ABSTRACT

Title of Document: INFANT PREFERENCES FOR TWO PROPERTIES OF INFANT-DIRECTED SPEECH

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This study examined preferences for prosodic and structural properties of infant-directed speech (IDS) in 20 infants, 11 girls and 9 boys, ages 0;11;3 to 0;13;0 (mean age 0;11;28). It was hypothesized that year-old infants would demonstrate a preference for infant-directed structure (IS) over adult-directed structure (AS) regardless of prosody, and that infants would demonstrate no preference for either infant-directed prosody (IP) or adult-directed prosody (AP) regardless of structure. Listening times to passages were compared across infants for four conditions: IS/IP; IS/AP; AS/IP; AS/AP. Results indicate a non-significant but noticeable trend toward a preference for infant-directed structure. In addition, weak correlations were found between vocabulary size and strength of preference for adult-directed prosody, and between age and strength of preference for adult-directed prosody. A non-significant but noticeable interaction was found between prosody and structure and vocabulary. Overall, infants appear to prefer listening to infant-directed structure to adult-directed structure; more advanced language learners show a stronger preference for adult-directed prosody than do their less advanced

age-mates; older infants show a stronger preference for adult-directed prosody than do younger infants; and preference for infant-directed structure (but not infant-directed prosody) depends on vocabulary level.

# INFANT PREFERENCES FOR TWO PROPERTIES OF INFANT-DIRECTED SPEECH

By

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# Introduction

One of the most important experiences for the human infant is becoming part of the world of language. As social beings, humans must learn to communicate with each other in order to survive. Infants are equipped at birth to begin the process of acquiring language. This process begins with perception: infants need to be able to hear subtle differences in sounds. They must detect patterns within the language they hear around them and begin to make sense of them. Before they can learn what words mean, they have to learn to isolate word units within the stream of speech. This involves the ability to distinguish individual sounds and identify the sounds that make up syllables, words, clauses, and sentences. Eventually they learn which patterns are meaningful and how to map meanings onto sounds patterns. Infants learn to do all this before they speak their first words.

## *Early Perceptual Abilities*

One of the most common methods for identifying what infants are able to perceive and discriminate is to analyze what they prefer to listen to. When infants listen selectively to certain stimuli, we assume they are able to differentiate that from other stimuli. Infants show listening preferences very early, even from birth. Newborns, for example, prefer their native language to non-native languages (Mehler, et al., 1988; Moon, Cooper, & Fifer, 1993) and, at 3 weeks or even earlier, they are able to distinguish their own mothers' voices from other female voices (Mills, 1974). By 4.5 months old, they will listen longer to their own names than to other words, even words that sound very similar to their own names (Mandel, Jusczyk, & Pisoni, 1995). This suggests that infants only a few months old can discriminate not just individual sounds, but familiar sound patterns. Eight-month-old infants listening to fluent speech are able to discriminate other kinds of words besides their own names (Jusczyk & Aslin, 1995). In order to perceive sound patterns, they must separate the fluent speech stream into individual words. This is a task known as segmentation. One skill that may help them segment the speech stream is their emerging knowledge of statistical relationships between the sounds that occur together in their native language (Saffran, Aslin, & Newport, 1996). By 9 months of age, infants show a preference for the prosodic pattern of their native language over non-native patterns (Jusczyk, Cutler & Redanz, 1993). They are developing the ability to process language-specific aspects of speech by 10 months of age. They are beginning to learn more about the acoustic features of their native language, such as stress patterns (Jusczyk, Friederici, Wessels, Svenkerud, & Jusczyk, 1993), and the phonotactic rules that accompany sound patterns (Jusczyk, Luce, & Charles-Luce, 1994). As these changes are occurring, infants' vocalizations begin to reflect the properties of their native language (de Boysson-Bardies, Halle, Sagart, & Durand, 1989) and they lose their earlier ability to distinguish non-native sound contrasts (Werker & Tees, 1999). These studies and others show that infants generally prefer the familiar sound patterns of their native language to unfamiliar, non-native examples (Jusczyk et al., 1993), and that their language-specific knowledge changes over the first year of life.

### *Infant-Directed Speech*

One tool that may help infants learn to perceive and analyze the many aspects of language is the special speech register often used when speaking to infants. This register, sometimes referred to as "baby talk," "motherese," or, more recently, "infant-directed speech" (IDS), is characterized by acoustic and structural properties that differ from the properties of normal adult-directed conversation. Among acoustic properties that distinguish IDS and ADS are higher pitch (Fernald & Mazzie, 1991; Fernald & Simon, 1984; Shute & Wheldall, 1999), greater pitch variability (Fernald & Mazzie, 1991; Fernald & Simon, 1984; Fernald et al., 1989; Jacobson et al., 1983), longer vowel duration (Andruski & Kuhl, 1996; Englund & Behne, 2006; Shute & Wheldall, 1999), greater vowel clarity (Bernstein Ratner, 1984; Bernstein Ratner, 1985), prosodic highlighting of new words (Fernald & Mazzie, 1991), and longer pauses between utterances (Broen, 1972; Fernald & Simon, 1984; Fernald et al., 1989). Structural properties include shorter utterances (Bernstein Ratner & Rooney, 2001; Fernald & Simon, 1984; Fernald et al., 1989; Snow, 1972; Soderstrom, 2007), more repetition (Fernald & Mazzie, 1984; Snow, 1972), simplified vocabulary (Goldfield, 1993; Mervis & Mervis, 1982; Phillips, 1973), slower rate (Broen, 1972), more pauses, and increased paraphrasing (Snow, 1972).

**Acoustic Changes**

IDS is marked by changes along several acoustic dimensions. We will first examine the acoustic characteristics of fundamental frequency, pitch range, and pitch variability. These are among the most noticeable differences between the infant-directed and adult-directed speech (ADS) registers.

*Fundamental frequency*

Pitch is the perceptual correlate of fundamental frequency. Fundamental frequency ($F_0$) is determined by the rate of modulation of the vocal folds during voiced speech. While the relationship between pitch and fundamental frequency is not linear, it can be said that a high pitch sound generally corresponds to a higher fundamental frequency and a low pitch sound generally corresponds to a lower fundamental frequency. There are several aspects of fundamental frequency that characterize the IDS speech register. Mothers use higher mean $F_0$ in their speech to infants and young children (Fernald & Mazzie, 1991; Fernald & Simon, 1984; Shute & Wheldall, 1999); fathers[1] appear to do this as well (Fernald et al., 1989; Shute & Wheldall, 1999). Cross-language studies indicate that a higher mean $F_0$ is used for IDS than for ADS across a range of languages and cultures (Fernald & Simon, 1984; Fernald et al., 1989; but see Bernstein Ratner & Pye, 1984, for an alternative example). Native-speaking mothers and fathers of six different languages used not only higher mean $F_{0,}$ but also higher $F_0$ maximum and minimum values (Fernald et al., 1989). Furthermore, adults seem to produce the higher $F_0$ and greater pitch variability characteristic of IDS when simply imagining speaking to an infant; neither the presence of an infant nor experience with young children is necessary to elicit these changes (Jacobson, Boersma, Fields & Olson, 1983).

*Pitch range and Variability*

Mothers and fathers do more than speak with a higher pitch when addressing infants and young children. They also vary their pitch more, making greater departures from the mean pitch (Fernald & Mazzie, 1991; Fernald & Simon, 1984; Fernald et al., 1989; Jacobson et al., 1983), though this wider pitch range may be a feature of IDS used primarily by mothers (Shute & Wheldall, 1999). Expanded pitch range is demonstrated by a greater difference between the maximum and minimum $F_0$ values in ADS. Increased pitch range in IDS has been found across languages (Fernald & Simon, 1984).

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[1] Fathers increased $F_0$ mean and $F_0$ mode in their conversational speech to children; they raised only $F_0$ mode, not $F_0$ mean, during reading to children.

Evidence of expanded pitch range in the IDS of fathers has not been consistently confirmed (Fernald et al., 1989) but some studies report that mothers and fathers both use greater pitch variability in IDS (Cooper & Aslin, 1994; Fernald et al., 1989).

**Structural Changes**

In addition to changes in the acoustic properties of speech, IDS is characterized by modifications that tend to simplify utterances to young children and provide some redundancy. We will now examine the characteristics of vocabulary, length of utterance and sentence complexity, and repetition.

*Vocabulary*

Mothers' speech to infants contains simpler, more repetitive vocabulary, consisting of lower type-token ratios (Bernstein Ratner & Rooney, 2001; Broen, 1972; Phillips, 1973; Soderstrom, 2007) and higher concreteness ratings (Phillips, 1973). Speech characterized by a lower type-token ratio has a smaller number of unique words to total words, which means that it has a more repetitive vocabulary than speech with a higher type-token ratio. Bernstein Ratner & Rooney (2001) found that mothers' one-, two-, and three-word utterances to their young children contained a high proportion of nominals, and almost a third of the lexical types seen in both one- and three-word utterances were common to both lengths. This high degree of redundancy gives the novice language-learning child multiple examples of the same words and reduces word-learning demands. One of the ways that words used in infant-directed speech differ from those in adult-directed speech is through object labeling. Mothers speaking to their infants and young children tend to label objects at the child-basic rather than adult-basic category level (Mervis & Mervis, 1982). These levels appear to differ depending on the experience of the addressee; Mervis and Mervis (1982) found that mothers will actually mis-label an object in order to conform to the child's experience level (e.g., labeling "tiger" as a "kitty cat"). Mothers tend to use common (frequently-occurring) words in the language rather than uncommon words (Bernstein Ratner, 1988). Another way that vocabulary in IDS is simplified is by using more concrete words. Speech with a higher concreteness rating contains a higher proportion of imageable, tangible words. Imageable words are usually object nouns (e.g. "ball," "dog") or action verbs ("run," "sit") in contrast to mental state or intangible words (e.g. "happiness," "think"). Speech with a higher concreteness rating must be selected from a particular subset of adult vocabulary, reducing the "pool" of words infants must process and understand (Phillips, 1973).

*Utterance Length*

Mothers tend to use shorter utterances in their speech to infants and young children (Bernstein Ratner & Rooney, 2001; Fernald & Simon, 1984; Fernald et al., 1989; Snow, 1972; Soderstrom, 2007). There is evidence that mothers decrease the length of utterances in speech to their infants across the first 9 months (Murray, Johnson, & Peters, 1990); in the second year of life, Bernstein Ratner & Rooney (2001) found that almost a quarter of the utterances spoken by mothers to their infants were only a single word in length, and more than half (almost 60%) of speech directed to these children contained utterances of three or fewer words. Reducing utterance length automatically reduces complexity since it limits the number and type of syntactic relationships the infant must process and remember. In addition, shorter utterances contain more nouns than verbs; a preponderance of nouns may benefit young children learning language because, at least in English, they occur with fewer variations of form compared with verbs, thus making them easier to detect in the speech stream (Goldfield, 1993).

*Sentence complexity*

Mothers use reduced sentence complexity in speech to their infants. Reduced complexity can be measured in different ways, but generally refers to modifications such as fewer subordinate clauses and compound verbs, shorter pre-verb length, a smaller number of different verb forms, fewer modifiers, and higher numbers of content words to function words (Goldfield, 1993; Mervis & Mervis, 1982; Phillips, 1973). Mothers not only use fewer compound verbs to their infants and young children, they also tend to use fewer verbs overall compared to their speech when talking to adults (Goldfield, 1993; Snow, 1972). One reason IDS is simpler than ADS is that it contains shorter utterances, causing complex features like clauses and noun phrases to be omitted, or alternatively, these features are omitted causing utterances to be shorter (Soderstrom, 2007). A sentence with fewer clauses means there are fewer subject-verb and subject-verb-object associations to figure out. Likewise, shorter pre-verb length means a smaller chance of separation of the subject and verb and thus less demand on memory, since the verb is less delayed relative to the noun. Because verbs require arguments, using fewer verbs overall reduces demands on the infant to make sense of syntactic relationships. These simplifications reduce the task demands on novice language users and may help them process language and learn elementary grammatical rules for sentence production.

*Repetition*

IDS is characterized by an increase in phrase and complete sentence repetition in speech to young children compared to speech to older (10-year-old) children and adults

(Fernald & Mazzie, 1984; Snow, 1972). Mothers tend to repeat nouns to young children rather than substitute pronouns (Snow, 1972) and their speech to infants contains a high degree of repetition of words and sentence frames (Bernstein Ratner, 1996). Bernstein Ratner & Rooney (2001) found that in the very short utterances used by mothers of 13- to 20-month-old infants, two- and three- word utterances had forty percent of their words in common. In addition to repeating words, phrases, and sentences, parents also repeat prosodic patterns. Essentially, pitch contours are often repeated without repetition of linguistic features. Fernald and Simon (1984) found that prosodic repetition was twice as frequent as phrase repetition in the speech of German mothers to their newborn infants. Repetition of prosodic patterns in IDS can be considered an acoustic change, but it is also a marker of syntactic units and thus can be thought of as a structural change as well. It is evident that some components of IDS cannot easily be divided into acoustic and structural changes.

**Other Features of IDS**

There are a number of other modifications that characterize the IDS register. Though these are not features manipulated for the present study, they are part of the group of features that characterize IDS. These changes include increased vowel space (Bernstein Ratner, 1984; Bernstein Ratner, 1985) and duration (Andruski & Kuhl, 1996; Englund & Behne, 2006; Shute & Wheldall, 1999), prosodic highlighting of new words introduced to infants (Fernald & Mazzie, 1991), longer vowel duration in content words compared with function words (Swanson, Leonard & Gandour, 1992), longer pauses between utterances (Broen, 1972; Fernald & Simon, 1984; Fernald et al., 1989), fewer words per minute (Broen, 1972), and increased use of paraphrasing (Snow, 1972).

Moreover, the "happy" tone of voice that results in IDS prosodic changes can also result in segmental changes, caused by the differential shape of the mouth when smiling (Tartter & Braun, 1994).[2]

The range of acoustic and structural modifications that define IDS has been demonstrated across a wide variety of contexts. IDS has been observed across languages and cultures; even Deaf mothers signing to infants slow their tempo, reduce utterance length, reduce syntactic complexity, and increase repetition compared to their signing to other adults (Reilly & Belugi, 1996). Though parents do not use IDS in all cultures and languages (or at least IDS that is characterized by the modifications described here; see Bernstein Ratner & Pye, 1984), the diversity of contexts in which IDS is normally used in speech directed toward infants and young children supports the argument that it plays a key role in the process of language learning.

*Preference for Infant-Directed Speech*

Infant preferences can be tested in the lab by using a head turn preference procedure (Kemler Nelson et al., 1995). Infants hear different speech samples on different trials and listening times are measured for each trial. The types of samples with the longest listening times are presumed to be the ones that infants prefer. This procedure has been used to examine infant preferences for many types of stimuli. For example, preference for the infant-directed speech of unknown female talkers over the same talkers' adult-directed speech has been found to be present in infants as young as a few days old (Cooper & Aslin, 1990, 1994). Four-month-old infants preferred the infant-directed speech of their mothers to the adult-directed speech of their mothers (Fernald,

[2] Indeed, given such correlations, it is possible that segmental differences may be present in the current study, although not directly manipulated.

1985). Infants also preferred listening to IDS over ADS spoken by unfamiliar women, demonstrating that they were responding to the properties of IDS rather than to their own mothers' voices (Fernald, 1985). Preferences for IDS of both male and female talkers were found in infants aged 7 weeks (Pegg, Werker & McLeod, 1991), 4- to 5.5-months, and 7.5- to 9-months (Werker & McLeod, 1989). Infants preferred IDS in male voices even when the pitch was lower than the IDS in female voices. This suggests that there is something more than simply a high pitch that infants respond to in IDS. Infants also showed greater affective responsiveness to the vocal features of IDS than ADS (Werker & McLeod, 1989). This finding was extended by investigating the relative contributions of face and voice to infants' attentional and affective preferences for IDS. Since facial expression tends to be more dramatic when spoken in IDS, the non-verbal variable (face) was held constant by having a speaker present both IDS and ADS with a neutral face. Attentional preference was demonstrated by longer listening times to IDS than to ADS. Trained raters judged that infants showed greater affective responsiveness to IDS than to ADS on measures of interactivity, interest, and positive emotion (Werker & McLeod, 1989). The preference for IDS over ADS extends even to unfamiliar languages such as Cantonese in English-learning 4- and 9-month-old infants (Werker, Pegg & McLeod, 1994). These studies suggest that infants respond with attentional and affective preference to infant-directed speech compared with adult-directed speech, even when the infant-directed speech is presented in an unfamiliar language or by male rather than female talkers.

Yet which of IDS' properties really drive these preferences? Young infants (4 months of age) seem to respond to the pitch varying aspect of IDS. Fernald (1985) low-pass filtered IDS and ADS speech samples to preserve prosodic qualities but remove lexical content. Infants clearly preferred the IDS samples, which strongly suggests that they are attracted to the pitch aspects of IDS. As an extension of this work, Fernald and Kuhl (1987) conducted several experiments to test the hypothesis that the pitch contours of the IDS speech samples of Fernald's (1985) work were sufficient to drive the preference that was demonstrated. Because any of the three major acoustic correlates of intonation (fundamental frequency, amplitude, and duration), or any combination of these correlates could be responsible for the demonstrated preferences, Fernald and Kuhl's 1987 work isolated the three variables in a series of three experiments, and used low-pass filtered speech samples in order to remove lexical content (following the 1985 method). They found a significant preference for the $F_0$ pitch contours, but no preference for the amplitude or duration variables of the IDS speech samples over the ADS speech samples. These results confirm that it is the pitch characteristics of IDS, including higher $F_0$ mean, wider $F_0$ excursions, and expanded $F_0$ range, that drive preference for IDS in young infants. Equivalent studies have not been done with other ages, however, so it remains unclear whether these characteristics continue to drive the preference in older infants.

*Potential Role of IDS*

Roles related to attention, affect, emotional regulation, social interaction, and speech processing have all been proposed as potential benefits of IDS. Evidence from Japanese mothers who raised their fundamental frequency only after their initial attempts to gain their 3- and 4-month-old infants' attention failed indicates that IDS serves as an attention-getting device (Masataka, 1992). As early as 6 months of age infants can discern approving and comforting infant-directed utterances (Spence & Moore, 2003), which suggests that IDS conveys affective information. Mothers have been shown to pair specific intonational patterns with specific behavioral contexts (e.g. rising intonation to call attention to something, falling intonation to soothe or comfort), suggesting that IDS might contribute to the regulation of emotional states (Kitamura & Burnham, 2003). Infants have been shown to smile more in response to IDS compared with ADS, which in turn may make them more attractive to caregivers and thus contribute to emotional bonding between adult and infant (Werker & McLeod, 1989). Intonational patterns of IDS may help identify the turn-taking aspects of conversation, helping to develop an awareness of the give-and-take nature of social interaction (Fernald, 1985). IDS may also contribute to infants' learning of the grammatical structure of the native language via segmenting the input. Kemler Nelson, Hirsh-Pasek, Jusczyk, and Cassidy (1989) found that infants listen longer to IDS (but not ADS) speech samples containing pauses at clause boundaries compared with matched speech samples containing mid-clause interruptions. Infants also demonstrated a preference for IDS containing clause-boundary pauses over ADS containing clause-boundary pauses. Preferences for speech containing breaks at natural clause boundaries suggests that infants pay attention to where pauses occur within utterances; pauses at clause boundaries may serve as cues to sentence boundaries. These cues could assist infants in learning about basic syntactic units of language. The prosodic contours and rhythmic stress pattern often used in IDS may make the sound patterns characteristic of infants' native language more salient and assist auditory pattern recognition skills (Fernald & Simon, 1984).[3] In terms of language

[3] Another view is that infant-directed prosody could simply serve an alerting function to cue infants when speech is addressed to them. If so, any changes in preference for it would be completely separate from the development of a preference for easier-to-process speech.

structure, a simplified lexicon may help to reduce word-learning demands in the infant (Soderstrom, 2007). Infants may be assisted in word learning in other ways as well. Mothers of older infants tend to place target words on exaggerated pitch peaks at the ends of utterances (Fernald & Mazzie, 1991). This type of acoustic highlighting of target words may make them perceptually more prominent and thus contribute to lexical acquisition.

Some clues to why infants respond the way they do might be found by examining the reciprocal relationship between mothers' infant-directed speech and infants' responses over the course of early development. Since the modifications that characterize mothers' IDS change somewhat as their infants mature (Bernstein Ratner, 1984; Kitamura & Burnham, 2003; Stern, Spieker, Barnett & MacKain, 1983), it has been suggested that IDS may serve different functions for the infant at different stages of development. For example, at the age when infants develop social awareness and the ability to interact with caregivers at about 4 to 6 months, IDS may play a role in facilitating universal qualities such as socialization. But in later infancy when they have acquired some perceptual language skills, IDS may play a role in facilitating more language-specific abilities (Kitamura, Thanavishuth, Burnham & Luksaneeyanawin, 2002).

*Developmental Changes in Use of and Preference for IDS*

Mothers have been found to alter the type and extent of prosodic aspects of their infant-directed speech according to their child's age and gender (Kitamura & Burnham, 2003), stage of language development (Bernstein Ratner, 1984), and whether the children were visible to them (Snow, 1972). Mothers seem to adjust their pitch and communicative intent in response to their infants' developmental progress. Kitamura and Burnham (2003) found several shifts in mothers' speech to infants between 6 and 12 months of age: a decline in mean $F_0$, an increase in pitch range, and greater use of directive-type utterances. These changes in mothers' speech all began to occur when their infants were approximately 9 months of age. As the infants neared 12 months of age, the mothers' speech reverted to pitch values and intents that were present when the infants were 6 months of age. These changes suggest that something different was happening in infants' development at approximately 9 months of age, and that mothers responded to it by changing the input.

Presumably, mothers do more than simply adopt a speech register consisting of higher pitch, increased pitch variability and range, shorter utterances, simpler vocabulary and syntax, and so on. Research supports the idea that mothers finely-tune these variables in response to their infants' changing developmental needs. Mothers make adjustments to MLU in speech to their 3- to 9-month-old infants that appears to influence the infants' scores on a measure of receptive language at 18 months of age (Murray, Johnson, & Peters, 1990) and also use slower rates of speech, more repetition, more pitch contouring, and a tighter tempo when infants are 4 months of age than when they are 12 or 24 months of age (Stern et al., 1983). The clarity of mothers' vowel production also changes over the course of their children's language development. Vowels in mothers' speech to preverbal infants are underspecified, with almost no more clarity than the vowels in their speech to adults (Bernstein Ratner, 1984; Englund & Behne, 2006). But mothers articulate vowels with greater clarity in the content words of their speech to children at the single-word level of language production, and articulate vowels with greater clarity in content *and* function words of speech to children who are at a more advanced level of combining words (Bernstein Ratner, 1984). These specialized modifications seem to occur just when they might be most helpful to the language task the child faces at each stage. For example, the preverbal infant faces sublexical-learning tasks that may not benefit from vowel clarification as much as increased vowel duration. Children at the single-word stage of production face a word-learning task; children at this stage are learning mainly content words. But children at the combinatorial word stage face a syntax-learning task; they are learning how to combine content and function words. It is possible that increased vowel clarity in content words benefits children who are actively learning words, whereas greater vowel clarity in both content and function words benefits children who are learning to put words together.

Infants' responses to IDS may also change with development. Cooper, Abraham, Berman, and Staska (1997) reported developmental changes in infants' preference for maternal and non-maternal IDS between the ages of 1 to 4 months, with infants initially equally interested in the IDS of their mothers and unfamiliar female talkers. As infants develop in the first year of life, the strategies they use to make sense of the language around them appear to transition from non-language-specific to language-specific strategies (Hayashi, Tamekawa, & Kiritani, 2001; Kitamura et al., 2002). Infants' initial sensitivities to acoustic properties are broad-based; as they grow and develop during that crucial first year, those sensitivities become specifically tuned to the native language. Werker and Tees (1999) suggest that reorganization of perceptual strategies helps the infant move toward word learning. Research shows that the IDS spoken to very young infants is different from the IDS spoken to older infants in characteristics that include a higher level of exact repetitions when infants are young, dropping off to a lower level as the child ages. Vocal play routines (such as *peek-a-boo*) that are essentially without content become less common as infants grow older, and references to absent objects become more common (Soderstrom, 2007). While extensive research exists to establish that infants show a significant preference for infant-directed speech over adult-directed speech (Cooper & Aslin, 1994; Fernald, 1985; Werker & McLeod, 1989), there is some evidence that the IDS preference begins to wane at about 7 months of age (Hayashi et al., 2001, though see Werker & McLeod, 1989, for alternative findings). Recent research demonstrates that infants show a renewed preference for infant-directed speech at around 10 months of age (Hayashi et al., 2001). This “U-shaped” IDS preference curve suggests that while infants up to about 7 months old strongly prefer listening to infant-directed speech, between 7 to 9 months of age they show no preference (or even prefer adult-directed speech; see Hayashi et al., 2001), only to show a strong preference for infant-directed speech once again between 10 to 14 months of age.

Why might infants lose interest in IDS for a period of time only to regain that interest a few months later? If IDS benefits infants in several ways (to draw and maintain attention, communicate affect, regulate emotion, encourage social interaction, highlight lexical items and grammatical units of language), it is possible that different aspects of IDS benefit infants at different points in their development. Those aspects of IDS that could benefit infants’ language acquisition during the first half-year of life may no longer be beneficial as they approach the end of their first year. That is, the language learning tasks that infants face at 9 months of age are qualitatively different from earlier tasks.

Perhaps the aspects of IDS that had assisted them up until 9 months of age even interfere with new tasks at this age (Kitamura & Burnham, 2003; Soderstrom, 2007). This is the age at which infants show preferences for native language over non-native language. Research on infant's preferences for affective intent demonstrates that at 9 months of age they preferred directive and approving affective intent, but the approving intent was only preferred when the stimuli were low-pass filtered to highlight the suprasegmental (prosodic) information. It appears, then, that at 9 months of age approving intent becomes less interesting while directive intents more interesting (Kitamura & Burnham, 2003; Kitamura & Lam, 2009). According to Hayashi et al. (2001), infants return to a preference for IDS at between approximately 10 and 14 months of age. Since this is a time in language development when infants begin to produce their first words, one hypothesis is that 12-month-old infants face new linguistic challenges for which IDS provides a benefit.

Another explanation for the U-shaped developmental curve found by Hayashi et al. (2001) is that young infants between birth and about 7 months old have an emotional attachment to certain prosodic characteristics of infant-directed speech. As they become more skilled at using language-specific strategies such as stress and phonotactic patterns to segment the speech stream, infants may rely less on language-general strategies such as prosody. But as they reach the stage where they are beginning to interpret some of the other aspects of their native language (such as phonetic and phonological properties) at about 9 or 10 months of age, IDS could make those structures more salient and therefore easier to learn (Hayashi et al., 2001). Thus, the U-shaped developmental curve could be the result of two different developmental processes: the waning of a language-general preference for variable pitch and higher fundamental frequency, and a growing preference for language-specific patterns.  Since IDS has both language-general and language-specific properties, an overall preference for IDS could appear to be a U-shaped preference curve.  In addition, claims that prosody is the primary force driving IDS preference in infants may be too general.  That is, Fernald (1985) showed that IDS prosody is responsible for the IDS listening preference in 4-month-old infants.  Speech samples were low-pass filtered to remove lexical content but preserve prosodic content; these very young infants demonstrated a preference for speech with IDS prosody over speech with ADS prosody.  However, little research has been done to test the listening preferences of infants older than 4 months of age where the prosody and structural properties of IDS have been separated.  Newman and Hussain (2006) tested 4.5-, 9-, and 13-month-old infants using stimuli that were matched for content and presented in both IDS and ADS prosody.  They found that the 9-month-old and 13-month-old infants did not show a preference for the suprasegmental prosodic properties that drive very young infants' listening preferences.  Indeed, this research provides evidence that preference for the prosodic properties of IDS disappears sometime between 4.5 months and 9 months of age and does not reappear.  Taken together, the evidence thus far suggests that there is a U-shaped developmental preference curve for IDS in general, but that preference for IDS prosody does *not* follow a U-shaped pattern.  If this is so, some other property must drive the IDS preferences demonstrated by older infants.

It is helpful to consider the developmental changes in IDS preference within the larger context of linguistic development.  Speech perception is a necessary skill that allows infants to eventually assign meaning to sounds, thus achieving comprehension and ultimately speech production. Infants are born with well-developed speech perception abilities. Young infants are able to discriminate subtle acoustic and phonetic information from a very early age (Werker & Tees, 1999). They appear to be able to process the speech stream in increasingly complex ways, and as they do, they begin to lose some of their ability to discriminate non-native sounds. It seems as if infants become more highly tuned to their native language starting at about by 9 months of age, when they show a preference for listening to words that reflect the phonotactic and phonetic rules of the language around them. Along with the shift toward language-specificity may come other changes, such as age-related changes in preference for infant-directed speech.

The present study explores 12-month-old infants' preference for two properties of IDS. In doing so, it extends the work of two prior studies: Hayashi et al. (2001) and Newman and Hussain (2006). Hayashi et al. (2001) investigated the developmental change in auditory preference for infant-directed (ID) and adult-directed (AD) speech pairs among infants aged 4 to 14 months. They used stimuli consisting of recordings of a mother talking to her 11-month-old infant and talking to an experimenter. Infants from 4 to 6 months and from 10 to 14 months of age preferred listening to the recordings of the mother talking to her infant, but infants from 7 to 9 months of age did not. Based on these results, the authors propose that infants' preferences shift over three developmental stages. In stage 1, newborns and very young infants prefer to listen to ID speech over AD speech; in stage 2, infants between approximately 7 and 9 months of age show no preference for ID over AD speech; in stage 3, older infants once again show a preference for ID speech. They suggest that this U-shaped developmental preference curve may be related to the changing speech perception abilities of infants. While young infants may prefer to listen to ID because of an emotional attachment to its rhythm and pitch characteristics, that attachment wanes over time. Older infants may prefer ID because of a growing ability to perceive the special language-specific structures of native speech.

Newman and Hussain (2006) investigated preference for IDS across ages and listening conditions.[4] They investigated whether IDS would confer an advantage to listening in noisy conditions. As stated previously, they tested infants at 4.5, 9, and 13 months of age. They found that only the youngest infants preferred IDS to ADS; infants of 9 and 13 months of age demonstrated no preference for either speech register. While these results seem to contradict the findings of Hayashi et al. (2001), there is an important difference in the speech stimuli used in the two studies. Newman and Hussain (2006) used passages matched for content, thus eliminating the structural variable of IDS. The infant preferences in their study were driven by just the prosodic cues of IDS, not the structure/content. Hayashi et al. (2001), in contrast, used passages that differed in meaningful content; thus the infant preferences in their study could have been driven by either the prosody or content of IDS (or both). Both Hayashi et al. (2001) and Newman and Hussain (2006) provide evidence that infants' preference for IDS decreases sometime between 4 and 9 months of age. The fact that Hayashi et al. (2001) found that the preference for IDS returned at about 10 months of age and Newman and Hussain (2006) did not, may not be as contradictory as it appears. If older infants (9 to 13 months of age) attend more to content than to prosody, then the content-matched passages used in the Newman and Hussain (2006) study would have minimized preferences between the two

[4] The terms "IDS" and "ADS" were used in both Hayashi et al. (2001) and Newman and Hussain (2006) to describe speech stimuli, but the authors of the two studies may use these terms to refer to different aspects of the stimuli.

speaking styles as well. The re-emergence of the IDS preference in Hayashi et al.'s (2001) older infants could be accounted for by an emerging preference for IDS content rather than prosody. Since content was not matched in Hayashi et al. (2001), a preference for IDS content would not have been evident.

The purpose of the present study is to extend the results of the two studies cited above. The goal is to find which properties of IDS drive its preference in older infants. It seems clear that prosodic elements such as exaggerated intonation with higher pitch and greater range, smooth pitch contours, and slower rhythm and tempo are adequate to drive younger infants' preference for IDS (Fernald, 1985; Fernald & Kuhl, 1987; Cooper & Aslin, 1994), but it is unclear what properties attract the attention of older infants. One hypothesis is that older infants may prefer the simplified structural content of infant-directed passages regardless of prosody (Newman & Hussain, 2006).

**Summary**

This study investigates infant preferences for prosodic and structural properties of infant-directed speech, and asks whether older infants (11 to 13 months) prefer to listen to passages with more IDS-like structural content (such as restricted vocabulary, short utterances, and more repetition) over passages with more adult-like structural content (broader vocabulary, longer utterances, and less repetition), when both types of passages are matched for prosody. Specifically, we predict that 1) infants will listen longer to passages with infant-directed structure presented in infant-directed prosody than to passages with adult-directed structure presented in infant-directed prosody; 2) infants will listen longer to passages with infant-directed structure presented in adult-directed prosody than to passages with adult-directed structure presented in adult-directed prosody; 3) infants will not listen longer to passages presented in infant-directed prosody over passages presented in adult-directed prosody when passage structure is infant-directed.

# Methods

## *Participants*

Participants were 20 full-term infants (11 girls, 9 boys) aged 12 months[5] (mean age 0;11;28; range 0;11;3 to 0;13;0) from homes where the infants hear English at least 75% of the time. Infants were recruited through the University of Maryland's Infant Studies Consortium database of parents who have expressed interest in having their infants participate in research studies. All infants included in the study have a normal developmental history and were free of ear infections or other conditions that could affect the ability to listen at normal speaking levels (60 dB) at the time of the study, according to parent report. Infants were given a small toy for participating. A total of 27 infants participated in the study; data from 7 infants were not included in the analysis because of the following reasons: 5 for fussiness/crying; 2 for failing to listen for a total of at least 3 seconds to one or more of the four conditions. Table 1 lists participant characteristics.

[5] Three infants were between 3 and 4 weeks premature. Adjusted ages were used to determine whether infants met age requirements for inclusion in the study.

**Table 1. Participant Characteristics**

| Participant | Age | Gender | Ethnicity |
|---|---|---|---|
| 1 | 0;11;19 | F | Asian/White |
| 2 | 0;11;14 | F | White |
| 3 | 0;12;13 | M | White |
| 4 | 0;13;0 | F | African American |
| 5 | 0;11;3 | F | White |
| 6 | 0;11;13 | F | White |
| 7 | 0;11;9 | M | White |
| 8 | 0;12;9 | M | White |
| 9 | 0;12;14 | M | White |
| 10 | 0;11;7 | F | Hispanic |
| 11 | 0;12;8 | F | African American |
| 12 | 0;12;22 | F | Native American/African American/Asian |
| 13 | 0;11;11 | F | African American |
| 14 | 0;12;28 | F | White |
| 15 | 0;11;17 | M | White |
| 16 | 0;11;24 | M | White |
| 17 | 0;11;26 | F | White |
| 18 | 0;11;26 | M | African American |
| 19 | 0;12;9 | M | White |
| 20 | 0;12;22 | M | White |

*Stimuli*

**Properties**

Test passage content was developed to reflect the natural acoustic and structural properties of mothers' speech to infants and to other adults. To help design appropriate stimuli, 13 mothers were recorded playing with their 11-month-old infants and speaking to an adult. Measures of MLU, TTR, and VOCD were taken from these mothers, and the test stimuli for the current study were designed to model those values as much as possible. In creating the test passages, our objective was to use repetition of content words, variety of words, and length of utterance to differentiate passages with infant-directed structure from those with adult-directed structure. We did not want the adult-directed passages to contain more advanced lexical items than the infant-directed passages. Infants listen longer to words that are familiar to them than to unfamiliar words (Swingley, 2005) and to familiar sound patterns than to unfamiliar patterns (Jusczyk, Luce, & Charles-Luce, 1994); therefore, introducing an unfamiliar lexicon would bias their listening preferences. Our aim was to keep the level of lexical sophistication similar between the passage types so that the actual words in both types of passages would be words that infants typically hear in their daily lives. Despite this ideal of comparable words, the ADS passages would have a wider range of word types (since each word would be repeated less often), and would therefore clearly differ from the IDS passages. In order to check that our passages contained words that are roughly equivalent, we measured their typical ages of acquisition. We analyzed each passage using the MRC Psycholinguistic Database (Wilson, 1988). The mean age of acquisition of words in our infant-directed passages is 194 days; the mean for our adult-directed passages is 204 days. Moreover, looking just at the focal content words of the passages, average age of acquisition for infant-directed passages is 181 days and 236 days for adult-directed passages. The MRC Psycholinguistic Database (Wilson, 1988) is small and did not contain every word in our passages; however, the results show that the two passage types are roughly equivalent in terms of the age at which children typically acquire the words we used. Both averages, it should be noted, are well under the ages of the participating infants in this study. Therefore all the infants in this study should be familiar with the majority of words in each of the passages.

Test stimuli consisted of 8 short passages. Four passages contained infant-directed structure (IS) and four contained adult-directed structure (AS). The passages with infant-directed structure contained shorter sentences with less varied vocabulary and multiple repetitions of focal content words. The passages with adult-directed structure contained longer sentences, more varied vocabulary, and fewer repetitions of focal content words. Each of the 8 passages was presented in 2 prosody conditions: infant-directed (IP) and adult-directed (AP). Passages with adult-directed prosody were characterized by lower average fundamental frequency, restricted pitch range, and less frequency variability. Passages with infant-directed prosody had higher average fundamental frequency, wider pitch range, and more frequency variability. In creating the stimuli, care was taken to match prosody measures so that all passages with adult-directed prosody had similar mean pitch and pitch range; likewise, all passages with infant-directed prosody had similar mean pitch and pitch ranges, regardless of structure type. By the same token, care was taken that passages with different prosody types differed from one another in mean pitch and pitch ranges, regardless of structure type. Our goal was to objectively separate the two components of IDS into passages that differed by prosody but not by structure and passages that differed by structure but not by prosody. The final stimuli consist of passages acoustically differentiated into AP and IP by mean pitch and pitch range and passages structurally differentiated into AS and IS by target word repetition, type-token ratio, vocabulary diversity, and mean length of utterance. Appendix A lists stimuli characteristics. Figure 1 illustrates acoustic differences between passages with infant-directed and adult-directed prosody. Figure 2 illustrates acoustic similarities between passages with infant-directed and adult-directed structure. Figure 3 illustrates the Mean Length of Utterance (MLU) in passages with infant-directed and adult-directed structure. Figure 4 illustrates Type-Token Ratio in passages with infant-directed and adult-directed structure. Figure 5 illustrates Vocabulary Diversity (VOCD) and Target Word Repetition in passages with infant-directed and adult-directed structure.

**Figure 1. Acoustic Variables of Passages with Infant-Directed and Adult-Directed Prosody**

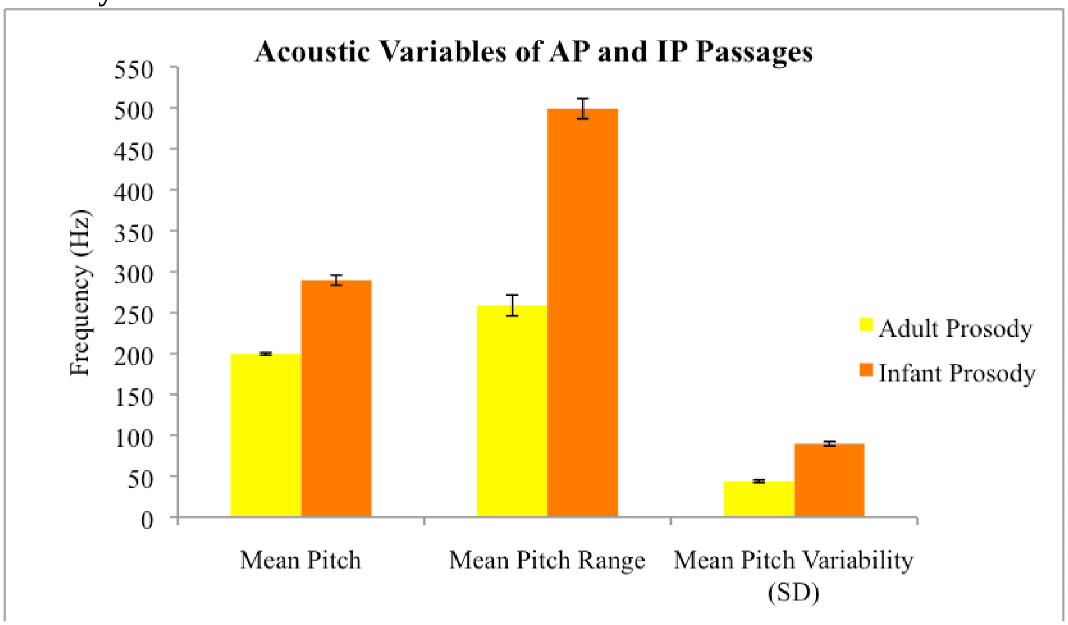


**Figure 2. Acoustic Variables of Passages with Infant- Directed and Adult-Directed Structure**

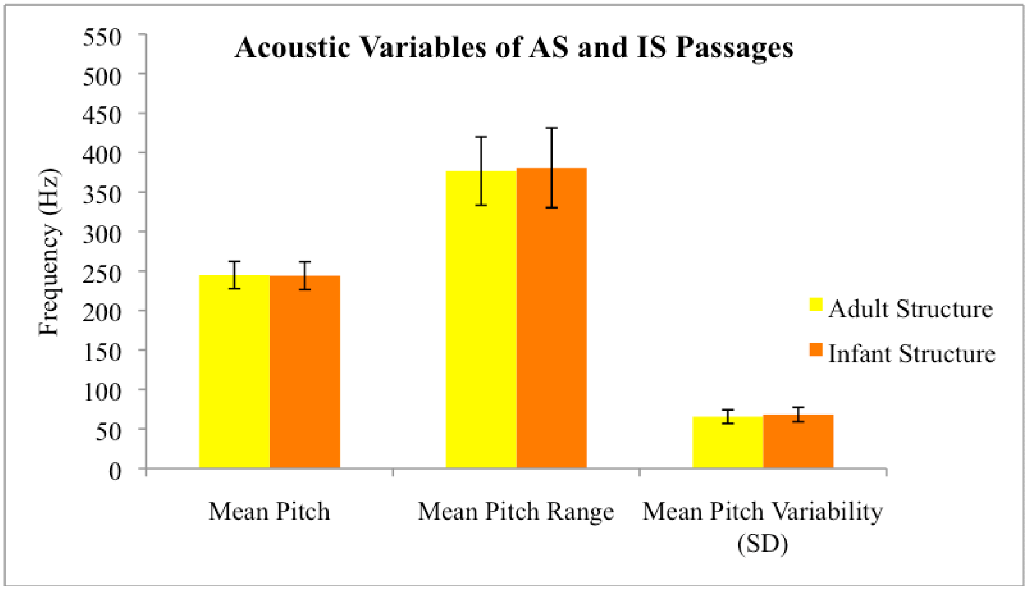



**Figure 3. Mean Length of Utterance in passages with Infant-Directed Structure and Adult-Directed Structure**

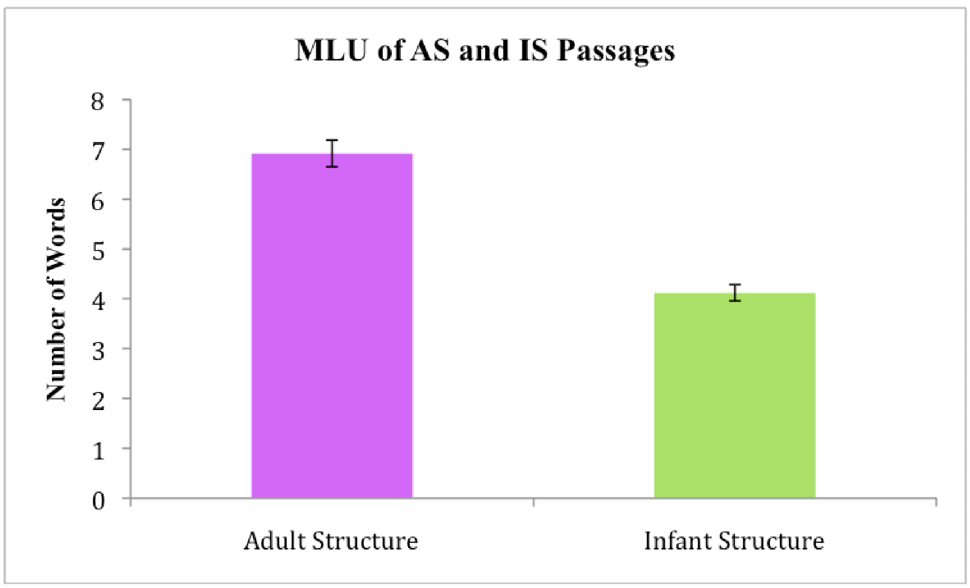


**Figure 4. Type-Token Ratio in passages with Infant-Directed Structure and Adult-Directed Structure**

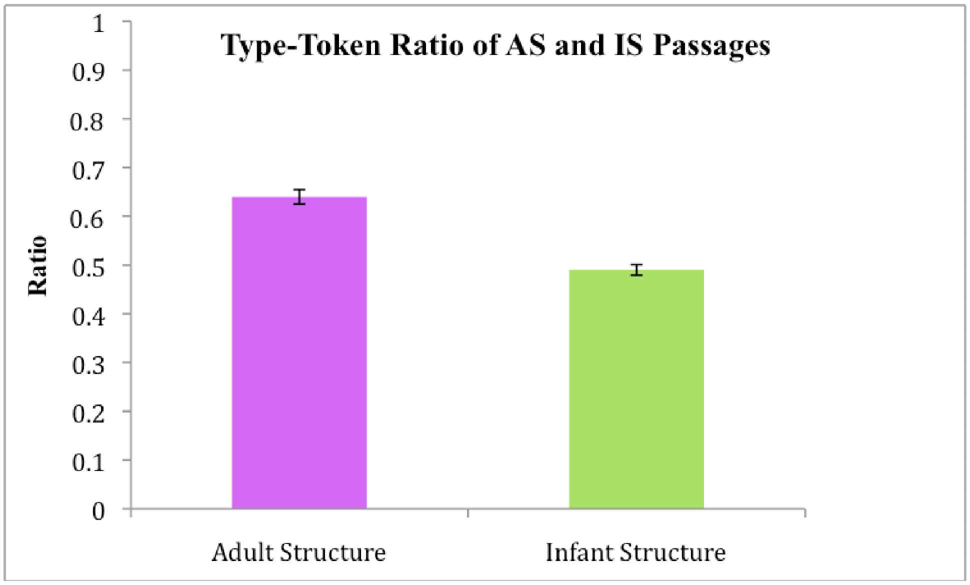
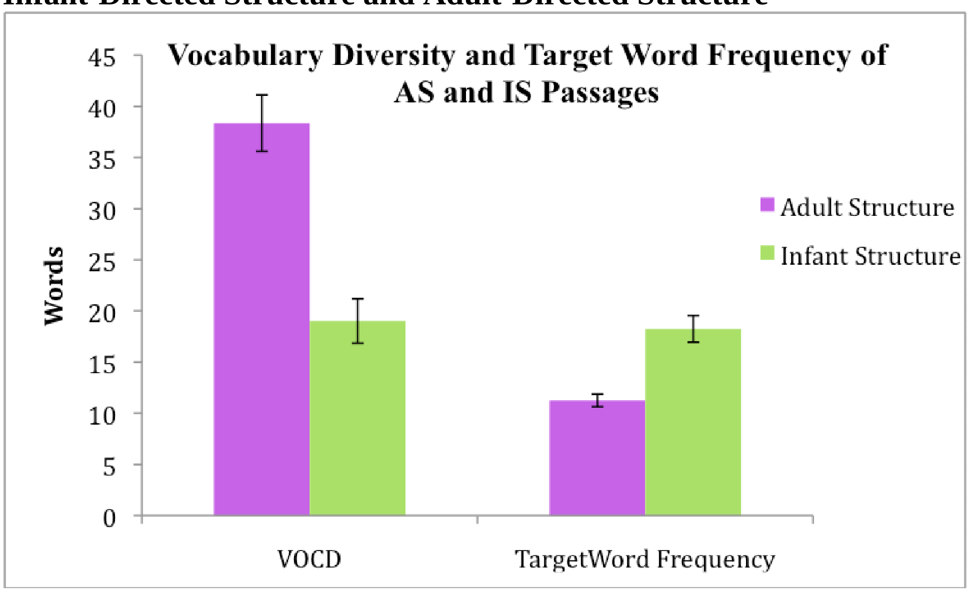



**Figure 5. Vocabulary Diversity[6] and Target Word Repetition in passages with Infant-Directed Structure and Adult-Directed Structure**




[6] Although VOCD and TTR are both intended to capture relative diversity of word types, the magnitude of differences is not the same in the two measures in the present data. This demonstrates the fact that the two are not interchangeable, which is an important methodological issue for future research.

Overall, the passages with the same prosody but different structure have similar acoustic characteristics but different lexical characteristics, while the passages with different prosody but the same structure have different acoustic characteristics but similar lexical characteristics. Appendix B lists test passage text.

**Design**

Two practice stimuli consisting of musical passages were recorded for use during the practice phase. The test trials were blocked in groups of four so that one example of each type of passage (IDS structure/ADS prosody, IDS structure/IDS prosody, ADS structure/ADS prosody, and ADS structure/IDS prosody) was heard in each block. Passages were recorded in both infant-directed and adult-directed registers in a sound-attenuated room using a Shure SM51 microphone and digitized via a 16-bit, analog-to-digital converter at a 44.1 kHz sampling rate and stored on a computer (after Newman & Hussain, 2006) and were matched for amplitude and length. No infants were present during the recording. The stimuli were presented at a comfortable listening level.

*Procedures*

This study used a variant of the headturn preference procedure (Kemler Nelson et al., 1995). Testing occurred in a three-sided test booth (open in the back) constructed of 4 ft. x 6 ft. pegboard panels. The center of the front panel contained a white light and a hole for the lens of a video camera. The center of each side panel of the booth contained a red light and a loudspeaker. A curtain prevented the infant and caregiver from seeing the equipment and experimenter located behind the front panel of the booth. The experimenter watched the session on a monitor connected to a video camera behind the front panel of the booth, and used a response box to signal the computer when to start and stop the flashing center and side lights.

Infants sat in their caregiver's lap in the center of the test booth. Testing began with a familiarization phase to introduce the infant to the task. The infant heard one of two musical passages on alternating trials until at least 25 seconds of listening time had accumulated for each passage (measured by total time spent looking toward the source of the sound). Both familiarization and test trials began with the white light in the center of the front panel blinking. When the infant oriented toward the blinking light, it turned off and one of the two red side panel lights began blinking. Once the infant oriented to the blinking side light, the stimulus began to play from a loudspeaker on that side. The stimulus for that trial continued until completion (approximately 30 seconds for test trials) or until the infant looked away for 2 consecutive seconds, whichever occurred first. Total listening time was measured by the length of time the infant remained oriented to the sound on the side with the blinking red light, minus any time spent looking away whether that time was 2 seconds or less. Depending on the direction of the infant's head turn, the computer either initiated or terminated the trial stimuli. Direction of head turns and their duration were encoded on the computer and saved in a data file. A puppet was used to refocus infants' attention and reduce fussiness for all 4 trials of any block (but not on two consecutive blocks) as judged necessary by the experimenter. While the center light blinked, the puppet was pushed through the curtain over the front panel, moved back and forth momentarily, and pulled back behind the curtain. If the infant then looked at the center light, the experimenter signaled the computer to continue. Masking music was played through Peltor aviation headphones worn by both the experimenter and caregiver during the test session to prevent unintentional influence on the infant's behavior or the coding process.

Infants' receptive vocabulary was assessed by parent report via the MacArthur-Bates Communicative Development Inventory (CDI). The CDI was mailed to parents before the scheduled appointment date. Parents either completed the inventory prior to the visit and brought the completed form with them to their scheduled appointment, completed the inventory during their scheduled visit to our laboratory, or returned a completed inventory to us in the mail a short time after their visit to our laboratory.

*Reliability*

Reliability was tested by having another experimenter recode 5 of the participants via videotape. Recoding was accomplished by watching videotapes of the actual test sessions as if they were live sessions, and coding infant head turn behavior as if it was online. Because difference in experimenter judgment cannot alter previously recorded infant behavior, the second coder noted any trials that were judged to have ended earlier or later than the original coding indicated. The computer compiled listening times as coded by the second coder. Of 80 total trials recoded (5 test sessions with 16 trials each), the second coder noted no trials that were judged to have ended too soon and only 3 trials that were judged to have ended too late, compared to the original coding. Comparisons of computer recorded listening times indicate high reliability between coders. Correlations for individual subjects ranged from .80 to .99, with an average correlation of .96.

## Results

12-month-old infants show a trend toward the hypothesized preference for infant-directed structure and, as predicted, do not show a preference for infant-directed prosody. A 2 (adult prosody, infant prosody) by 2 (adult structure, infant structure) Analysis of Variance was conducted on participant mean listening times. The main effect of structure did not reach significance $F(1,19) = 2.47$, $p = .13$; main effect of prosody was not significant $F(1,19) = .19$, $p = .67$. The interaction of prosody x structure also was not significant, $F(1,19) = .18$, $p = .68$. Table 2 lists mean listening times to the different passage types; Table 3 lists mean listening times to the different stimulus conditions; Table 4 lists results of the ANOVA. Figures 6 and 7 depict mean listening times to AP/IP and AS/IS passage types.

**Table 2. Mean Listening Times to Passage Type***

| | Adult Prosody | Infant Prosody | Adult Structure | Infant Structure |
|---|---|---|---|---|
| Mean (seconds) | 8.501 | 9.016 | 8.034 | 9.270 |
| SD | 0.749 | 0.700 | 0.698 | 0.767 |

*Averaged across 8 trials

*Structure*

We predicted that infants would listen longer to passages with infant-directed structure presented in infant-directed prosody (ISIP) than to passages with adult-directed structure presented infant-directed prosody (ASIP). A t-test on the mean listening times to each of these conditions is not significant ($p = .21$). We also predicted that infants would listen longer to passages with infant-directed structure presented in adult-directed prosody (ISAP) than to passages with adult-directed structure presented in adult-directed prosody (ASAP). A t-test on the mean listening times to each of these conditions is not significant ($p$ = .22). Table 3 shows the mean listening times to these four stimulus conditions.[7]

**Table 3. Mean Listening Times to Stimulus Conditions***

| | ISIP | ASIP | ISAP | ASAP |
|---|---|---|---|---|
| Mean (seconds) | 9.477 | 8.091 | 9.134 | 8.118 |
| SD | 2.94 | 4.11 | 3.68 | 4.04 |

*Averaged across 4 trials

While neither the results of the ANOVA for passage type nor the results of t-tests comparing stimulus conditions reach confirmatory levels of significance, they do reveal trends that suggest that year-old infants prefer listening to passages that contain infant-directed structure compared with passages containing adult-directed structure. It is possible that the large amount of variability among infants in this study contributed to masking underlying effects. This is supported by a follow-up analysis discussed below. Of the 20 infants tested, 11 showed a preference for infant-directed structure. While this is only half of the infants, those infants that did show such a preference showed it to a greater degree than those who showed a preference for the adult-directed structure. A t-test to compare the 11 participants who preferred infant-directed structure ("IS infants") with the 9 participants who preferred adult-directed structure ("AS infants") on the size of their listening preference differences to passages with adult- and infant-directed structure shows a significant difference in size of preference ($p$ = .027). This is suggestive of significant differences between infants, with some showing strong preference for infant-directed structure, but others not showing this preference. One possibility is that these differences between infants relate to vocabulary, with infants who

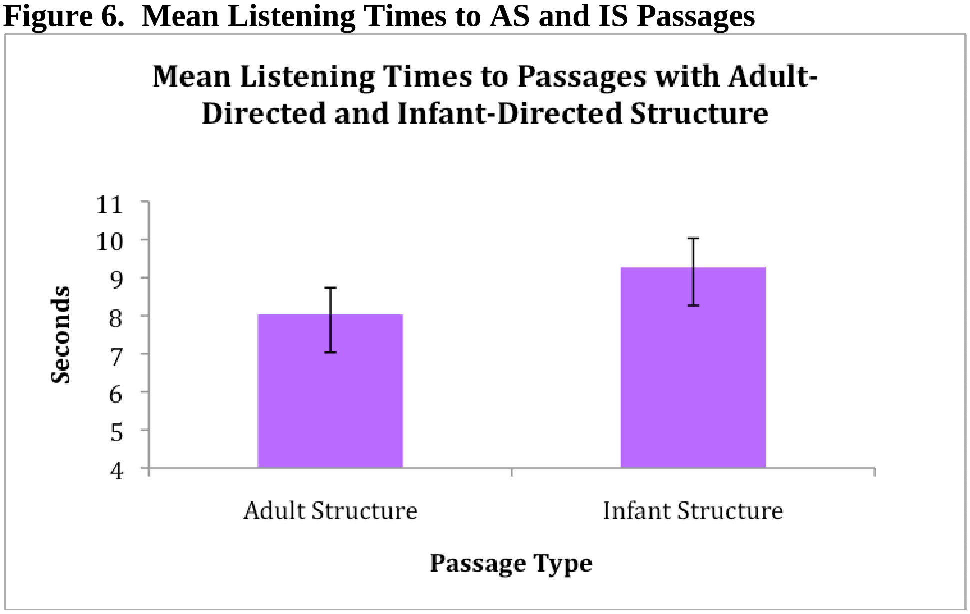
[7] These average listening times are similar to the 7-10 second averages found in other studies (Jusczyk & Aslin, 1995; Newman & Hussain, 2006)

are more lexically advanced showing the preference for infant-directed structure and those who are less advanced not demonstrating this preference. Alternatively, perhaps those infants who are slightly older show the preference for infant-directed structure, while younger infants do not. We therefore conducted follow-up analyses with vocabulary and age as factors, discussed below.

**Table 4. 2 x 2 Analysis of Variance: Within-Subjects Contrasts**

| | df | F | Significance | Partial Eta Squared |
|---|---|---|---|---|
| Prosody | 1 | .185 | .672 | .010 |
| Error | 19 | | | |
| Structure | 1 | 2.475 | .132 | .115 |
| Error | 19 | | | |
| Prosody x Structure | 1 | .179 | .677 | .009 |
| Error | 19 | | | |

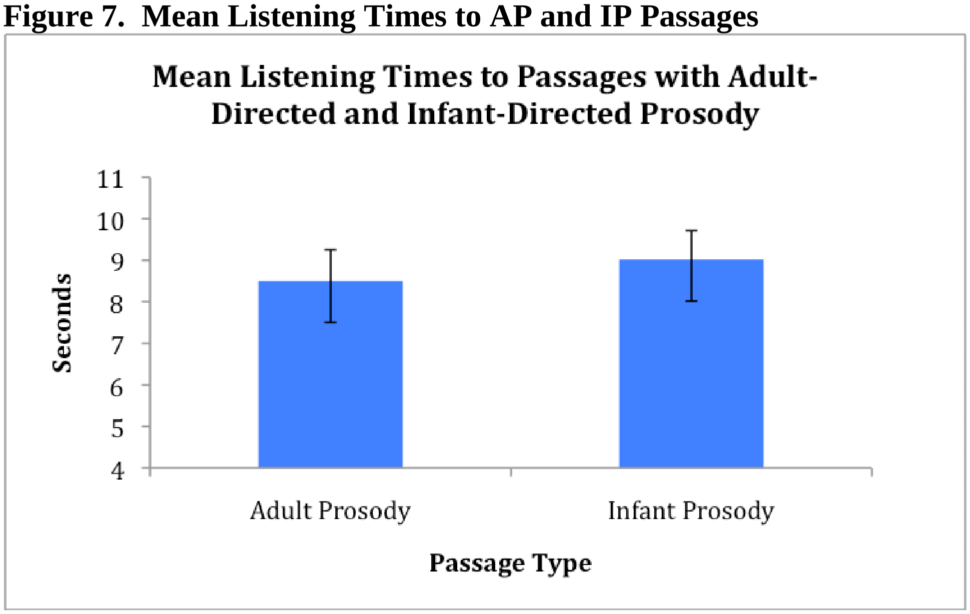
**Figure 6. Mean Listening Times to AS and IS Passages**



*Prosody*

We hypothesized that infants would not listen longer to passages presented in infant-directed prosody than to passages presented in adult-directed prosody when passage structure is infant-directed (IPIS/APIS). A t-test on the mean listening times to each of these stimulus conditions was not significant (p = .73). Both the ANOVA on mean listening times for passage types and the t-test comparing mean listening times for stimulus conditions support our prediction that type of prosody (adult, infant) did not change infants' listening behavior in the presence of infant-directed structure. Infants did not listen significantly longer to passages with either infant-directed or adult-directed prosody $F(1,19) = .19$, $p = .67$, indicating that the acoustic cues associated with infant-directed speech are no longer as attractive to 12-month-old infants as they are to younger infants. Only 8 of the 20 infants showed a preference for listening to infant-directed prosody over adult-directed prosody.

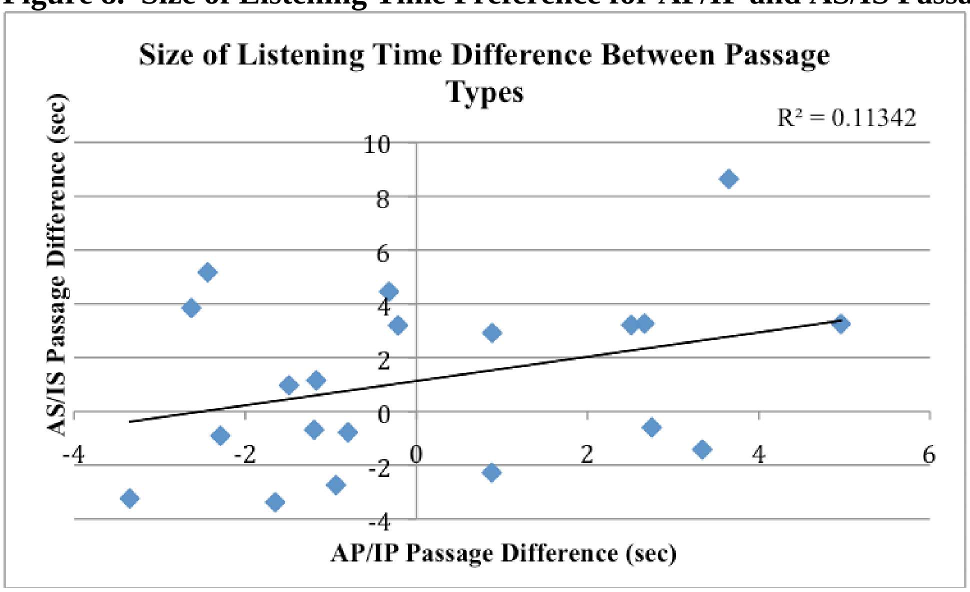
**Figure 7. Mean Listening Times to AP and IP Passages**



*Interaction of Structure and Prosody*

We found no significant interaction of the effects of structure and prosody $F(1,19) = .18$, $p = .68$. That is, listening times for different conditions of prosody (adult-directed, infant-directed) are not dependent on different conditions of structure (adult-directed, infant-directed), and vice versa. However, we did find a weak correlation between the size of preference for adult-directed prosody and size of preference for adult-directed structure ($r = .34$). This correlation suggests that as infants' preference for adult-directed prosody increases, so does the preference for adult-directed structure; likewise, as infants' preference for infant-directed prosody increases, so does the preference for infant-directed structure ($r = .34$). The correlation is depicted in Figure 8.

**Figure 8. Size of Listening Time Preference for AP/IP and AS/IS Passages**




*Vocabulary*

The MacArthur-Bates Communicative Development Inventory was completed for 16 of the 20 infants in the study. Four parents did not return these forms. Vocabulary scores consist of the number of words that are understood or said by the infants as reported by their parents. The scores for infants in the present study fall into roughly 3 groups: low, medium, and high vocabulary scores. Table 5 lists the scores by group.

**Table 5. Vocabulary Scores by Group**

| Low | Medium | High |
|---|---|---|
| 12 | 34 | 71 |
| 19 | 35 | 73 |
| 20 | 35 | 85 |
| 23 | 38 | 116 |
| | 48 | 118 |
| | | 123 |
| | | 124 |

Vocabulary Scores represent the number of words understood (as reported by parents)

One of the goals of the follow-up analyses was to identify relationships between listening preferences and vocabulary level. Mean listening times to passage type for the 16 infants for whom we obtained vocabulary information are given in Table 6 and depicted in Figures 9 and 10. When we entered this reduced set of data into a 2 (adult prosody, infant prosody) by 2 (adult structure, infant structure) Analysis of Variance, the result was a highly significant main effect of structure $F(1,15) = 7.73$, $p = .01$. No other results were significant: main effect of prosody $F(1,15) = .29$, $p = .60$, *ns*; the prosody x structure interaction $F(1,15) = .22$, $p = .64$, *ns*. Table 7 lists results. A moderate effect-size ($\eta p2 = .34$) of structure indicates that infant-directed structure accounts for approximately one-third of the variance in the data. The fact that we found a highly significant effect of structure in the reduced data set suggests not that there is something different about the 4 infants who were excluded (besides the fact that we did not obtain vocabulary information for them), but that the variability in the full data set masks the effect of structure. We have clear evidence in this analysis that these 16 infants strongly prefer listening to passages with infant-directed structure.

We then conducted a mixed Analysis of Variance with 2 within-subjects factors and 1 between-subjects factor in a 2 (adult prosody, infant prosody) by 2 (adult structure, infant structure) by 3 (low vocabulary, medium vocabulary, high vocabulary) design. Results of this analysis are given in Table 8 and reveal a significant main effect of structure $F(1,13) = 6.75$, $p = 02$. The main effect of prosody is not significant $F(1,13) = .13$, $p = .73$, nor is the main effect of vocabulary score $F(2, 13) = 1.12$, $p = .34$. None of the interactions are significant: prosody x structure $F(2,13) = .13$, $p = .72$; prosody x vocabulary score $F(2, 13) = 1.50$, $p = .26$; structure x vocabulary score $F(2, 13) = 1.51$, $p = .26$, though the three-way interaction prosody x structure x vocabulary score $F(2, 13) = 3.20$, $p = .07$ approaches significance. An effect-size correlation calculated using partial eta squared revealed moderate effect-sizes for structure ($\eta_p 2 = .342$) and for the 3-way interaction ($\eta_p 2 = .330$). Infant-directed structure accounts for approximately 34% of the variance in this set of data, while the interaction between prosody, structure, and vocabulary accounts for approximately 33% of the variance. These effect-sizes are notable because there are so many possible contributors to variability among infants (e.g., whether the infant is fussy, tired, hungry).

**Table 6. Mean Listening Times to Passage Type***

| | Adult Prosody | Infant Prosody | Adult Structure | Infant Structure |
|---|---|---|---|---|
| Mean (seconds) | 9.173 | 9.526 | 8.312 | 10.387 |
| SD | 0.775 | 0.706 | 0.823 | 0.697 |

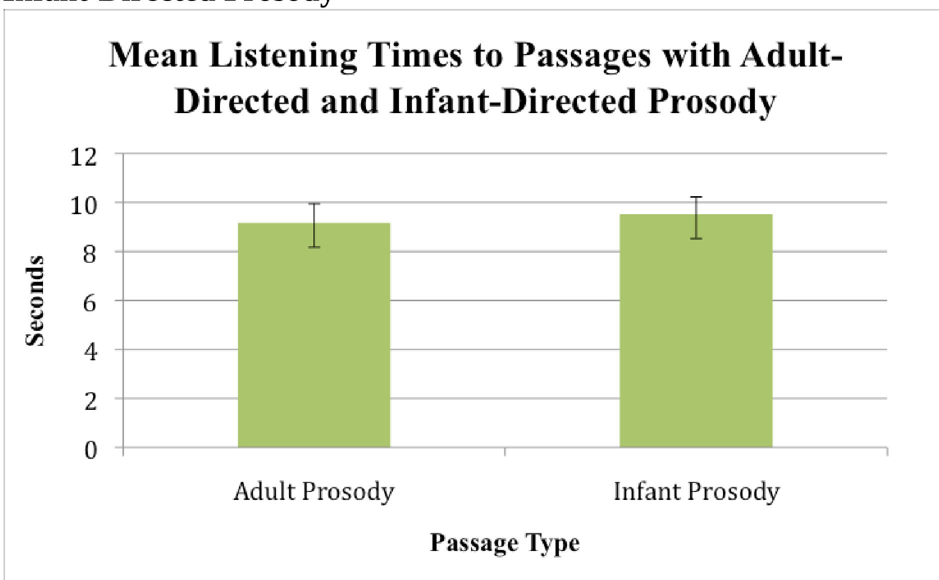
*For the set of 16 infants for whom we obtained vocabulary scores

**Table 7. 2 x 2 Analysis of Variance: Within-Subjects Contrasts**

| | df | F | Significance | Partial Eta Squared |
|---|---|---|---|---|
| Prosody | 1 | .291 | .598 | .019 |
| Error | 15 | | | |
| Structure | 1 | 7.729 | .014 | .340 |
| Error | 15 | | | |
| Prosody x Structure | 1 | .224 | .643 | .015 |
| Error | 15 | | | |

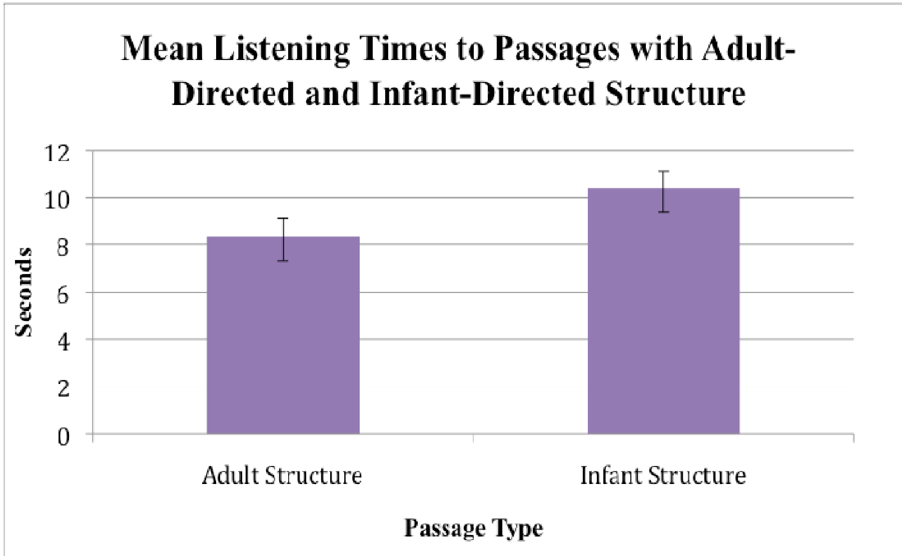
*For the set of 16 infants for whom we obtained vocabulary scores

**Figure 9. Mean Listening Times to Passages with Adult- and Infant-Directed Prosody***




*For the set of 16 infants for whom we obtained vocabulary scores

**Figure 10. Mean Listening Times to Passages with Adult- and Infant-Directed Structure***




*For the set of 16 infants for whom we obtained vocabulary scores

**Table 8. 2 x 2 x 3 Analysis of Variance: Within-Subjects Contrasts and Between-Subjects Effects**

**Within-Subjects Contrasts**

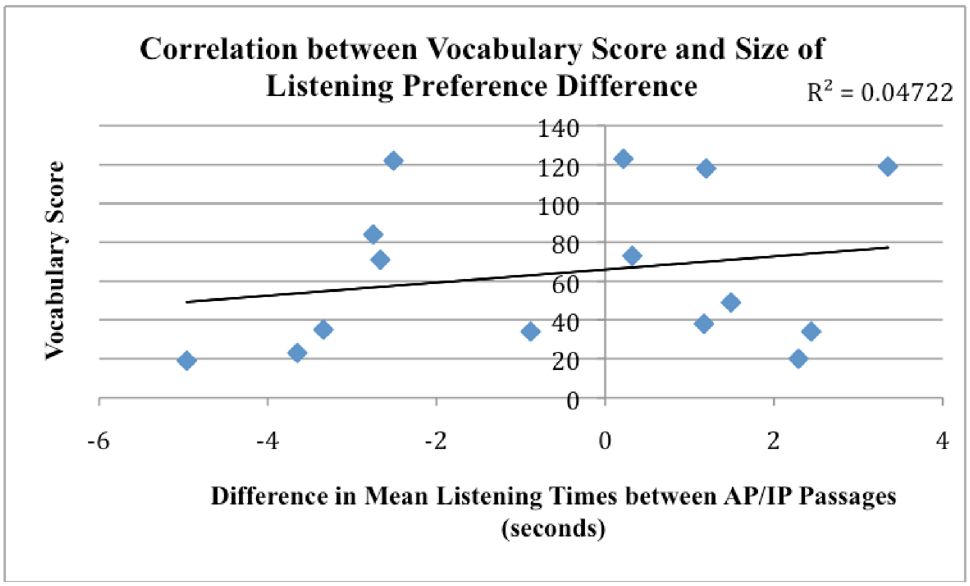
| | df | F | Significance | Partial Eta Squared |
|---|---|---|---|---|
| Prosody | 1 | .128 | .726 | .010 |
| Error | 13 | | | |
| Prosody x Vocabulary Score | 2 | 1.500 | .259 | .188 |
| Structure | 1 | 6.750 | .022 | .342 |
| Error | 13 | | | |
| Structure X Vocabulary Score | 2 | 1.516 | .256 | .189 |
| Prosody x Structure | 1 | .134 | .720 | .010 |
| Error | 13 | | | |
| Prosody x Structure x Vocab | 2 | 3.203 | .074 | .330 |

**Between-Subjects Effects**

| | df | F | Significance | Partial Eta Squared |
|---|---|---|---|---|
| Vocabulary Score | 2 | 1.178 | .339 | .153 |
| Error | 13 | | | |

Correlations were calculated for vocabulary score vs. size of preference for type of prosody, and for vocabulary score vs. size of preference for type of structure. Results indicate that vocabulary does not correlate with the size of the preference between adult-directed and infant-directed structure ($r$ = .19). However, there is a weak correlation ($r$ = .31) of vocabulary and size of preference for adult prosody, shown in Figure 11. As vocabulary score increases, size of preference for adult prosody becomes slightly greater.

**Figure 11. Correlation of Vocabulary Score and Difference in Listening Time between Passages with Adult-Directed and Infant-Directed Prosody**




*Age*

Although we were looking at what we have labeled as 12-month-old infants, actual infant ages ranged from 11 months, 3 days to 13 months. Mean listening times and infant age data were entered into a 2 (adult prosody, infant prosody) by 2 (adult structure, infant structure) by 2 (older than 12 months, younger than 12 months) Analysis of Variance with prosody and structure as within-subject variables and age as the between-subjects variable. Table 8 lists results. We found that the main effect of structure demonstrates a trend but is not significant $F(1,18) = 2.5$, $p = .13$. The main effect of prosody is not significant $F(1,18) = .02$, $p = .88$. The prosody x age interaction also demonstrates a trend but is not significant $F(1,18) = 2.38$, $p = .14$. The other interactions did not reach significance. We also calculated correlations for age (in days) + size of preference for type of prosody, and for age + size of preference for type of structure. Results showed similar trends to the vocabulary correlations. Age does not correlate with size of preference for adult-directed and infant-directed structure ($r = .12$), but there is a weak correlation for the difference between adult-directed and infant-directed prosody ($r = .36$), shown in Figure 12. Preference for adult prosody increases slightly with increased age.

**Table 9. 2 x 2 x 2 Analysis of Variance: Within-Subjects Contrasts and Between-Subjects Effects**

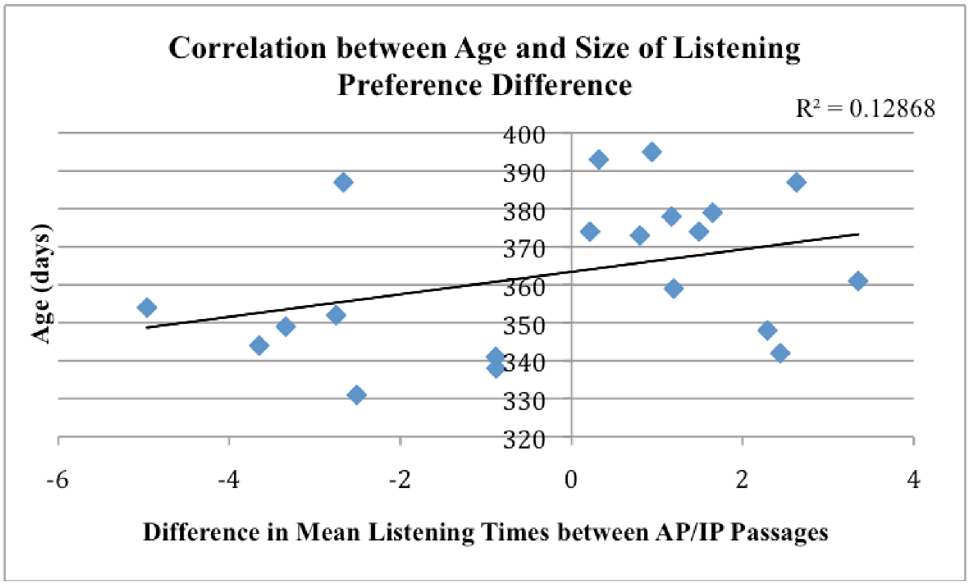
**Within-Subjects Contrasts**

| | df | F | Significance | Partial Eta Squared |
|---|---|---|---|---|
| Prosody | 1 | .022 | .884 | .001 |
| Error | 18 | | | |
| Prosody x Age | 1 | 2.379 | .140 | .117 |
| Structure | 1 | 2.555 | .127 | .124 |
| Error | 18 | | | |
| Structure x Age | 1 | .013 | .911 | .001 |
| Prosody x Structure | 1 | .063 | .804 | .003 |
| Error | 18 | | | |
| Prosody x Structure x Age | 1 | .247 | .625 | .014 |

**Between-Subjects Effects**

| | df | F | Significance | Partial Eta Squared |
|---|---|---|---|---|
| Age | 1 | 1.307 | .268 | .068 |
| Error | 18 | | | |

**Figure 12. Correlation of Age and Difference in Listening Time between Passages with Adult-Directed and Infant-Directed Prosody**




These results suggest that infants who understand more words have a stronger preference for adult-directed prosody than do their age-mates who understand fewer words. Infants, especially those who are older or with higher vocabulary scores, may derive some benefit from adult-directed prosody. Alternatively, it is possible that something about infant-directed prosody impedes some aspect of word-learning for these infants. Previous studies showed that young infants prefer infant-directed prosody to adult-directed prosody. Later studies suggest that the preference for infant-directed prosody disappears between 7 and 9 months of age. The growing trend for adult-directed prosody reported here may represent a continuation of the trend away from a preference for infant-directed prosody in the second half of the first year, and ultimately toward a preference for adult-directed prosody.

## Discussion

We found that there is a non-significant trend toward 12-month-old infants preferring to listen to infant-directed structure over adult-directed structure, regardless of which type of prosody was presented. This result is consistent with the Hayashi et al. (2001) finding that year-old infants prefer IDS to ADS. However, Hayashi et al. (2001) did not separate the prosody and structure components of their IDS stimuli so we do not know whether their infants were responding to the structural characteristics or the prosody, or both. Our results appear to contradict the findings by Newman and Hussain (2006) that year-old infants do not prefer IDS to ADS. This discrepancy may not represent a true contradiction, however. The Newman and Hussain (2006) stimuli held structure constant and manipulated only prosody. In reality our study actually supports Newman and Hussain (2006) because we found no preference for prosody, whether infant-directed or adult-directed. The issue becomes clear when we examine what is meant by "IDS." Most researchers use this term to refer to the entire complement of modifications, both acoustic and structural, made by caregivers when speaking to infants. This study is the first to separate prosodic modifications from structural modifications and manipulate the variables separately. As a result, our data support the findings of both Hayashi et al. (2001) and Newman and Hussain (2006) and lend evidence to the suggestion that acoustic properties of IDS are less important to older infants than to younger infants (Soderstrom, 2007). This study makes contributions to several areas of research in infant language acquisition. One area, mentioned above, is the question of whether older (year old) infants prefer to listen to IDS because of its structural characteristics rather than its prosodic characteristics. The second is the question of how long infants continue to prefer infant-directed prosody. The third is the area of maternal fine-tuning of speech to infants.

*Infant Preference for Infant-Directed Structure*

Speech to infants is characterized by certain modifications that may make it easier for them to process and understand lexical items. Among the changes are increased redundancy and shorter utterances in the input (Bernstein Ratner & Rooney, 2001). Other modifications such as reduced complexity are also characteristic of structural changes in infant-directed speech. Our study suggests that infants who are in the early stages of acquiring words prefer to listen to the structural aspects of infant-directed speech. When prosodic modifications are separated from structural modifications in infant-directed speech, infants tend to prefer listening to the passages with the structural modifications no matter what type of prosody is presented. Our subset of 16 infants demonstrated a significant preference for passages with infant-directed structure over passages with adult-directed structure, and our full set of data for all 20 infants echoed that trend. This implies that the variability in the larger set is masking a significant effect of structure. Although listening preferences may not necessarily equate with advantages for the infant, it makes sense to consider that when infants prefer to listen to certain types of input, it benefits them in some way. Recall that infant-directed structure includes reduced utterance length, reduced vocabulary diversity, and increased repetition, as well as other changes related to duration, pausing, and paraphrasing. These modifications are thought to reduce processing demands and thus would seem to be especially beneficial when one is just beginning to map meanings to word forms. Redundancy provides multiple opportunities to experience the same word; shorter utterances reduce the amount of information that must be processed at one time; and a limited variety of words provides a smaller pool of possible words from which to map meanings. Our study may have captured trends occurring at a point in lexical development where infants who are just beginning to acquire words could be employing new strategies to process the input. Year-old infants are typically at the very early stage of lexical development; it is possible that this is the time when infants' preference for infant-directed prosody wanes, and their preference for infant-directed structure grows.

*Infant Preference for Infant-Directed Prosody*

One question that remains unanswered in the literature is the age and developmental stage at which infants' preference for the prosodic qualities of infant-directed speech subsides. This study supports the hypothesis that older infants do not show a preference for passages with infant-directed prosody compared with adult-directed prosody no matter what type of structure (infant-directed or adult-directed) is presented. Both our full set of data and the partial set of 16 infants substantiate this prediction. However, some variation in preference to the two types of prosody is to be expected. When the difference in listening times to the two types of prosody is measured, an interesting trend is revealed. As infants grow older and as their receptive vocabularies increase, we found that they exhibit a slightly greater preference for adult-directed prosody.

We selected the MacArthur-Bates Communicative Development Inventory (CDI) to assess infants' vocabulary. This is a parental-report instrument with a high degree of reliability. Styles and Plunkett (2009) demonstrated that the words that parents reported their one-year-old children could understand actually predicted which words attracted looking behavior indicating word comprehension. The CDI is therefore a good measure of children's receptive vocabulary. The average number of words understood by 11- and 12-month-old children reported in the literature varies by study. Two recent studies show great variability among the children sampled, as evidenced by large standard deviations at each age, and large increases in mean vocabulary from 11 to 13 months of age (Fenson, et al., 2000; Feldman et al., 2000). Table 8 below shows that the mean vocabulary of 11-month-olds in the present study is significantly lower than the scores reported in the two other studies. This is most likely due to the relatively small sample size in the present study.

**Table 10. Vocabulary Scores by Age**

| Source of Vocabulary Score | 11-month-olds Mean (SD) | 12-month-olds Mean (SD) | 13-month-olds Mean (SD) |
|---|---|---|---|
| CDI Norming Study (Fenson et al., 2000) | 78.4 (75.1) | 86.4 (49.2) | 121.8 (68.9) |
| Prospective CDI Study (Feldman et al., 2000) | 92.3 (74.0) | 105.0 (77.2) | 119.0 (77.4) |
| CDI for Present Study | 46.8 (40.5) | 84.3 (31.5) | -- |

When we considered the group of 16 infants for whom we have vocabulary information, we found a modest correlation between vocabulary size and strength of preference for prosody type. The small trend we noted was that as infants' receptive vocabularies increased, there was a stronger preference for adult-directed prosody ($r$ = .31). One explanation is that infants with larger vocabularies no longer rely on the prosodic cues in infant-directed speech as much as the infants with smaller vocabularies do. When we looked at the correlation between age and size of preference for prosody we found a similar trend ($r$ = .36; we used the full set of 20 infants for this correlation). As children grow and acquire more advanced language skills, they may shift from using cues such as infant-directed prosody that were helpful earlier in their development to using different cues, such as infant-directed structure, to help them with new language tasks, such as mapping word meanings. Some aspects of adult-directed speech, such as prosody, may begin to have a role in infants' language learning as they near their first birthday. It is even possible that some properties of infant-directed speech, perhaps its acoustic properties, may actually interfere with infants' ability to learn new words by distorting the speech signal in a way that is problematic for the early language learner at a certain developmental stage (Soderstrom, 2007). Our study raises the interesting possibility that adult-directed prosody is either neutral or slightly helpful for older infants and those whose vocabulary is becoming quickly acquired.

There are three possibilities that could explain a trend that begins with a waning of the preference for infant-directed prosody and continues with a growing preference for adult-directed prosody. First, since infants typically listen longer to things that are familiar to them, this changing preference for prosody could be driven by changes in the way parents speak to their infants. As infants mature, parents may begin to reduce the proportion of infant-directed prosody in their speech to their children. Children's growing preference for adult-directed prosody could mirror the proportion of adult-directed prosody they hear directed toward them. Second, infant-directed prosody may be beneficial to young infants because it attracts their attention at a time when they cannot control attention on their own. As they mature and get better at this, they may not require the external control provided by the exaggerated prosody characteristics of the infant-directed register, leading to a change in their preferences. Third, infant-directed prosody may be beneficial in difficult listening conditions because it could highlight important parts of the signal. Perhaps this is more important for younger infants whose signal processing skills are not as developed as those of older infants. Thus, infant-directed prosody could benefit younger infants in listening situations where signal processing is difficult relative to their level of skill. As their skill develops, infants may derive less benefit from infant-directed prosody and thus their preference for it may wane.

Observations of changing preference for IDS may represent infants' abandonment of one technique in favor of a new one as their language abilities develop. It seems reasonable to conclude that infants attend to and prefer different forms of input at different stages in their linguistic development.

*Maternal Fine-Tuning in the Input*

The question of fine-tuning the input might be addressed by exploring infant preferences in combination with analyses of individual mothers' productions. While this study did not analyze mothers' productions, a number of studies have demonstrated that maternal input changes depending on infants' responses (Bernstein Ratner, 1984; Kitamura & Burnham, 2003; Huttenlocher, Vasilyeva, Waterfall, Vevea, & Hedges, 2007). Caregivers modify their speech along several dimensions depending on the characteristics of their children. For example, they increase complexity (as measured by diversity and composition of speech) across their children's development (Huttenlocher et al., 2007). Mothers reduce utterance length in speech to their infants beginning in the second half of the first year (Murray, Johnson, & Peters, 1990). Mothers and fathers both appear to fine-tune their speech to infants by increasing redundancy. Mothers tend to give basic level category names for objects in order to match these labels to their child's knowledge and experience, and use more frequently-occurring words more repetitively compared with fathers (Bernstein Ratner, 1988). These and other studies provide ample evidence that parents, especially mothers, modify and fine-tune their speech directed to infants. The present study used two types of maternal language input to test infants' responses. Our passages with infant-directed structure contain input modifications representative of changes mothers are known to make when fine-tuning their speech to their infants (e.g., reducing complexity and length of utterance, increasing redundancy). These modifications are thought to reduce the linguistic demands on novice language learners. As infants respond to simplified input, mothers are encouraged to continue fine-tuning; as mothers fine-tune the input, infants increase their responsiveness to the language. Our results support the idea that infants at 12 months of age prefer the simplified linguistic input that mothers have been shown to provide.

Year-old infants are extremely variable in their cognitive, motor, and language abilities. We were interested in knowing which type of input infants were most interested in listening to in order to contribute to understanding the nature of their preferences for IDS at this age. There is very limited evidence in the literature on the issue of how long infants prefer the IDS register and what drives the preference at different ages. Our data support the idea that infants continue to prefer the *structural* aspects of IDS through at least one year of age, but we would caution that it is important to identify the structural properties as driving this preference. We did not find that infants prefer the prosodic aspects of IDS at this age. The question of when infants no longer prefer IDS *prosody* remains unanswered by this study; we know that it must be before infants are 12 months old. As Soderstrom (2007) has suggested, infants during the first year may begin by attending primarily to IDS, but as they acquire greater competency with language they may begin to attend to some aspects of ADS. It seems reasonable to predict that in the early stages of language learning the ability to access adult-directed prosody would come before the ability to process adult-directed structure. Perhaps our study detects the period of time when infants' use of infant-directed prosody has waned but the ability to fully access adult-directed prosody is not yet realized.

The one-year point is an important milestone in infants' development because it ushers in a time when they are beginning to learn words. If style of maternal input assists infants in this task, it can be assumed that infants would be most interested in it at a time in their development that it will benefit them the most. That is, infants who are primed to learn words might be more disposed to listen to speech that helps them in this task than would infants who are not yet developmentally ready to begin acquiring words. The issue of maternal fine-tuning comes into play as infants' needs and preferences change with maturity and experience with language.

## Limitations of Current Study

The fact that we found somewhat stronger effects in our reduced set of data (for the 16 infants with vocabulary information) suggests that the study sample size was inadequate to fully answer the original research questions. Additional data are necessary in order to confirm or refute the trends reported here. Typical infant development is notoriously variable with a large range of normal skills and behavior. Fairly large sample populations are necessary so that any meaningful differences in listening behavior are more likely to be revealed. Prior studies that have found significant effects with IDS stimuli used large numbers of infants. Numbers of participants range, for example, from 32 8.5-month-old infants (Kemler Nelson et al., 1989); 125 4-month-old and 42 6-month-old infants (Spence & Moore, 2003); 48 4-month-old infants (Fernald, 1985); 72 infants aged 7 weeks old (Pegg, Werker, & McLeod, 1992); to 90 infants, 30 each at 4.5 months, 9 months, and 13 months of age (Newman & Hussain, 2006). The 20 infants used in our study were not enough to confidently identify patterns of infant listening preference.

The incomplete data on infants' vocabulary was a limitation in the current study. Incomplete vocabulary data limited the conclusions we were able to draw about whether vocabulary size was related to infants' interest in type of prosody or structure. There was a trend toward greater preference for adult-directed prosody with increasing vocabulary, but this was not a strong correlation. There was also a non-significant but noteworthy 3-way interaction showing a vocabulary-dependent preference for infant-directed structure but not prosody. A more complete set of vocabulary information might have strengthened and clarified these trends.

Although our study did capture listening trends, its design may have contributed to less robust results than might have been obtained if we had presented our test stimuli in a different format. The infants in our study heard four story passages, each of which consisted of four trials representing the four conditions (ISIP, ISAP, ASIP, ASAP). Infants heard all four conditions for each story passage in a block of four trials. It is possible that they became bored with repeated trials of the same story theme. While we found no order effects to indicate that infants listened longer to the first trials of a block and less to the last trials[8], we might have obtained better results if we had mixed the story themes within each block of four trials. Mixing story themes within a block might have reduced overall restlessness that is prevalent with this age group. Another possibility was to have designed the study to present infants with two conditions rather than four. Although the four-condition design is not unusual (Newman & Hussain, 2006), more studies have used a two-condition design (Cooper & Aslin, 1994; Hayashi, 2001; Jusczyk & Aslin, 1995; Jusczyk, Cutler & Redanz, 1993; Jusczyk et al., 1993; Saffran et al., 1996). Reducing listening choices might have simplified the task for infants and led to more robust findings.

[8] $F(3,19) = 1.43$, $p = .24$

## Directions for Future Research

There are several promising avenues for future research related to this study. First, the present study should be extended to include additional infants. As previously noted, large numbers of infants are often necessary to observe the full effect of experimental conditions. Additional infants would allow a more conclusive answer to the question of whether 12-month-old infants prefer to listen to infant-directed structure compared to adult-directed structure, and whether there is a stronger correlation between vocabulary size and size of preference for prosody or structure. Another avenue for future research is to explore different ages using the same stimuli. If IDS serves more universal roles such as attention and social interaction in younger infants and more language-specific roles such as language acquisition in older infants (Kitamura et al., 2002), prosodic cues should be preferred between 4 to 6 months and structural cues should be preferred between 8 to 12 months. Since we suspect now that 12-month-old infants prefer IDS structure, and previous work suggests that the preference for IDS wanes between 7 and 9 months of age (Newman & Hussain, 2006; Hayashi et al., 2001), infants aged 4 to 6 months and 8 to 10 months should be tested. Infants older than 12 months should be tested as well. Since they continue to rapidly acquire new words through at least 18 months, this would be an appropriate upper age to test using the stimuli from the present study.

There are several possible directions for future research related to infant preferences for the prosodic characteristics of IDS. The relationship between listening preferences, particularly prosody, and vocabulary size should continue to be explored. Vocabulary size may be a better indicator of when infants' preference for infant-directed prosody wanes than chronological age. Ideally, a longitudinal design would be employed to look these relationships across development. In addition, in order to explore the question of whether parents possibly drive infants' prosody preference, parent-child interactions should be explored in a naturalistic setting over longer time frame than is typical for laboratory studies. Parents may change not only the proportion of infant-directed prosody addressed to their children as the children mature, but it is likely that they use more infant-directed prosody in certain situations and more adult-directed prosody in others. An analysis would need to include a measure of prosody across an adequate time frame (e.g., an entire day) to get at the more situational aspects of its use. A related avenue would be to look at parents' use of infant-directed prosody and infant lexical acquisition. Results of the current study suggest that preference for infant-directed prosody would wane sooner in more lexically-advanced infants; if so, parents' use of it might be expected to wane as well. This reduction of infant-directed prosody use in parents could be an indication of the level of lexical advancement of the infant. It would also be fruitful to explore the extent to which infant-directed prosody could benefit infants in difficult listening conditions. Infant preferences for infant-directed prosody should be tested in a variety of challenging listening conditions in order to shed light on possible benefits of the register in signal processing. Ultimately this type of study should be done across several ages to test the relationship between skill level and prosody preference. A final direction for future research would refine the exploration of infant preferences for the structural characteristics of IDS by recreating the stimuli used in the current study so that a single structural variable is manipulated at a time. Perhaps our stimuli included modifications to too many variables at once: MLU, TTR/VOCD, target word repetition.  Looking at “infant structure” components individually (e.g. MLU or TTR/VOCD or repetition) would perhaps give a more straight-forward answer to the question of which properties drive the preference for IDS at 12 months of age.

# Appendices

## Appendix A

*Test Stimuli Characteristics*

| | Mean Pitch (Hz) | Min Pitch (Hz) | Max Pitch (Hz) | Pitch Range (Hz) | Standard Deviation | MLU | TTR | VOCD | Target Word Frequency |
|---|---|---|---|---|---|---|---|---|---|
| Infant Prosody/Infant Structure (IPIS) | | | | | | | | | |
| Passage 1 | 274.68 | 124.44 | 624.53 | 500.10 | 83.82 | 3.8 | 0.49 | 19.74 | 22 |
| Passage 2 | 316.63 | 99.97 | 649.07 | 549.10 | 104.41 | 4.5 | 0.47 | 13.24 | 16 |
| Passage 3 | 287.14 | 129.55 | 648.20 | 518.65 | 83.56 | 3.9 | 0.52 | 23.75 | 18 |
| Passage 4 | 278.18 | 116.77 | 596.25 | 479.48 | 94.37 | 4.3 | 0.49 | 19.33 | 17 |
| Infant Prosody/Adult Structure (IPAS) | | | | | | | | | |
| Passage 1 | 280.72 | 130.19 | 618.92 | 488.73 | 84.92 | 6.5 | 0.63 | 40.32 | 13 |
| Passage 2 | 312.45 | 107.68 | 641.76 | 534.08 | 93.75 | 6.7 | 0.66 | 33.90 | 10 |
| Passage 3 | 292.21 | 155.66 | 636.37 | 480.70 | 85.31 | 7.7 | 0.61 | 33.93 | 11 |
| Passage 4 | 272.14 | 128.16 | 568.40 | 440.24 | 88.14 | 6.8 | 0.68 | 45.32 | 11 |
| Adult Prosody/Infant Structure (APIS) | | | | | | | | | |
| Passage 1 | 200.48 | 127.73 | 394.34 | 266.61 | 45.05 | 3.8 | 0.49 | 19.74 | 22 |
| Passage 2 | 193.35 | 91.93 | 295.85 | 203.92 | 38.59 | 4.5 | 0.47 | 13.24 | 16 |
| Passage 3 | 205.16 | 92.05 | 346.20 | 254.15 | 45.22 | 3.9 | 0.52 | 23.75 | 18 |
| Passage 4 | 196.61 | 86.30 | 361.22 | 274.92 | 51.09 | 4.3 | 0.49 | 19.33 | 17 |
| Adult Prosody/Adult Structure (APAS) | | | | | | | | | |
| Passage 1 | 196.77 | 120.47 | 331.10 | 211.53 | 38.57 | 6.5 | 0.63 | 40.32 | 13 |
| Passage 2 | 198.04 | 80.37 | 356.27 | 275.89 | 39.48 | 6.7 | 0.66 | 33.90 | 10 |
| Passage 3 | 201.53 | 80.06 | 347.76 | 267.70 | 43.41 | 7.7 | 0.61 | 33.93 | 11 |
| Passage 4 | 205.07 | 81.24 | 395.71 | 314.47 | 50.84 | 6.8 | 0.68 | 45.32 | 11 |
| Mean IPIS | 289.16 | 117.68 | 629.51 | 511.83 | 91.54 | 4.1 | 0.49 | 19.01 | 18.25 |
| Mean IPAS | 289.38 | 130.42 | 616.36 | 485.94 | 88.03 | 6.9 | 0.64 | 38.37 | 11.25 |
| Mean APIS | 198.90 | 99.50 | 349.40 | 249.90 | 44.99 | 4.1 | 0.49 | 19.01 | 18.25 |
| Mean APAS | 200.35 | 90.53 | 357.71 | 267.40 | 43.07 | 6.9 | 0.64 | 38.37 | 11.25 |
| Mean All IP | 289.27 | 124.05 | 622.94 | 498.88 | 89.78 | 5.5 | 0.56 | 28.69 | 14.75 |
| Mean All AP | 199.62 | 186.14 | 353.56 | 258.65 | 44.03 | 5.5 | 0.56 | 28.69 | 14.75 |
| Mean All IS | 244.03 | 108.59 | 489.46 | 380.86 | 68.26 | 4.12 | 0.49 | 19.01 | 18.25 |
| Mean All AS | 244.86 | 110.47 | 487.03 | 376.67 | 65.55 | 6.92 | 0.64 | 38.37 | 11.25 |

MLU: Mean Length of Utterance; TTR: Type Token Ratio; VOCD: Vocabulary Diversity

## Appendix B

*Test Stimuli Passages*

**BATH**

Infant Structure

*See the water! Feel how warm! Nice water for a bath. Bath time is fun! Time to wash. It's nice and warm. Feel the water. Clean water to wash in. It feels good. You can splash! See the splash. It's time to wash and play. Having a bath is good. The water is clean. Children can play, they can have fun.*

Adult Structure

*Bath time is good fun for children and it gets them nice and clean too. They can splash and play before the warm water gets cold. Give them plenty of bath toys. Some bath toys are good for pouring, some for floating, and some for squirting. There are even bath books. Children can learn, play, and wash in the water all at the same time.*

**DUCKS**

Infant Structure

*Look at the baby duck. It is yellow. See the little duck. There it is. It is with its mother. They are by the water. You like the little duck. It is soft and cute. What a nice duck. Look there! There is the cute yellow duck. The cute yellow duck is with its mother. There they go!*

Adult Structure

*This is a story about a cute baby duck and its mother. They walked by the water, but the little yellow duck was scared to go in. The water looked nice and cool, but the duck would not go in. The mother and the baby duck went in together. A soft, fluffy duck is very appealing when it is young.*

**KITTEN**

Infant Structure

*See the sweet kitten! See there! There is a cute gray kitten. Come and play. Kittens are soft and small. This one likes milk. Look there! See it drink. Drink the milk! Now it is sleepy. Look at how sweet it is. It's so sleepy! The small gray kitten is so cute. It is nice and soft. It likes to have fun. Let's play!*

Adult Structure

*Kittens are very cute and sweet when they are small. They run and play, leap and hide, and they are a lot of fun to watch. A kitten likes to curl up into a soft ball when it is sleepy. When it wakes up, it wants to drink milk and play again. A kitten is fun to have and nice to touch, but it can make a big mess.*

**TEDDY**

Infant Structure

*Teddy bear is so nice! Look there! See Teddy! He has a red bow. He's sitting on the chair. Go get Teddy! He has soft brown fur. See the soft brown bear. Hi Teddy! There he is! The bear is nice to hug. It's good to hug the soft bear. See how he likes you! See how he likes to play.*

Adult Structure

*Every child should own a teddy bear. This teddy bear is a nice brown color, with a handsome red bow around his neck. The bear is sitting in a chair while he waits for someone to play with him. He could join a tea party, or take a ride in a car. A teddy bear is a soft toy to hug and a perfect friend for any child.*

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