they stay home, visit family, go to the grocery store, etc)
		In-Person Orientation: Give Gmail credentials and create name label in new column of CDS spreadsheet.
		In-Person Orientation:

		Match file # in CDS spreadsheet with file # in "Lena" computer and file # in Convolabel app.
		In-Person Orientation: Review hard copy heuristics A. Category guide (P504a) B. Decision tree (P504e)
		In-Person Orientation: A. What is an embedded imperative? Explain with more examples B. What are the different kinds of directives? Explain with more examples
		In-Person Orientation: Shadow a senior labeling team member A. RA Lead begins to label and talks out their decision (10 min with intermittent questions; x>20%) B. RA allows trainee to navigate the Convolabel all and talk over their decisions. RA Lead gives the final call on labelling choice before saving to her file (10 min; x>20%). B. Look through previously labelled files of Team Lead at any time any location in files above 20% from RA Lead's previous work. (Find 5-10 specific examples not covered in 5.A, including various kinds of directive CDS, minimal 2 each type of directive).
		Email Karmen, let her know your In-Person Orientation is complete, you will then be matched with a 2nd senior labeling team member for 1 more hour of shadow labeling
		Complete shadow labeling with 2nd senior labeling team member
		Complete practice file C170 under your name within 1 week of final shadowing session
		Email Karmen when this file is complete
		Confirmation email from Karmen that inter-rater agreement analysis is complete, and you passed ☺
		Reserve an un-labeled file through the labeling spread sheet and get to work!

Please email this completed checklist to Karmen.

-Done-

Appendix J: Making Blocks for ConvoLabel

Baby Language Lab
via Trevor Sie

To make conversational blocks....in two sequences:

1.Convert your .its files to .cha files

2. Make blocks to be labelled

From Lena software program...
First you have to get the .its files converted to .cha; alternatively, the second file type required to make blocks which are .wav files, don't need to be converted.
.wav files for each converted .cha file need to be stored in the same place where the .cha files are exported to, after the file conversion.

Steps to convert .its to .cha

1. Access files from the Lena desktop application.

2. When relevant (participant files for block-making) raw files are found via file directory within Lena, files need to be exported for file conversion before blocks can be made. To export, first find export button in bottom left of screen.
Clicking that button will open a window with many options for export. The defaults will set a reporting on 5-minute time frames. The only options that need to be selected are as follows:
A) Set date of file to be exported (typically, 1 file of each kind for export at a time); &
B) Select .cha to be exported (.wav file is exported automatically).
Both will be exported to desktop.

3. Click export/ok. - .its files in addition to .wav files from Lena will be exported to desktop folder for quick retrieval for file conversion.

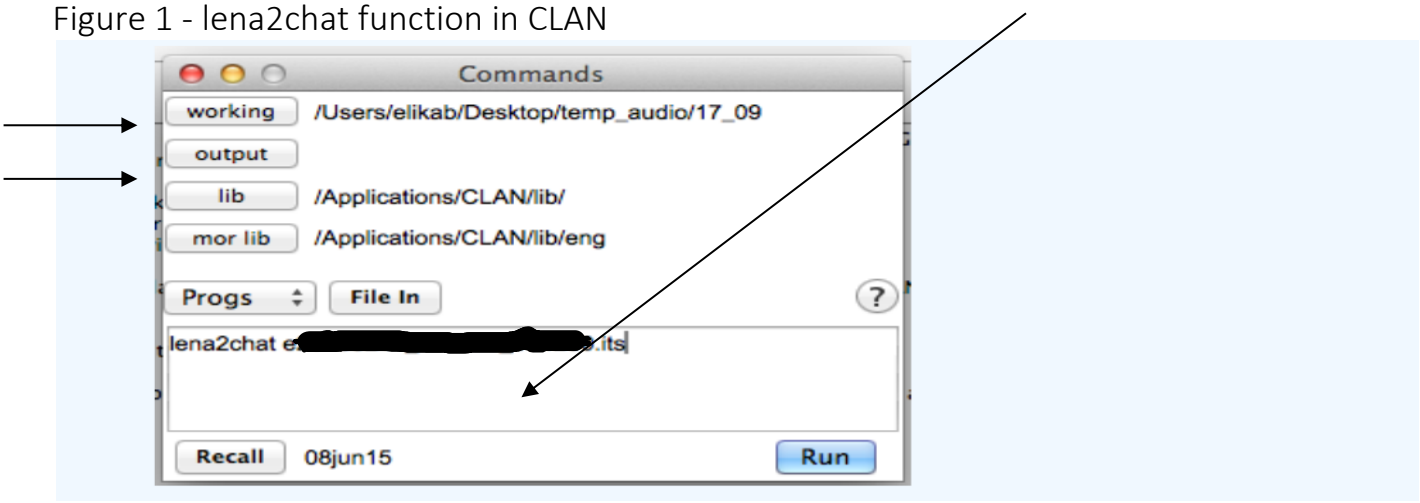
4. Create a new folder and put them in a folder on desktop.

5. When .its are successfully exported, and the file directory specified (new desktop folder), then use the desktop application called Clan to convert .its to .cha.

6. When Clan has been opened, the lena2cha command is run in Clan over an .its file. In the command box, type:
lena2chat (add a space, add file name and then add the .its file you exported from Lena, which you will find in the directory you created in new desktop folder). Remember to add the .its file extension before you continue.

The command box text you enter before you hit run, should look something like this.

Figure 1 - lena2chat function in CLAN



Before you click run, click the **working button** (see picture) to establish where the .its file is taken from for the file conversion (this is the new folder you created when you exported .its file from Lena.

Before you click run, also click **output button** to establish the destination for your new .cha file. (You will need to create a new folder location where your .cha(t) files will go, if you haven't already 😊.

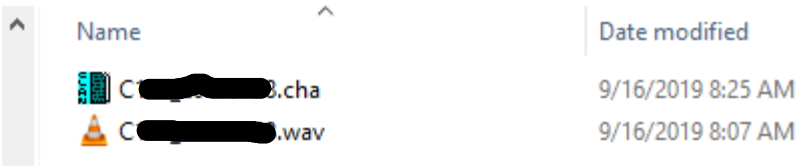
Note: you can move the corresponding .wav files in this next folder too, because you will need .wav and .cha files in the same place before you make blocks.

7. Then click **Run**

Now you should have your newly created .cha file and your corresponding .wav file. (**This process has to be done for each participant recording that you need to make blocks for**).
Make sure they both have the same filename. The only thing different will be the file extension (the last three letters) for each file (.wav and .cha).

Making blocks:

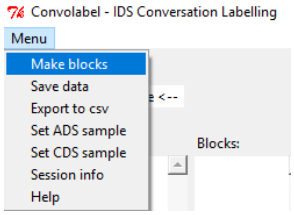
1. Make sure you now have a file folder with both .cha and .wav files:



There should be three folders: One folder in the file directory labeled input (I.e. input for making blocks); inside the input folder, include another folder with the folder name = participant number; thirdly, then a general folder that you put those files in input folder into, after blocks are made. That way, the input folder remains empty for next batch of .its and .wav files for making blocks.

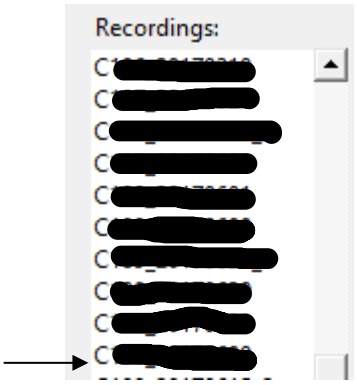
2. Go to ConvoLabel

3. Click upper left drop down menu from the title bar:



4. From drop down menu, click make blocks (blocks can only be made from south east computer in P504a).

5. When program is finished running, you can see your blocks in ConvoLabel.



You're finished !!

Appendix K: Recording Sheet

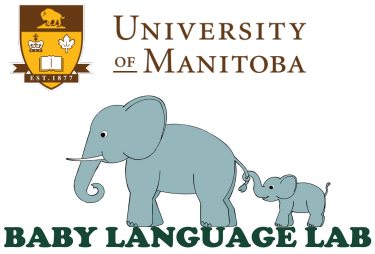
Adolescent Mother Study LENA Recording Sheet

DATE: _____

ID: _____

RECORDING #: _____

START TIME: _____ END TIME: _____



Please record naptime throughout the day:

NAPTIME

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

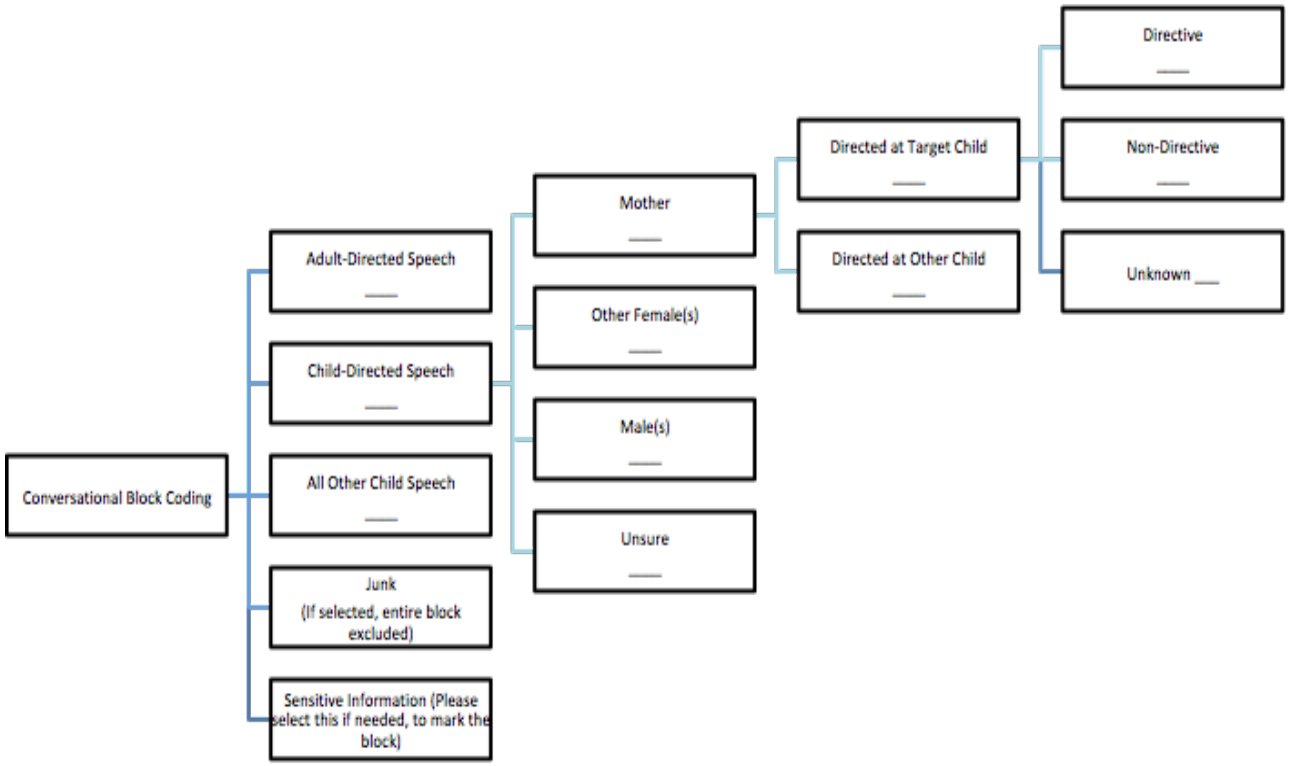
Please record an overview of activities completed throughout the day. Please complete this *at the end of the day* (not throughout the day while interacting with your child), as a summary:

ACTIVITY CATEGORIES (examples):

PLAYTIME *STORYTIME* *OUTSIDE VISITS* *TV TIME* *BATH TIME*

ACTIVITIES (approximate start and end times)	LOCATIONS	COMMENTS

Appendix L: Flow Chart of Labeling Sequence



Appendix M: Data Excluded, Missing, or Altered for Analysis

Participant	Data Type	Reason	Additional Information
C169	LENA File C169_*	Recording paused one time	LENA file altered
C170	MCDI	MCDI not completed	Excluded from MCDI analyses
C171	All LENA Files	Not enough recording data	Participant excluded from all analyses
C172	All LENA Files	Not enough recording data	Participant excluded from all analyses
C173	LENA File C173_* KIDI	Recording paused one time KIDI not completed	LENA file altered Excluded from KIDI analyses
C175	All LENA Files	Sensitive Information found in recording	Participant excluded only from R ConvoLabel analyses
C177	MCDI	MCDI not completed	Excluded from MCDI analyses
C179	All LENA Files	Not enough recording data	Participant excluded from all analyses
C180	All LENA Files	Not enough recording data	Participant excluded from all analyses
C183	LENA File C183_*	LENA ADEX output shorter than the WAV file	Participant excluded from all LENA analyses
C183	LENA File C183_*	Recording paused one time	LENA file altered
C184	All LENA Files	Recordings took place over multiple days	Participant excluded only from R ConvoLabel analyses
C185	MCDI	MCDI not completed	Excluded from MCDI analyses
C187	LENA File C187_*	Recorded over multiple days	Participant excluded from all LENA analyses

C187	LENA File C187_*	Recording paused one time	LENA file altered
C188	LENA File C188_*	ConvoLabel labeler error	Participant excluded only from R ConvoLabel analyses
C190	LENA File C190_*	Recording took place over multiple days	Participant excluded from all LENA analyses
C191	LENA File C191_* MCDI	Recording paused two times MCDI not completed	LENA file altered Excluded from MCDI analyses
C192	MCDI KIDI	MCDI and KIDI not completed	Excluded from MCDI and KIDI analyses

* = recording file name removed to maintain confidentiality

Appendix N: ConvoLabel Language Descriptive Statistics Per Second and 5-Minutes

ConvoLabel Language Descriptive Statistics Per Second (Global means by participant (i.e., unweighted by N of recordings of each participant), N=20)

Participant Number	Quantity of Maternal Infant Directed Speech (in AWC per second)	Quantity of All Adult Directed Speech (in AWC per second)	Quantity of Maternal Directive-Infant Directed Speech (in AWC per second)	Quantity of Maternal Non-Directive-Infant Directed Speech (in AWC per second)
C167	0.01	0.01	0.001	0.005
C168	0.1	0.1	0.004	0.01
C169	0.06	0.13	0.007	0.02
C170	0.08	0.28	0.004	0.05
C173	0.03	0.04	0.009	0.01
C174	0.13	0.01	0.03	0.09
C176	0.05	0.04	0.005	0.03
C177	0.07	0.05	0.008	0.05
C181	0.07	0.2	0.01	0.03
C183	0.04	0.19	0.008	0.02
C185	0.02	0.09	0.008	0.008
C186	0.07	0.13	0.03	0.03
C187	0.11	0.13	0.03	0.03
C189	0.01	0.03	0.005	0.005
C190	0.05	0.24	0.003	0.01
C191	0.07	0.13	0.009	0.04
C192	0.05	0.14	0.01	0.01
C193	0.12	0.19	0.02	0.07
C195	0.02	0.04	0.003	0.01
C196	0.02	0.07	0.003	0.006
Mean Across all Participants:	0.06	0.11	0.01	0.03
Standard Deviation Across all Participants:	0.04	0.1	0.01	0.02
Range Across all Participants:	0.01-0.13	0.01-0.28	0.001-0.03	0.005-0.09

ConvoLabel Language Descriptive Statistics Per 5-Minutes (Global means by participant (i.e., unweighted by N of recordings of each participant), N=20)

Participant Number	Quantity of Maternal Infant Directed Speech (in AWC per 5-minutes)	Quantity of All Adult Directed Speech (in AWC per 5-minutes)	Quantity of Maternal Directive-Infant Directed Speech (in AWC per 5-minutes)	Quantity of Maternal Non-Directive-Infant Directed Speech (in AWC per 5-minutes)
C167	4.33	2.09	0.33	1.36
C168	30.55	29.44	1.16	4.15
C169	18.64	38.79	2.16	6
C170	24.85	85.34	1.08	16.13
C173	9.05	10.62	2.57	2.94
C174	37.66	1.57	10.49	26.08
C176	15.34	13.38	1.54	8.18
C177	20.79	15.68	2.41	15.47
C181	22.18	58.65	4.45	9.31
C183	11.23	56.81	2.39	5.42
C185	5.39	27.98	2.37	2.52
C186	21.2	37.61	9.29	9.81
C187	34.22	37.44	8.06	10.13
C189	2.98	8.17	1.4	1.38
C190	13.79	72.91	0.93	4.05
C191	20.13	38.15	2.63	11.23
C192	15.72	42.94	3.8	3.59
C193	36.83	55.94	5.03	20.18
C195	5.74	12.61	0.8	3.19
C196	4.89	21.2	0.96	1.93
Mean Across all Participants:	17.78	33.37	3.19	8.15
Standard Deviation Across all Participants:	11	23.64	2.92	7.43
Range Across all Participants:	2.98-37.66	1.57-85.34	0.33-10.49	1.36-26.08