Dedication

To my family, John, Pirjo, and Michael Strunk
I would like to start out by thanking all of the mothers who so willingly participated in this project. Without their gracious time and cooperation, this project would have never been possible. I also would like to give special thanks to my committee members, Dr. Robin Cooper, Dr. Martha Ann Bell, and Dr. Jack Finney, whose guidance and patience has greatly assisted me in designing, running, and completing this project. In addition, I would like to thank my lab members for all their input and advice during this project. Finally, I would like to thank my friend and colleague, Jen Vendemia, for all of her help setting up my analysis and bearing with me until its completion.
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The dynamic interplay that exists between infants and their caretakers dramatically shapes both partners. From birth on, this social interplay affects how the infant and parent respond to each other, what types of information and interactions are encouraged and discouraged, and the paths by which they will both proceed in development. This interaction provides a framework within which vocal behaviors can be purposefully produced and perceived by both the caretaker and the infant. Over time, this 'conversation' between the infant and the caregiver lays the groundwork for the infant to hook into the language process, learn about the world, and allows the mother to feel connected and communicative with her infant (Fernald, 1992; Penman, Cross, Milgrom-Friedman, & Meares, 1983).

The linguistic and prosodic features of maternal speech provide the infant a great deal of interpersonal and environmental information. Although there exists a large amount of research on the linguistic content of speech to older infants, and the prosodic input to both younger and older infants, there is relatively little research examining the linguistic content of speech to young infants and the relationship between the linguistic content and prosodic features of infant-directed (ID) speech. The purpose of this research project was to examine both the linguistic and prosodic content of ID speech to infants, and explore the relationship that exists between the prosodic features and the content of this speech, and how this relationship changes over the first eight months after birth. First, however, it is important to have a model of language development in which to frame the current project, and to provide an overview of what we know regarding the prosodic and linguistic features of speech to infants.
Language as a social consequence

Rather than a static event that 'happens' to an infant, language learning is an ongoing and evolving perceptual process. Infants are given the opportunity to perceive speech, and therefore learn language by the guidance of perceptually experienced caretakers who may limit choices and help educate the attention of the infant (Zukow, 1990). Examining language from such a socio-perceptual/ecological approach, a fluid speech stream potentially provides a wealth of information about the structure of language to an infant. However, infants are unfamiliar with the perceptual processing involved with parsing this speech stream into meaningful relations to the world (words). This inexperience puts infants at a seemingly significant disadvantage for learning language (Zukow, 1990). In order for perceptual differentiation of a fluid stream of speech to take place, the infant must have the ability to detect invariant relationships between the perceptual information of the speech sounds and ongoing events. In essence, the infant must be able to parse the words within a continuous speech stream into distinct units, and be able to relate those units to events in the environment.

However, the ability of a naive language-learner to achieve this complex feat alone is unlikely because of the shear richness in possible co-occurring yet unrelated events. For example, when a mother says to her infant 'See the ball?', and also shows the infant a ball, the infant has several perceptual tasks. The infant must somehow determine the focus of the mother's attention (the infant and the ball), differentiate the ball from the background (e.g. from the mother's hand, the stimuli behind the ball) and differentiate components of the speech stream from within the stream and from other background noise. In addition, the infant must make an association between the auditory stimulus (the speech) and perceived events in the environment. In other words, to understand that there are words within sound, that those words pertain to events in the environment, and to perceive those things as separate from other events is a complex and daunting task to achieve. Moreover, the infant is unaware of any language tasks it needs to 'achieve'. In other words, infants do not know that they are suppose to learn language (Locke, 1996).
Instead, the infant listens and analyzes language for immediate consequences, including arousal modulation, interaction with caregivers, and the pleasing sounds of ID speech.

Fernald (1992) has proposed that ID speech provides different affective, social and linguistic functions during infant development. According to this model, the melody of maternal ID speech is initially an unconditioned stimulus, eliciting responses from the infant based on the acoustic, prosodic features of the speech stream. The prosodic features of ID speech include exaggerated and higher pitch, greater pitch variability, and longer pauses in speech patterns. In essence, ID speech alerts, soothes, alarms, or calms the infant. As the infant ages, ID speech becomes more important to the attention and emotional regulation of the infant, signaling nurturance, security, and encouraging development of emotional connections between the mother and infant. The connection between ID speech and the development of emotional responsiveness continues as the infant begins to use both vocal and facial cues to interpret situations in the environment. Called social referencing, the infant attends to the positive and negative vocal and facial expressions of the mother to cue their own affect and reactions to interpersonal and environmental situations.

Ultimately, ID speech serves a more direct linguistic function. Because infants are not born with a lexicon, or with the understanding that there are sequences of words within the speech stream, these relationships must be discovered during listening experiences. The exaggerated prosody of ID speech appears to make a contribution to the infant's increasing ability to segment the speech stream into words and phrases, detect word boundaries, and to detect overall syntactic structure (Aslin, Woodward, LaMendola, & Bever, 1996a; Cutler, 1996; Echols, 1996; Fisher & Tokura, 1996).

There are multiple theories explaining how ID speech assists in the different aspects of linguistic functioning. Cutler (1996) has suggested that segmentation of word boundaries may be facilitated by the exaggerated rhythm of ID speech. She notes that adults can increase their recognition of word boundaries and segmentation by attending
to the prosodic structure (in the form of language rhythm). Infants also appear to be highly sensitive to language rhythm (Cutler, 1994), and this language rhythm may foster specific strategies to solve initial word boundary problems. For example, English listeners use stress patterns (alternations in amplitude and frequency) within the speech stream to segment words, and these stress patterns are exaggerated in ID speech. There are a couple of ways that stress may contribute to word segmentation. Infants may perceive stressed, salient syllables in a stream of speech, and those syllables may become initial representations of words. That is, infants may preferentially attend to and store syllables based on some absolute level of stress that speech reaches (Echols, 1996). Likewise, infants may also attend to the relative stress of contiguous words, using stressed and nonstressed syllables (essentially the rhythm of speech) as cues for word segments (Cutler, 1996; Echols, 1996). For example, infants embedded and exposed to the English language may differentially attend to strong-weak disyllables, a common pattern of English word-type. Therefore, as the infant has more exposure to his/her native language and learns its stress patterning, he/she inadvertently may also be learning a foundation in which word segmentation in the speech stream can occur.

Aslin et al. (1996a) note that prosodic modifications are not necessarily enough to learn word segmentation. Rather, prosodic cues appear to direct infant attention to general areas within an utterance which provide important information regarding segmentation. In addition to stress patterns, ID speech includes certain linguistic characteristics like simplification of sentences, longer pauses between sentences or phrases, extreme final word lengthening and pitch changes at the end of sentences, increased likelihood of a prosodic break between the subject and verb phrase units, and the placement of target object words in the utterance final position (Aslin et al., 1996a; Fisher & Tokura, 1996). All of these characteristics may provide the infant initial opportunities to learn about the structure of their native language.

Importantly, this whole process is fostered through the guidance of a sensitive caretaker (Zukow, 1990). Caretakers unintentionally yet actively educate the infant's
attention to the language properties of the speech stream, and the relationship between those properties and the world, at least in older infants. An example of this would be a mother showing an infant a ball, and then saying 'see the BALL?', emphasizing the object noun. By doing this, the mother is attempting to engage the infant in an interaction between the infant and the object. As an unintended by-product, the mother is also educating her child about the relationship between the world and language.

However, this active process of relating speech sounds to the world is probably not the reason mothers talk to their young infants. Locke (1996) notes that although ID speech may contain some unique characteristics that permit the infant to learn language, the reasons that mothers speak to their infants in ID speech is not necessarily to teach them language. Mothers speak to their infants to promote a sense of connectedness, to calm and comfort, and to alert and interact (essentially to foster socio-emotional regulation). In other words, infants do not attend to ID speech because they 'know' it will help them learn language (Locke, 1996). Rather, ID speech provides immediate assistance in arousal regulation, emotional information and opportunities for interaction with the mother. Therefore, it is the unique perceptual, emotional, and social aspects of vocal communication that eventually lead to language learning.

Understanding the progression that infants go through in order to learn language includes developing an appreciation for the specific prosodic features that infants can and do attend to, understanding the changes in linguistic features that are perceived by the infant and provided by the mother, and developing further understanding of how both the prosodic and the linguistic features influence the overall process of language learning.

Prosodic Features and Linguistic Content of Maternal Speech

Research indicates that there is a unique quality of speech directed to infants, and that ID speech is attended to in qualitatively different ways by infants than AD speech. As mentioned earlier, the prosodic features of ID speech include exaggerated and higher
pitch, greater pitch variability, and longer pauses in speech patterns (Fernald, 1991; Garnica, 1977). These prosodic features are able to mark lexical and grammatical differences within a speech stream (Garnica, 1977). The linguistic features of ID speech include shorter utterances, greater repetition of words and sentences, syntactically simplified sentences, systematic variation of noun-verb structure, and increasing use of information-loaded sentences, in which the function is to convey information about the world (Aslin, Jusczyk, & Pisoni, 1996b; Penman, et al., 1985; Snow, 1977). Because both prosodic and linguistic features of ID speech are dynamically interrelated and influential in language learning, it is important to understand how these features work together in the language learning process.

Young infants appear to be sensitive to features of speech. For example, newborns showed a preference for their mother's voice in ID speech over another woman's voice in ID speech (DeCasper & Fifer, 1980). In addition newborns have shown an overall preference for ID speech which continues throughout the first year (Cooper & Aslin, 1990; Fernald, 1985; Pegg, Werker, & McLeod, 1992). Prosodic features of ID speech appear to assist the infant in engaging and maintaining attention. Infants as young as 2 months of age have shown greater attention to natural rising contours than to a computer generated rising contour (Sullivan & Horowitz, 1983), and 4-month-old infants have shown greater visual attention to a picture of an adult face when presented with an 'approving' contour rather than a 'disapproving' contour (Papousek, Bornstein, Nuzzo, Papousek, & Symmes, 1990).

Infants also appear to be sensitive to linguistic properties of ID speech as well. Young infants are sensitive to changes in syllables and polysyllabic sequences within words. Karzon and Nicholas (1989) found that infants between the ages of 2 to 3 months can discriminate between rising and falling syllabic pitch contours, such as [ra] and [la], and this may influence attention systems and segmentation of the speech stream (Fernald, 1978, in Karzon & Nicholas, 1989; Snow, 1977). Karzon (1985) examined the ability of infants to discriminate three-syllable sequences in which a change occurred.
in the middle syllable speech sound (marana vs. malana). Results revealed that even 1-month-old infants could discriminate between these two consonant-vowel changes, but only when the stimulus word was spoken in ID speech. The same comparison did not result in discrimination when the stimulus was spoken in AD speech. This pattern of results suggests that the prosodic features of ID speech may function to enhance perceptual discrimination of phonemes, and suggests that even as young as 1 month, infants are beginning to detect patterns within the speech stream. It is important to note that research has shown that even newborns can discriminate between phonemes (see Kuhl, 1985). However, Aslin et al. (1996a) notes that this research on newborn speech perception has often been done with single presentation, computer generated stimuli in sound proof and distraction minimized rooms, not in the natural settings of speech presentation. Therefore, ID speech may assist in phoneme discrimination when the phonemes are within a natural speech stream and with background sound distracters.

In fact, evidence seems to suggest that young infants are able to recognize the sound patterns of words early on. Mandel, Kemler-Nelson, and Jusczyk (in press) presented 48 infants between 6-12 weeks old with single well-formed and complete sentences and sentential fragments. Within each, the word order was changed. The results were that 2-month-old infants were able to detect changes in alternations of word order when the changes occurred in a complete sentence. Additional research has indicated that young infants are able to recognize the sound patterns of their own names. Mandel, Jusczyk, and Pisoni (1995) found that 4.5-month-old infants demonstrated a preference for their own names versus another name with either a matched or mismatched stress pattern, when the names were presented as single utterances. However, infants did not detect their names embedded in sentences until they were 7.5 months old (Mandel & Jusczyk, 1996). Therefore, although infants do seem to have some of the skills necessary to perceive elements of language, the early perception of speech appears to combine elements of social and affective relations while gradually allowing for the linguistic information to become as important as the prosodic information.
Although the above research provides us with some idea of how young infants respond to ID speech, it is important to examine the changes that occur in the prosodic and linguistic structure of maternal speech to infants as they develop. For example, research has shown that adults produce a significant increase in the average pitch and pitch variability of their speech when talking to an actual infant versus pretending to talk to an infant (Jacobson, Boersma, Fields, & Olson, 1983). Stern, Spieker, Barnett, and MacKain (1983) examined some prosodic features of maternal ID speech to infants during the neonatal period, and then at 4 months, 12 months, and 24 months. These prosodic features included the fundamental frequency (Fo) (pitch), repetitiveness of utterances, timing, tempo, and mean length of utterance (MLU). Stern et al. found patterns of elevated Fo and overall shorter utterances in the ID speech used with these children. However, these authors also found a significantly greater elevation in Fo and more repetitiveness of utterances in the speech addressed to 4 month-olds, compared to all other ages.

Stern et al. (1983) explained these results by suggesting that the social context between infant and mother leads to increased vocal diversity of pitch contours, variable rhythms, and repetitions. At the newborn stage, the mother's goal is often to keep the infant alert and calm, modulating arousal at a relatively low level. The newborn infant can typically only tolerate lower levels of stimulation. However, by four months, the infant is better able to engage the mother in interactive face-to-face play. During this period, the mother is rewarded for using greater pitch variation and increasingly exaggerated ID speech patterns with smiles and signs of active engagement by the infant. As the infant reaches the 12-24 month stage, however, the infant's goals are more oriented toward objects. Therefore, the use of ID speech is no longer exclusively affective in orientation. The linguistic/analytic properties of ID speech may slowly begin to come into greater play, whereas the social and emotional functions of ID speech recede into secondary importance (Fernald, 1992; Garnica, 1977). The shift in the function of ID speech, from affective to informational, may indicate a shift in the
communicative goals of the mother and infant, and therefore should relate to shifts in the linguistic as well as prosodic content of the mother's speech.

To date, the investigation of the content of mothers' speech to their young infants has been somewhat neglected. Because it is assumed that young infants cannot understand the content of their mothers' speech, and rely on the prosodic aspects of the speech to convey emotional information, most researchers have examined the relationship between these prosodic elements and infants' attention to these elements. Such analyses have excluded any information on the progression of content until the infant is close to the first-word stage (see Werker, Lloyd, Pegg, & Polka, 1995). However, there are several key reasons why linguistic content is important. First, mothers do engage their infants in dynamic verbal interplay. Snow (1977) argues that from the beginning, mothers talk to their infants in conversational ways, attempting to elicit responses from them. Examining the speech of two mother-infant dyads (5-7 month old), Snow found that the tone of maternal conversations was not 'monologue-like', full of nonsense words, or speeches. Instead, the mothers' verbal contents suggested turn-taking and some expectations of responsiveness. For mothers to maintain this type of verbal play with their infants, the conversations must be interesting and relevant to the mother (and supposedly to the infant).

In addition, ID speech is not merely a melody of sound. Rather, the melody and the content are directly intertwined, and may be related to each other beyond temporal space. It could be that the content of maternal speech has a direct effect on its concomitant prosodic features, and/or that the intention of creating specific prosodic features results in a specific type of content in maternal speech. Since we know that infants are attuned to the prosodic features very early on, and that they even begin to recognize their names by 4.5 months, it is important to examine the early content of maternal speech.

In this vein, Kruper and Uzgiris (1987) examined the structure and content of mothers' and fathers' speech to their 3 and 9 month old infants. These researchers
examined the relationship between the gender of the parent and infant, the age of the infant, and the content and structure of the parent's speech. The categories of content that they examined were attention-seeking utterances (e.g., greetings), game-related statements (e.g., 'gotcha'), utterances made in lieu of the child, interpretations of infant's actions, comments about behavior or appearance of the infant, and explanations about the environment. These content categories appear to have been chosen based on their perceived parental gender bias; fathers and mothers are reported to have different interaction styles with their infants, with fathers engaged in more active, physical play (Field, 1978, in Kruper & Uzgiris, 1987). Kruper and Uzgiris hypothesized that this would be reflected in the content of their speech, and appear to have chosen the categories accordingly.

Results of their study indicated that there was a significant pattern of speech content for mothers and fathers. All parents appear to use significantly more questions than other types of sentence structures (between 44.68% and 40.78%). Mothers used significantly more comments than fathers, used more game-related comments and attention-seeking comments to older infants, and used more directives with their older infants. Fathers, on the other hand, used significantly more game-related statements than mothers, especially to their sons, and were much less likely to use directives, especially if the infant was older. However, this study emphasized the differences between parental genders, and did not examine the overall function of the speech content spoken to infants.

Penman, Cross, Milgrom-Friedman, and Meares (1983) examined the content of maternal speech to prelingual infants, and focused on how the content of maternal speech was affected by the behavioral modes of the infant. Penman et. al. (1983) began by stating their belief that maternal speech to infants is somehow modified by a form of "communicative " feedback given by the infant to the mother. This feedback takes the form of nonverbal modes of behavior which communicate the intent of the infant's actions. The infant has three major modes of behavior that develop out of experience
and from which action is generated: communicative (for social interaction with humans), praxic (for knowing and using objects) and reflective (for self-directive or thoughtful behavior). Penman and her associates believed that it is through the action of one of these modes that different types of maternal speech are cued.

In Penman et al.’s (1983) study, maternal speech style was characterized by two superordinate categories: affective-salient and information-salient. Information-salient utterances are those utterances which contained a full, creative proposition, and were not stock expressions. Also, information-salient utterances were determined by the coders to be used in normal adult conversation. These utterances are made up of directions, interpretations, questions and reports, and are influenced by their referential nature. In other words, these utterances can allude to the infant's actions or feelings, the mother's actions or feelings, and the events and objects in the environment. For example, the phrase 'You've got my finger' would be considered an information-salient report of the infant's behavior. Interestingly, a phrase like 'Are you happy now?' would also be considered information-salient, questioning the infant's feelings. According to Penman et al. (1983), the function of this phrase is to inform and gather information regarding emotive states, not to alter those states through vocal inflections. However, Penman and her colleagues did not account for a dual function in these utterances: both conveying information and affective regulation.

According to Penman, et al., affective-salient utterances primarily function to convey emotive information through alternations in the physical sound of the speech stream. Affective-salient utterances are those utterances that are idiomatic, meaningless outside the context, and non-propositional. These utterances are made of phrases containing positive affect, comforting, discouraging, nonsense words, mimics of infant sounds, greetings, and recitations. For example, phrases such as 'good girl' would be an affect-salient, positive utterance, or a phrase like 'aboo-boo' would be a nonsense affect-salient utterance. These 'contentless' utterances can be distinguished from content utterances in that an utterance is contentless when the verbal information conveyed is
subordinate to the effect of the physical sounds created (Penman, et al., 1983; Sylvester-
Bradley & Trevarthen, 1978). In essence, affective-salient vocalizations are used for
more emotional tone, and rely more heavily on how the words are being said (prosody)
than what is being said.

Penman and her colleagues believed that the behavioral modes of the infant affect
the type of speech in which the mother engages. The three modes of behavior that
Penmen et al. (1983) have described are the Communicative, the Praxic, and the
Reflective. Accordingly, infants who exhibit behaviors in a Communicative mode
(reflected in behaviors that encouraged interaction with the mother) would increase the
mother's use of affect-salient speech. However, if an infant exhibited behaviors
concerned with interacting with objects in the environment (Praxic mode), the mother's
speech would reflect greater use of information-salient content. Therefore, Penman et
al. (1983) hypothesized that mothers' speech to their prelingual infants would differ in
both function and reference at two different stages (3 and 6 months), and that aspects of
maternal speech would also differ according to shifts in the infant's behavioral mode.

They found that there was a significant change in the type of mothers' speech
between 3 and 6 months. Mothers speech to their infants at 3 months was more
affective-salient in nature than at 6 months. This speech showed more greetings, phrases
of encouragement, comfort, reassurance, and nonsense words. In contrast, maternal
speech to 6 month olds became much more informative. Non-referential, affective
utterances (such as coos, ahh, and nonsense words) decreased significantly, whereas
references regarding the external environment, such as objects and the actions of others,
increased significantly. In essence, maternal speech shows a decrease in the use of
affective utterances, and becomes more and more informational in its function.

In addition, they found no significant differences between the behavioral modes of
the infant when informational utterances were used. The infants' behavioral styles did
not appear to have an effect on the use of informational utterances. Significant effects
were found in affective utterances, with mothers using more affective utterances when their infants were in a Communicative mode of behaving than in a Praxic mode. Therefore, when infants were exhibiting behaviors that were interactive in nature, affect-salient utterances were used more frequently. Penman et al. assumed that the infant's behavioral mode was affecting the type of speech production that the mother exhibited. However, they did not empirically show which came first, the mode or the speech. Although Penman et al. assumed that the infant's behavioral mode was the influencing factor in the type of speech that the mother used, it is just as likely that the speech characteristics of affect-salient speech were influenced by the type of behavior the infant was exhibiting.

Penman et al. (1983), did not account for the possibility that an 'information-salient' utterance, when paired with affective content, could serve a dual function of conveying information and using prosody to affect the infant. In fact because the linguistic and prosodic properties of speech are directly interrelated, it is entirely possible that when a mother is speaking to her infant about emotion, the prosody of that speech stream would reflect it.

Finally, Bornstein, Tal, Rahn, Galperin, Pecheux, Lamour, Toda, Azuma, Ogino, and Tamis-LeMonda (1992) conducted a functional analysis of maternal speech to infants 5 and 13 months of age in four cultures (Argentine, French, Japanese and U.S. American) using the same content classification structure as Penman et al. (1983). Their subjects were all matched on economic level, educational level, and urban/rural status. Bornstein et al. (1992) found that the mothers in these four cultures all had similar patterns of changes in content. In all four cultures, the mothers exhibited an overall increase in speech production in both categories. Information-salient speech increased in both frequency and proportion of total speech, whereas affective-salient speech also showed an increase in frequency but a decrease in overall proportion by 13 months. In essence, mothers in all four cultures spoke more to their infants by 13 months, and exhibited more informational speech compared to affective speech at 13 months. This
result supports Penman et al. (1983) results in which information-salient speech increased in proportion to affective-salient speech between 3 and 6 months. Unlike Penman, et al., however, Bornstein et al. found that all mothers favored affective speech versus informational speech with their 5-month-olds, and informational versus affective with their 13-month-olds. Penman et al. found an overall greater use of informational speech even at 3 months. It is unclear why this discrepancy exists. However, Bornstein et al.’s (1992) evidence does support Fernald's theory of the progressive function of ID speech during infant development.

One difficulty with both the Penman et al. (1983) and Bornstein et al. (1992) studies is the use of the same categorization technique. This categorization structure assumes that all utterances that contain full creative sentences are salient for their informational function. Therefore, any utterances that are affective in content but are full sentences would be considered informational in nature. For example, sentences like 'Are you getting cranky?' or 'Mommy is so happy!' would be considered salient for their informative function only. Neither Bornstein et al. (1992) nor Penman et al. (1983) account for any dual functioning of contentful utterances. Additionally, some confusion exists in the categorization of affective phrases. Penman et al. (1983) categorized the phrase "that's naughty" (pp. 24, Table 1) as affective-salient. Structurally, "that's naughty" is a full sentence and does have meaning outside of context (however limited it may be). Therefore, it appears that this categorization technique suffers from confused goals and a lack of clarity in technique, and it may be worthwhile to try a new approach.

Rationale for the Present Study

The results of the Bornstein et al. (1992), Penman et al. (1983) and Stern et al., (1983) studies suggest that a change occurs in both the prosodic and linguistic content of ID speech as the infant ages. Early in the first postnatal year, maternal speech is characteristically more affective in content, and exhibits significantly greater prosodic alterations. As the infant ages, the affective content of speech decreases as the informational content increases. In addition, the prosody of the speech also decreases.
The co-occurrence of these two characteristics of ID speech suggests a possible connection between them. The affective, state-focused speech may lend itself to greater prosodic adjustments. During the third and fourth month after birth, the infant is primarily tuned into emotional communication with the mother, which is conveyed through the prosody of her speech (Fernald, 1992). Therefore, by using speech with a primarily affective content, the mother has greater freedom to use prosodic variation. However, as the infant becomes able to regulate emotion and shows increased interest in the external world, the mother can adjust her speech content to convey greater information about the world. This alteration in content results in a decrease in prosodic variability, which is not as important anymore.

However, a conflict exists between this potential connection between the content and prosody of maternal speech. Fernald (1992) has suggested that ID speech is a modulator of arousal and affective information. Penman et al. and Bornstein et al. agree and believe that the content of maternal speech starts out almost completely affective, and gradually becomes more informative as the infant shows greater desire to learn about the world. However, Stern et al. (1983) have shown that the prosodic characteristics of ID speech for the newborn were not significantly different than from 12 and 24 month old infants, and that greater prosodic variability only appears to occur when the infant is about 4 months of age. If there is a relationship between the prosody and content of ID speech in which highly exaggerated prosody is related to greater affective content and decreases in this exaggerated prosody is connected to more informational speech, then it is important to explain this discrepancy by systematically examining the content and prosody of ID speech to infants across a broad range of ages in the first postnatal year. Therefore, the goals of this study were to examine the changes in both content and prosody of ID speech over the first postnatal year, and to examine the relationship that exists between content and prosody of ID speech.

Hypotheses
1. Maternal speech to infants will show a negative linear change with age in several prosodic features (e.g. mean pitch, pitch maximum, pitch minimum, standard deviation of pitch), with greater prosodic exaggeration expressed to infants at younger ages and progressively becoming less exaggerated as the infant becomes older.

2. The linguistic content of maternal speech will show a positive linear relationship with age, being more contentless and affective at younger ages and becoming more contentful and informational as the infant ages. There will be an interaction between linguistic content and prosody, in which contentless and affective speech will show greater prosodic exaggeration, while contentful and informational speech will show significantly less prosodic exaggeration.

Chapter 2
Methods
Speech Recordings
Seventy-five mothers of infants at 1, 4, or 8-months of age (25 mothers per age group) were recorded as they talked to their infants. All of the infants have had an uncomplicated prenatal and perinatal history as determined by maternal report. All of the mother-infant dyads were recruited from the Blacksburg, Christiansburg, Radford, and Roanoke areas.

Participants for the 1 and 4-month-old groups completed the mother-infant interaction sessions as a part of another study (Cooper, et al., 1997). In this study, mothers were tape-recorded in their homes during face-to-face interactions with an interviewer and with their infants in as natural a setting as possible. For the current study, the mothers of the 8-month-olds were recorded under fairly similar conditions except that they were asked to spend 5 minutes alone talking with their infants (Appendix A). Recordings of mother speech were obtained via a lapel microphone (Sony, Model ECM-011) attached to the mother’s collar, and recorded on a high-quality portable tape recorder (Sony, Model WM-D6C). Utterances were defined as any continuous vocalization that was bounded by at least 300 msec (Kruper & Uzgiris, 1987; Penman, et al., 1983).
Linguistic Data Reduction

Initially, complete written transcripts were prepared from each mother’s tape-recorded home session. From these transcripts, coders examined the functional content of the speech samples, and were analyzed using a series of coding sheets which coded the type of content and specific function of each utterance. The first 25 infant-directed utterances were coded per mother. While recordings were taken of all 75 mothers, only 23 mothers in the 4-month-old group had the minimum requirement of 25 utterances. Therefore, in order to keep the three groups equal, only 23 mothers per age group were used for the linguistic analysis (N = 69). Coding was conducted by two trained coders and interrater reliability analyzed using Cohen’s Kappa to assure rater agreement. While initially proposed, formal analysis of repetitions and runs could not be conducted because of the extremely low occurrence of those events within this sample.

Maternal utterances were analyzed for both content of the utterances and frequency of utterance types. Two superordinate categories were originally created: Content utterances and contentless utterances. Content utterances consisted of phases which contain information regarding affective or environmental events that are conveyed. Within this category, two subcategories of Affective Functional utterances refer to actions or descriptions of events pertaining to emotional states. For example, phases such as ‘Show me you are happy’ or ‘Give me a smile’ would be considered Affective Function utterances. In contrast, Informational Functional utterances act to convey information about environmental or infant actions and describe event that are not related to emotions. For example, phrases such as ‘See the ball’ and ‘What is that noise?’ would be considered Informational Functional (see Table 1 for additional examples). Finally, within each subcategory utterances were coded on whether they promote or pertain to actions (e.g. ‘look at mommy’), whether they just describe events and stimuli (e.g. ‘the sky is blue’ or ‘that is your nose’), and whether the utterance is referring to the infant, the mother, to the external environment, or “joint” referents (referring to both the mother and the infant) (see Appendix B). While the creation of the superordinate category for
Content utterances was formally done, analysis of the utterances was broken down into the Informational and Affective subcategories.

Contentless utterances were phrases which were idiomatic and meaningless outside of context. Within Contentless utterances there were five subcategories: Nonsense, Mimics, Greetings, Approval, and Disapproval. Nonsense utterances were made up of words and phrases which rely wholly on the context for any interpretation (i.e. Aboo-boo). Mimics are utterances in which the mother models the infant’s sound just recently made. Greetings are strictly attention-getting utterances (i.e. ‘hey mikey’ or ‘hi there’). Approval utterances are simple words or phrases such as ‘yes’ or ‘good girl’. Finally, disapproval utterances are simple words or phrases pertaining to maternal disapproval, such as ‘no no no’ or ‘shame’ (see Table 1).

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Insert Table 1 Here
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Acoustic Data Reduction

In addition to the linguistic analyses, acoustic analyses were also conducted on a subset of the speech sample. Overall, 225 utterances were selected for this analysis, with a total of 75 utterances per age group (25 utterances from each of the three speech categories). The sampled utterances were analyzed through a digital speech program using Micro Speech Lab software. The following acoustic measurements were made: a) mean pitch (i.e. $F_0$), b) maximum $F_0$, c) minimum $F_0$, d) variation in $F_0$, e) mean utterance duration.

Chapter 3
Results

Linguistic Analyses
Interrater reliability coefficients were calculated for the coder ratings of Informational, Affective, and Contentless Speech. Calculated Cohen's kappa coefficients resulted in interrater agreements of .89 for Informational speech, .93 for Affective speech, and .97 for Contentless speech.

An analysis of the linguistic content of maternal speech to their infants was conducted using a 3 x 3 analysis of variance (ANOVA), with infant age (1-, 4-, and 8-month-olds) as the between subject factor and the type of speech (Informational, Affective, and Contentless) as the within subject factor. The dependent measure for this analysis was the actual frequency of utterance types (out of a possible 25 per mother). Overall, the results of this ANOVA indicated main effects of Age, $[F(2, 66) = 5.18, \ p < .01]$, and Speech Type $[F(2, 66) = 213.30, \ p < .01]$, but these main effects were superseded by an Age by Speech interaction, $[F(4, 66) = 4.97, \ p < .01]$. In order to determine the source of the interaction between age and speech type, one way ANOVAs were conducted on speech type within each of the age conditions. No significant differences were found across the three ages for Informational speech. However, significant differences in the frequency of affective speech $[F(2, 66) = 7.73, \ p < .01]$, and contentless speech $[F(2, 66) = 11.77, \ p < .01]$ were found as a function of infant age. Student Newman Kuhls post hoc analyses (all $ps < .05$) indicated that there was significantly more affective speech directed at 4-month-olds ($M = 4.39; \ SD = 2.9$) than to either 1-month-olds ($M = 2.91; \ SD = 1.8$) or 8-month-olds ($M = 4.39; \ SD = 2.2$). Moreover, there was significantly more Contentless speech to 1-month-olds ($M = 5.13; \ SD = 2.9$) than to either 4-month-olds ($M = 2.73; \ SD = 1.7$) or 8-month-olds ($M = 2.04; \ SD = 1.8$; see Figure 1).
In addition, one way ANOVAs were conducted on infant age as a function of the three levels of speech type. These analyses indicated significant differences in the type of speech directed to 1-month-olds \( F(2, 66) = 66.57, p < .01 \), to 4-month-olds \( F(2, 66) = 62.56, p < .01 \), and to 8-month-olds \( F(2, 66) = 204.39, p < .01 \). Student Newman Kuhls post hoc analyses (all \( p < .05 \)) indicated that significantly more Informational speech (\( M = 14.04; SD = 4.66 \)) than either Affective or Contentless speech was directed to 1-month-olds. Also, significantly more Contentless speech (\( M = 5.13; SD = 2.98 \)) than Affective speech (\( M = 2.9; SD = 2.29 \)) was directed to 1-month-olds.

For the 4-month-olds, post hoc analyses indicated significantly more Informational speech (\( M = 12.69; SD = 4.43 \)) than either Affective (\( M = 4.39; SD = 2.95 \)) or Contentless speech (\( M = 2.73, SD = 1.73 \)). Finally, there was significantly more Informational speech (\( M = 15.39; SD = 3.73 \)) than either Affective (\( M = 1.61; SD = 1.83 \)) or Contentless speech (\( M = 2.04; SD = 1.84 \)) directed to 8-month-olds (see Figure 1).

Overall, there was significantly more Informational speech than either Affective or Contentless speech directed to infants in all three age groups. Moreover, the mothers in this sample used significantly more Affective speech to their 4-month-olds than to either their 1- or 8-month-old infants. They also used significantly more Contentless speech to their 1-month-old infants compared to either 4- or 8-month-old infants. Finally, mothers used significantly more Contentless speech to their 1-month-olds compared to Affective speech.

Additional analyses were conducted on the functional characteristics of the speech used to infants. Specifically, utterances were coded as either Action or Description oriented. Cohen’s kappa coefficients were conducted to determine interrater agreement on Action and Description data, with resulting interrater agreements of .79 for Action utterances and .79 for Descriptive utterances. Analysis was conducted to determine the relationship between the functional characteristics of the utterances across the three age
groups. A 2 x 3 ANOVA was conducted on the three levels of age and the two levels of function (action versus description), and results indicated a significant main effect for function of speech, \([F (2, 66) = 10.63, p < .01]\) (See Figure 2). Overall, mothers used significantly more Action oriented speech (\(M = 9.62, SD = 3.86\)) than Descriptive speech (\(M = 7.09, SD = 3.73\)) with their infants (See Figure 2).

Finally, analyses of the referential aspects of the speech samples was coded. A 3 x 4 ANOVA was conducted on the frequency of specific type of referent used (infant, mother, environment, or joint) across the three age groups. Analysis revealed a significant effect of referent type, \([F (3, 198) = 391.48, p < .01]\), and a significant Age by Referent type interaction, \([F (6, 198) = 3.85, p < .01]\). A one way ANOVA was conducted on the types of referent across age, with significant changes in frequency of referent type used across ages for the infant-referent, \([F (2, 66) = 3.20, p < .05]\), and the environment-referent, \([F (2, 66) = 3.65, p < .05]\). Student Newman Kuhls post hoc analyses indicated significantly more infant-referents at 4 months old than to eight month olds, and significantly more environment-referents as 8 months old than to one or four month olds. In addition, a one way analysis of variance was done to determine the differences between the different types of referent, \([F (2, 272) = 404.48, p < .05]\) Student Newman Kuhls post hoc analyses indicated significantly more infant-referents, than either environmental, joint, or mother referents, and more environmental and joint referents than mother referents (See Figure 3).

Acoustic Analyses
Analyses were conducted on certain acoustic characteristics occurring across speech type and as a function of infant age. A 3 x 3 multivariate analysis of variance (MANOVA) was conducted on six dependent variables (mean pitch (or F₀), maximum level of F₀, minimum level of F₀, standard deviation of F₀, and the duration of utterances). The independent variables for this analysis were age of infant (1-, 4-, and 8-months of age) as the between subjects factor and speech type (Information, Affective, and Contentless) as the within subject factor. The initial analysis revealed that one of the dependent variables (F₀ range) was highly intercorrelated with the other dependent measures. Therefore, the MANOVA was secondarily conducted on the remaining five dependent variables. The results of this mixed MANOVA indicated a significant main effect for age, a significant main effect for speech type, and an overall age x speech type interaction (see Table 2).

Insert Table 2 Here

Next, a series of univariate ANOVAs were examined to determine which of the dependent variables contributed to the significant effects found in the MANOVA. For each univariate, infant age (1-, 4-, and 8-months) was the between subjects factor and speech type (Informational, Affective, and Contentless) was the within subject variable. Their individual results are presented next.

Mean F₀

The univariate analysis on mean F₀ indicated a significant Age by Speech interaction, [F (2, 72) = 2.82, p < .05]. One way ANOVAs were conducted within each age group across speech type in order to help interpret this interaction. No significant differences in mean F₀ were found between speech types for either the 1- or 8-month-olds. In contrast, significant differences were found in the mean F₀ of the different speech types in the 4-month-olds [F (2, 72) = 5.87, p < .01]. Newman Kuhls post hoc analyses were conducted and revealed that mothers’ Affective speech was significantly
lower in mean $F_0$ ($M = 204.7$, $SD = 34.1$) than either their Informational ($M = 229.48$, $SD = 34.2$) or Contentless ($M = 239.44$, $SD = 41.2$) speech (all $p$s < .05; see Figure 4).

Additionally, one way ANOVAs were conducted on the differences in mean $F_0$ within each speech type across infant age. However, no significant differences in mean $F_0$ were found in these analyses.

Maximum $F_0$

The univariate analysis on maximum $F_0$ revealed a significant main effect for age [$F (2, 72) = 14.26, p < .01$]. Newman Kuhls post hoc analyses found that the overall maximum $F_0$ for infant directed speech was significantly higher when directed at 1-month-olds ($M = 367.78$, $SD = $) compared to either 4- ($M = 321.77$, $SD = $) or 8-month-olds ($M = 319.66$, $SD = $; all $p$s < .05; see Figure 5).

Minimum $F_0$

The univariate analysis on minimum $F_0$ indicated a significant main effect for age, [$F (2,72) = 4.28, p < .05$], but also an Age x Speech Type interaction [$F (4, 72) = 2.78, p < .05$]. One way ANOVAs were conducted to determine the significant differences in the minimum $F_0$ occurring for each speech type within the different age groups. Significant differences were found in minimum $F_0$ between the three types of speech directed to 1-month-olds [$F (2, 72) = 7.14, p < .01$]. Newman Kuhls post hoc analyses revealed significantly higher minimum $F_0$ in Contentless speech ($M = 129.64$, $SD = 61.15$) compared to either Informational ($M = 91.56$, $SD = 21.85$) or Affective ($M = 93.00$, $SD = 25.90$) speech, with all $p$s < .05.
A second series of one way ANOVAs were conducted to determine the significant differences between the three age groups within each speech type. Significant differences were found between the three age groups for both Informational \([F (2, 72) = 6.46, p < .01]\) and Affective speech \([F (2, 72) = 4.37, p < .05]\). Newman Kuhls post hoc tests showed significantly lower minimum F0 for Informational speech directed to 1-month-olds \((M = 91.56, SD = )\), compared to either 4- \((M = 120.36, SD = 37.46)\) or 8-month-olds \((M = 112.00, SD = 25.82)\). In addition, post hoc analyses indicated significantly lower minimum F0 for Affective speech directed to 1-month-olds \((M = 93.00, SD = 25.90)\) than to either 4- \((M = 120.48, SD = 43.02)\) or 8-month-olds \((M = 120.16, SD = 41.84)\), with all ps <.05.

In summary, Contentless speech had a significantly higher minimum F0 than either Informational or Affective when directed to 1-month-olds, and both Informational and Affective speech exhibited lower minimum F0 at when directed at 1-month-olds compared to either 4- or 8-month-olds (see Figure 6).

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Insert Figure 6 Here
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Variation in F0

The univariate analysis conducted on the standard deviation of F0 in mothers’ speech directed to infants showed a significant main effect for age \([F (2, 72) = 19.57, p < .01]\). Newman Kuhls post hoc analyses found that the overall standard deviation in F0 was significantly lower in mothers’ speech to their 4-month-olds \((M = 55.31, SD = 13.1)\) compared to their speech to either their 1- \((M = 75.41, SD = 12.5)\) or 8-month-olds \((M = 70.90, SD = 9.93)\), all ps <.05 (see Figure 7).

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Insert Figure 7 Here
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Average Utterance Duration

The univariate analysis conducted on the average length of utterances in mothers’ speech directed to infants showed a significant main effect for age \( [F (2, 72) = 34.84, p < .01] \) and for speech type \( [F (2, 72) = 25.83, p < .01] \), as well as an overall Age x Speech Type interaction \( [F (4, 72) = 17.29, p < .01] \). One way ANOVAs were conducted to determine the significant differences in the duration of the utterances for each type of speech within each age group. No significant differences were found in either the 4- or 8-month-old groups. However, there were significant differences in the duration of utterances of the three types of speech directed to 1-month-olds \( [F (2, 72) = 24.15, p < .01] \). Newman Kuhls post hoc analyses revealed significantly shorter utterance durations in Contentless speech (\( M = .93 \text{ s}, SD = .44 \)) compared to either Informational (\( M = 2.36 \text{ s}, SD = .86 \)) or Affective speech (\( M = 1.97 \text{ s}, SD = .86 \)), with \( p < .05 \).

Moreover, one way ANOVAs were conducted to determine the significant differences between the three age groups within each speech type. Significant differences were found between the three age groups for both Informational \( [F (2, 72) = 43.82, p < .01] \), and Affective speech \( [F (2, 72) = 20.23, p < .01] \). Post-hoc analyses indicated significantly longer durations in Informational speech directed to 1-month-olds (\( M = 2.36 \text{ s}, SD = .86 \)) compared to either 4- (\( M = 1.12 \text{ s}, SD = .41 \)) or 8-month-olds (\( M = 92 \text{ s}, SD = .35 \)). Post hoc analyses also indicated significantly longer durations in Affective speech directed at 1-month-olds (\( M = 1.97 \text{ s}, SD = .86 \)) than for either 4- (\( M = 1.09 \text{ s}, SD = .33 \)) or 8-month-olds (\( M = 1.07 \text{ s}, SD = .35 \)), with all \( ps < .05 \) (see Figure 8).

In summary, mothers’ Contentless speech was shorter in duration than either their Informational or Affective speech. In addition, Informational speech and Affective
speech was longer in duration when directed to 1-month-olds than either 4- or 8-month-olds.

Chapter 4
Discussion

This study examined both the linguistic and the prosodic characteristics of mothers’ speech to their infants across the first 8 months after birth, and also examined the relationship between these linguistic characteristics and the prosodic properties of mothers’ ID speech.

Interpretation of Linguistic Analysis

Based on previous studies, I hypothesized that mothers would engage in more Contentless and Affective speech to their younger than older infants. However, the mothers in this sample used significantly more Informational speech than either Affective or Contentless, regardless of the age of the infant. In addition, the frequency of Informational speech did not significantly vary between 1-, 4-, or 8-months of age. This finding directly contradicts the findings found by Bornstein et al. (1992) in which mothers used significantly more “affective-salient” (i.e. Contentless) utterances than “information-salient” to their 5-month-olds.

Bornstein has suggested that the greater use of affective or contentless utterances at younger ages is a reflection of the relative relationships between the infant and the mother. In essence, during the first half of the first year of life, the mother is focusing much of her attention on helping the infant with emotion and arousal modulation, and working to foster a growing interdependent relationship between herself and the infant. Therefore, the greater use of “affective-salient” or “contentless” speech at younger ages would reflect the specific goals of the mother at this time. In contrast, as the infant begins to orient more and more to the external environment, begins reaching and interacting with objects, and develops great mobility, the mothers’ goals show change in
order to guide and direct their infants’ attention to this environment. Therefore, as they age, infants should be exposed to increasing amounts of “information-salient” speech.

As noted, however, the results of this sample show that mothers use a great deal more informational speech during even the first month after birth. The results from Penman, et al. (1983) do lend some support to this finding. In Penman’s research, mothers’ speech at both 3 and 6-months also showed an overall greater use of “information-salient” speech than “affective-salient” speech, although the disparity between the two types of speech increased as the infant aged.

However, it is important to note that there were changes in the usage of affective types of speech across the different ages. Specifically, there was significantly more Contentless speech directed to 1-month-olds than to either 4- or 8-month-olds, and there was significantly more Affective speech to 4-month-olds than to either 1 or 8-month-olds. This does suggest that affectively-oriented types of speech may play a specific role during the first half of the first year. Indeed, the higher use of Contentless speech at 1-month than at either 4 or 8-months is not surprising. Contentless utterances, typically utterances such as simple greetings, approval utterances, and nonsense words, are all proposed to be used as both alerting, arousal modulating, and attention getting. Fernald (1991) suggests that one of the primary functions of ID speech at younger ages is its alerting, arousal modulation, and attention getting abilities, and the this type of ID speech (approval, prohibitive and game playing utterances) conveys more communicative intent by way of its prosodic features (Fernald, 1989). Therefore, the fact that you see this type of speech significantly more at one month than at any other time supports Fernald’s model.

In addition, the increased use of Affective speech at 4-months also lends support to Fernald’s model. Recall, Affective speech is similar to Informational speech in that they both consist of phrases which contain information regarding actions or descriptions about events in the environment. However, the content of the Affective speech category
specifically deals with information that is affective in nature. Typical Affective statements might include ones such as “Don’t cry sweetie” or “are you smiling?”. As the infant becomes more in tuned with the environment, and is able to develop greater emotional communicative feedback to the mother, the mothers’ speech should reflect the infants’ increased showing of emotions through shared vocal and facial cues. Fernald suggests that during this time, ID speech serves the greater function of helping bridge vocal and facial expression of the mother to the infant. In addition, the mothers’ use of describing and defining her infant’s behavioral and emotional states may help maintain her own attention to those states.

Penman et al. (1983) suggest that the greater use of informational types of speech may also serve an additional purpose: self education and verbal clarification of her observations and speculations regarding her infant thoughts, feelings, and actions. As the mother continues to learn more about her infant’s actions, abilities, changes, and moods, she may guide herself through the interaction processes by verbally reflecting on aspects of her infant. In fact, the increased use of Affective speech at 4-months may indeed reflect the increased use of emotional communication between the infant and the caregiver. Indeed, this may be one explanation for the significantly higher use of Informational types of speech found both here and in Penman. Mothers, by using large amounts of informationally oriented types of speech, may be focused on self-clarification and education regarding their infant’s actions and/or abilities.

Mothers in this sample may be exhibiting more Informational speech found in this sample may be because of situational constraints during the mother-infant interaction sessions. Mother-infant vocal interactions for the 1 and 4-month-old groups were sampled out of unstructured interviews in which an interviewer entered the home and was actively involved with the mother. While these interviews were conducted to merely obtain voice samples, the interviewer was often actively engaged with the mother and infant, asking a variety of questions regarding the mother’s experiences with parenting the infant and the infant’s current abilities and states. Often, the mothers’ speech to
their infant appeared to reflect a dual purpose: interacting with the infant and informing the interviewer regarding some aspect of the infants’ actions or abilities. For example, a great deal of mothers used the starting word “Say”, as in “Say...I’m a big girl” or “say...mommy and I went for a walk”. While these utterances were infant directed, they were often said within the context of the conversations being held with the interviewer. The mothers appeared to be including their infants into the conversation as well. It is possible that mother-infant interaction sample taken in a naturalistic setting (without a third person involvement) may have resulted in a greater use of affectively oriented speech. However, it is important to note that both Bornstein et al. (1992) and Penman et al. (1983) used naturalistic/observational samples, and found contradictory results. It is therefore unclear about how the relationship of a third individual changed the nature of interactions between the mother and the infant.

Finally, the greater use of Informational speech may be a reflection of the sample group. The current sample group was taken from a primarily well educated, college town population, in which many of the mothers had education levels of a BA or higher. It could be that this type of population of mothers is more focused on informing or educating their children, and this many reflect in a greater use of informationally oriented phrases. In addition, these mothers may be more motivated to exhibit ‘educating’ parenting behaviors when being observed by the interviewers. It is possible that obtaining samples from a more heterogeneous population may result in more overall use of affectively-oriented speech to younger infants.

Interpretation of Acoustic Analyses

Overall, the data support the contention that there is a negative linear change for several of the prosodic features of speech. Contrary to the evidence presented by Stern et al (1983) in which pitch variability was greater at 4-months, these results suggest that there is greater pitch variability in the speech presented to 1-month-olds than that presented to either 4 or 8-month-olds. Recall, Stern et al. examined several prosodic features of ID speech directed to newborns, 4-month, 12-month, and 24-month-olds,
including absolute pitch, range of pitch, and duration of utterances. Stern et al. found that while all ID speech exhibited higher levels of absolute pitch, that the ID speech directed to 4-month-olds showed overall significantly higher absolute pitch and greater pitch range when compared to the other age groups. However, in this sample, mothers generally reach both higher and lower levels of pitch when speaking to their one month olds, and appear to have the greatest variability when using either Informational or Affective speech. Therefore, when examining the differences in the use of pitch across the three ages, it is important to note that the mothers who are speaking to one months olds appear to use a wider range of pitch, and have a high level of pitch variability.

These mothers appear to make use of the higher and lower extremes of pitch. This is likely due to the alerting, attention getting, and soothing effects of ID speech. At one month of age, the infant’s ability to self regulate is still somewhat immature. Fernald (1989) notes that it is during these early months the primary purpose of ID speech is to alert, soothe, or calm the infant. Therefore, the 1-month-old relies heavily on the mother to soothe during times of distress, to “bring up” or “bring down” to optimal states of mood and attention, and to help gear or direct the infant’s attention to events in the world (Fernald, 1989). Mothers who are speaking to their 1-month-olds may use the full acoustic range available to assist the infant in achieving these goals. In addition, these mothers appear to extend the duration of their utterances in their speech to their 1-month-olds. When mothers speak Informationally or Affectively to their 1-month-olds, the duration of these utterances is much longer than speech directed to either 4 or 8-month-olds. This longer duration could be the result of increased drawing out of the words, essentially elongating the vowel sound of the words. Swanson, Lenoard, and Gandour (1992) note that ID speech facilitates increased vowel duration. If this is the case, it may be related to the greater pitch variability used in speech to these infants. Essentially, the longer time may be accommodating for the use of this increased variability in range. However, this greater duration of utterances could also be the result of longer phrases, with a greater number of words within the utterance leading to the
increased duration. A finer grained analysis of the number of words per utterance might
revel where these differences truly lie.

Stern et al. (1983) has suggested that aspects of the infant’s ability to interact with
their caregivers is what leads to greater pitch variability at 4-months (in contrast with
neonates, 12 and 24 month olds). Basically, at 4-months, the infant is better able to
regulate their state, is building social and emotional ties and actively seeking out
interaction with the mother via face to face play. In addition, the 4-month-old infant is
limited in ability to explore his environment and engage in interactions with objects.
These factors result in a dynamic in which the mother is most motivated to gain and hold
the infant’s attention to herself or specific events. Therefore, the mother uses her voice to
capture and maintain the infant’s attentional resources. It is important to note, however,
that Stern’s sample consisted of speech from only six mothers, and that the specific
testing situations varied greatly from one age group to the next. Specifically, 4-month-
olds lying on the floor and the mother’s positioned in front of them, emphasizing to the
pairs the face to face dynamic. The mothers of the newborns were cradling their infants,
and the 12 and 24 month old groups were engaged in free play on the floor. These
differing interpersonal dynamics may have played a role in the use of prosodic
modification. However, regardless of these problems, Stern does make some sound
arguments for the results.

Indeed, when examining the average pitch across these three age groups, both
Informational and Contentless average pitch exhibit a trend which is similar to Stern et
al.’s inverted U shaped finding. However, Affective speech significantly decreases in
average pitch in comparison to both 1 and 8-months. It becomes apparent now that the
relationship between the age of the infant and the type of speech that the mother is using
may have an affect of the prosodic features of that speech. At four months, the mothers
appear to be selectively using specific prosodic characteristics in order to achieve goals
such as soothing or maintaining a calm state, while using other prosodic features (within
the Informational and Contentless speech) to capture attention and engage the infant.
However, the use of these prosodic features differ at 1-month as a result of differences in the goals between the usage of specific speech types and the infant's needs.

For example, a 1-month-old infant has relatively short amounts of time in alert states, while spending most of their time in drowsy or sleeping states. Mothers of 1-month-olds may be spending more of their time attempting to rouse and encourage their infant to engage in interaction with the parent. While these mothers will no doubt spend some time soothing them as well, the use of all speech types (including Affective) will be used to encourage interaction and engagement with the mother as well. Indeed, when examining the variability of mothers’ speech to their 1-month-olds, it is clear that the mother is using prosody in a variety of ways across speech types.

However, as the infant ages, the type of speech may take on certain roles or characteristics within this dynamic of engagement, to fit the needs of the current situation. By 4-months, the attention getting and maintaining of attention may fall to Contentless and Informative utterances. For example, Informational utterances could play a largely attention keeping role, such as phrases like “see the doll”. In addition, Contentless utterances may affect the attention getting and engagement aspects of the interaction, such as phrases like “hey buddy”. If infants are truly attracted to greater use of prosody in speech, it makes sense that these types of speech may work best to engage the infant in interaction with the mother. In contrast, Affective speech may be primarily reserved for soothing the infant and helping to maintain state. If so, prosody may decrease in order to decrease overall arousal of the infant.

The possibility that there is a relationship between the type of speech used and the prosodic features of that speech has not, up until this point, been fully explored. Fernald (1989) did examine the prosodic features of both adult directed and ID speech within several different categories of communicative intent to determine if these prosodic variations affected the ability of adult listeners to determine the intent of the utterance through the those features alone. Adult listeners were able to use the prosodic cues of the
ID speech to identify the communicative intent of the speech significantly more often than when that speech pattern was presented in adult directed speech. There is no doubt that there does appear to be an overall relationship between type of speech and the prosodic features. However, at least for speech presented to infants, that relationship appears to be mediated by age. There are several future directions for this research. Questions still exist regarding the overall greater use of Informational speech during the early months after birth. Given the existence and apparent involvement of the interviewer in the dynamic between the mother and the infant, it is unclear what role the interviewer played in the increased use of Informational speech. Indeed, the interviewer may have biased the interaction between the infant and the mother. While the 8-month-old group did not have any involvement of the interviewer, the increased occurrence of Informational speech at this age may be an accurate reflection of the use of speech types at this age. In order to clearly define what is happening at 1 and 4-months-old, it would be necessary to take new speech samples of mothers and infants with no interviewer involvement.

Generally, these results support Fernald’s model regarding the differential purposes of ID speech over the course of the first year. In addition, it suggests that while ID speech may serve differential purposes over the first year in regard to attentional orientation, mood and state maintenance, and eventual assistance in language learning, there are also aspects of ID speech which change over the course of infant development and as a function of maternal goals. These changes (greater pitch variation at younger ages, differential levels of pitch dependent of age and type of speech) may be related to the specific purposes or goals of the mother-infant dyad during that stage of development.
References


### Table 1: Categorization of the Content of Maternal Speech

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>Examples</th>
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<tr>
<td><strong>Content</strong></td>
<td>Phrases in which information regarding affective or environmental events are provided.</td>
<td></td>
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<tr>
<td><strong>Affective Functional</strong></td>
<td>Pertain to actions or events affective in nature</td>
<td></td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Promote or pertain to actions</td>
<td></td>
</tr>
<tr>
<td>Infant referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Describing static events/behavior</td>
<td></td>
</tr>
<tr>
<td>Infant referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Information Functional</strong></td>
<td>Informs about non-emotional actions, events, or stimuli.</td>
<td></td>
</tr>
<tr>
<td><strong>Action</strong></td>
<td>Promote or pertain to actions</td>
<td></td>
</tr>
<tr>
<td>Infant referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother referent</td>
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<tr>
<td>External referent</td>
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<td><strong>Description</strong></td>
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<td>Infant referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External referent</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Contentless</strong></td>
<td>Idiomatic phrases, meaningless outside of context</td>
<td></td>
</tr>
<tr>
<td><strong>Approval</strong></td>
<td>Expressing positive affect, comfort, reassurance, encouragement</td>
<td>Good girl</td>
</tr>
<tr>
<td><strong>Disapproval</strong></td>
<td>Negative affect, prohibiting</td>
<td>Bad Boy; No</td>
</tr>
<tr>
<td><strong>Nonsense</strong></td>
<td>Utterances unacceptable in adult speech; rely wholly on context for interpretation</td>
<td>Aboo-boo</td>
</tr>
<tr>
<td><strong>Greetings</strong></td>
<td>Attention-getting utterances</td>
<td>Hey Mikey</td>
</tr>
<tr>
<td><strong>Mimics</strong></td>
<td>Models infant sounds recently made</td>
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</tr>
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</table>
Table 2

Factorial MANOVA on Acoustic Features for Age x Speech Type

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>Approx F</th>
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<tbody>
<tr>
<td>Age</td>
<td>10, 424</td>
<td>15.69*</td>
</tr>
<tr>
<td>Speech Type</td>
<td>10, 424</td>
<td>5.48*</td>
</tr>
<tr>
<td>Age x Speech</td>
<td>20, 704</td>
<td>4.12*</td>
</tr>
</tbody>
</table>

* Significant at p<.01
Average Speech Type Across Age

Figure 1
Average Functional Utterance

Figure 2
Figure 3
Figure 4
Figure 5
Average Minimum Level of Pitch

Figure 6
Average Standard Deviation of Pitch

Figure 7
Average Duration of Utterance

Figure 8
Title: Changes in Content and Prosody of Mothers' Speech to Infants Across the First Postnatal Year.
Principal Investigator: Pia Strunk

I. Research Purpose
You and your infant are invited to participate in a study about mothers' speech to their infants. The purpose of this study is to examine the changes in mothers' speech to infants at 1, 4, and 8 months of age.

II. Procedures
In order to obtain samples of mothers' speech, you will be asked to spend 5 minutes talking with your infant. You and your infant will be placed in a small playroom and left alone for the recording session. You will be asked to wear a lapel microphone which will be hooked to a tape recorder to obtain the speech samples. You may feel free to speak to your infant about anything you'd like, interacting as you normally would with your infant. If your infant falls asleep, recording will be stopped. There are no known risks to you or your infant for participation in this study. However, you have the right to stop this study at anytime and for any reason.

III. Benefits of this Research
Your participation in this study will increase understanding on quality of mothers' speech and language that infants are exposed to. No guarantee of benefits has been made to encourage you to participate. However, upon completion of this work, a summary will be sent to you if you like.

IV. Confidentiality
All of the information gathered in this study will be kept confidential and the results not released without parent consent. The information that you and your infant provide will have all names removed, and only a subject code number will be used to identify subjects during the analyses and in any written report. The results of this project may be used for scientific and/or educational purposes, presented at scientific meetings, and/or published in a scientific journal.

Audio recordings of your speech will be stored at the Infant Speech Lab and erased after five years. The tape will only be analyzed by trained undergraduate or graduate lab assistants and Dr. Robin Cooper.
V. Compensation
   You and your infant will receive no monetary compensation for participation in this research.

VI. Freedom to Withdraw
   You are free to withdraw from this study at any time without penalty.

VII. Research Approval
   This research project has been approved, as required, by the Human Subjects Committee of the Department of Psychology and the Institutional Review Board of Virginia Tech.

VIII. Permission
   I have read and understand the informed consent and condition of this project. I have had all of my questions answered. I hereby acknowledge the above and give my voluntary consent for my infant to participate in this project. I understand I have the right to end this session for any reason if I choose. If I have any questions regarding this research, I should contact one of the persons named below. Given these procedure and conditions, I give my permission to Pia Strunk and her coworkers to take these voice recordings.

   Pia Strunk, Principle Investigator (540)344-2573
   Dr. Robin Panneton Cooper, Faculty Advisor (540)231-5938
   Dr. R.J. Harvey, Chair, Human Subject Committee (540)231-7030
   Dr. Tom Hurd, Director, Institutional Review Board (540)231-5013

__________________________________________________________  _______________
Signature                        Date
Appendix B

Content Coding Key
Directions: Transcripts from each mother will be coded by its function and referent.
Each utterance will be written down and coded according to the following key.

Content key
- IAI = Information Action-infant referent
- IAM = Information Action-mother referent
- IAE = Information Action-environment referent
- IDI = Information Description-infant referent
- IDM = Information Description-mother referent
- IDE = Information Description-environment referent

- AAI = Affective Action-infant referent
- AAM = Affective Action-mother referent
- AAE = Affective Action-environment referent
- ADI = Affective Description-infant referent
- ADM = Affective Description-mother referent
- ADE = Affective Description-environment referent

Contentless key
- CA = Contentless Approval
- CD = Contentless Disapproval
- CN = Contentless Nonsense
- CG = Contentless Greeting
- CM = Contentless Mimics

Other:
- Questions = Q
- Length of Utterance = LoU
- Runs = R
- Directives = D
- Repeated Utterance = RU
Content Utterance Coding Sheet

Subject ______

Total Counts:

<table>
<thead>
<tr>
<th>IAI</th>
<th>IAM</th>
<th>IAE</th>
<th>IDI</th>
<th>IDM</th>
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</thead>
<tbody>
<tr>
<td>IDE</td>
<td>AAI</td>
<td>AAM</td>
<td>AAE</td>
<td>ADI</td>
</tr>
<tr>
<td>ADM</td>
<td>ADE</td>
<td>CA</td>
<td>CD</td>
<td>CN</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td>D</td>
<td>LoU</td>
<td>RU</td>
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Utterances:_____________________________________________________    __________

Codes:_____________________________________________________    __________
<table>
<thead>
<tr>
<th>Subject ______</th>
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<tbody>
<tr>
<td>Utterance</td>
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<tr>
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</tbody>
</table>
Vita

Pia Strunk

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                Blacksburg, VA 24060

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                Blacksburg, VA 24060

Telephone:     H (540) 961-3276
                W (540) 231-6581

Education

B.A.          University of Minnesota, Morris, MN. (May 1993)
              Major: Psychology
              Minor: Theatre Arts

M.A.          Hollins College, Hollins, VA (October, 1994)
              Experimental Psychology

M.S.          Virginia Polytechnic Institute and State University, Blacksburg, VA.
              (December, 1997)
              Psychological Sciences; Specialization: Developmental Psychology