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FUNCTIONAL INTONATION IN THE PRELINGUISTIC AND EARLY LINGUISTIC CHILD

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FUNCTIONAL INTONATION IN THE PRELINGUISTIC AND EARLY LINGUISTIC CHILD

by

JUDY FIVIS FLAX

A dissertation submitted to the Graduate Faculty in Speech and Hearing Sciences in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

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Abstract

FUNCTIONAL INTONATION IN THE PRELINGUISTIC
AND EARLY LINGUISTIC CHILD

by

JUDY FIVIS FLAX

Adviser: Professor Margaret Lahey

The purpose of this study was to investigate the relationship between specific elements of the intonation contour and the contextual language functions of infant vocalizations. In addition, the study looked at continuity in one of the elements over time.

Three children were audio and video taped at three different times; first, before conventional words were used; second when the first 10 words were reported by the mother; and third, when the first after 50 words were reported by the mother. All video recordings were transcribed and child vocalizations were categorized by contextual function. Audio recordings of the vocalizations were acoustically analyzed for final contour direction, mean fundamental frequency, peak, range, and duration.

Those contextual function categories which were common to all children were significantly differentiated by final contour direction, yet there was no effect for time or child. All children used their highest proportion of rises for requests and highest proportions of non-rises for general comments. Analyses of other productive categories for individual children also revealed some consistent patterns.

Mean fundamental frequency, peak and range were correlated with each other and all revealed a main effect for contextual function. Those categories associated with high affect such as "protests" and "calling attention to something", tended to have higher means, peaks, and ranges in contrast to those with less emotional force (eg. responses to questions and personal comments).

Duration was also statistically differentiated by contextual function. However, there was also an interaction of contextual function, time, and child. Individual differences in the amount of jargon, single words and two word utterances used during this period appear to account for these interactions.

The results indicate that there are some early consistent relationships between intonation and certain language functions. Some of these patterns begin prelinguistically and continue through at least the early linguistic period providing evidence for continuity in the association of intonation and language functions.

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CHAPTER ONE

INTRODUCTION

Most of us have been witness to or participated in a scenario similar to the following: A child is playing alone or with another person and will babble a sequence of sounds. Although the babble is not a standard word of her native tongue, there is something that enables you to interpret her utterance. What is it about a child's prelinguistic utterance that makes an adult respond to the utterance as though it were a meaningful sentence?

To answer this question, one might suggest that the adult is responding to the facial and body gestures of the child, or perhaps to the context of the utterance. These are certainly plausible reasons for an adult's response, but there may be more. Another possible reason for an adult's response could be that the child has produced an intonation pattern that sounds similar to those patterns used by adults in their sentence prosody. The adult recognizes a familiar intonation pattern and responds to the meaning associated with that pattern. The present thesis is concerned with this use of intonation by the child and its relationship to meaning.

Mention of prelinguistic intonation has been made in the literature for the past 100 years. As early as 1877, Taine commented on the flexibility of the child's "twitter". More recently, several people have commented on the early emergence of intonation and its relationship to the linguistic system. For example, Bever, Fodor, and Weksel (1971) noted that "It is widely accepted in the literature that the child effectively masters the intonation patterns of his language before he has learned any words at all" (p. 275). Weir (1962) had stated that intonation or sentence melody is one of the earliest linguistic features acquired by the child. Likewise, Engel (1973) observed that the first phonetic-phonemic differences in a particular child were not in sounds but in intonation, concluding that the melodic factors appeared in this child before the articulatory ones.

Dore, Franklin, Miller and Ramer (1976) examined the use of presyntactic devices (PSD) and concluded that these devices act as a bridging process allowing the child to acquire complex intonation patterns without having yet acquired structural meaning. The implication here was that one of the devices children use prior to syntax is a combination of single words, prelinguistic vocalizations (babble) and intonation to convey similar meanings that the child will later convey with conventional forms.

There are several reasons for studying intonation in very young children: The study of intonation may be one way of examining <u>how</u> children learn language. As mentioned earlier, the early emergence of intonation and its association with language development has been mentioned by many (e.g. Weir, 1962, Engel, 1973, etc.). Furthermore, Lieberman (1967, p. 42) suggested that "infant's innate referential breath-group furnishes the basis for the universal acoustic properties of the normal breath-group that is used to segment speech into sentences in so many languages."

Looking at intonation may also teach us more about <u>when</u> children begin to learn language. The issue of continuity versus discontinuity of language development has been debated over the past 45 years in the language development literature. Babbling, which contains both a phonetic and a prosodic component, has often been the object of controversy in discussions of the continuity of language development. Jakobson (1968) believed that the characteristics of very early vocalizations were irrelevant to later langauge acquisition.

Most recent studies fail to support the Jakobsonian position. There is evidence that babbling plays an important role in the later development of language. For example, Oller, Wieman, Doyle and Ross (1976) found preferences for certain phonetic elements and sequences in babbling that have been found in the early stages of language development. Their data suggested that aspects of the substitution and deletion process in early language could have been predicted by a phonetic preferences in babbling. Likewise, Kent and Bauer (1985), found that the acoustic-phonetic properties of the infants' vocalizations were basically continuous with (or similar to) the vocalizations of younger babbling children as well as to the vocalizations of children during the second year. Similarities included rhythmic or periodic organization of multisyllable utterances, fall and rise-fall intonation contours, and fundamental frequency in the range of 300-500 Hz. Thus, there appears to be some patterning during the prelinguistic period which relates to later utterances in terms of phonetic preference, intonation contour, and fundamental frequency.

In the past, researchers such as Halliday (1976), Dore (1974), and Menn (1976) have commented on the variety of intonation patterns used in children's earliest attempts at conveying meaning to others through vocalizations (functional communication).

There are prelinguistic precursors to other aspects of the form, content and use of language (Bloom and Lahey, 1978) which are qualitatively different. It is possible that there are some aspects of language that are more continuous in their development than others. There may be some segmental and suprasegmental aspects (such as intonation) of language that demonstrate different developmental histories. If, in fact, certain characteristics of intonation demonstrate a continuous association with meaning from some prelinguistic level through an early linguistic level this might be a clue as to <u>how</u> and <u>when</u> a child begins to learn her native language system.

One of the reasons that research in the area of intonation as related to meaning has been limited is the problem of obtaining good quality, reliable recordings of children. Young children are quite active which makes microphone placement difficult. Also, it has taken a disproportionate amount of time to analyze and transcribe child language data and acoustic data. Some of these obstacles can be overcome by the use of more advanced recording, acoustical, and computer-assisted equipment as discussed in the following chapter. In this study, intonation will be acoustically examined longitudinally from a late prelinguistic point until approximately the end of the single word period and will be studied in relation to functional communication behavior.

DEFINITIONS

Before going on, it is necessary to define certain terms that are used throughout this paper. Since this study includes both acoustic elements and linguistic elements, it is essential that certain terms be identified as to how they are being used.

Intonation has been described as a "system of non-segmental linguistic contrastivity which varies primarily in terms of pitch direction and pitch range, variations in loudness, duration, and rhythm" (Crystal, 1973, p. 5). It has also been described as "perceived changes in fundamental frequency" (Borden and Harris, 1980, p. 277). Intonation in both of these cases is a linguistic element. In this study the acoustic correlates of intonation (specific elements of the fundamental frequency contour) such as final contour, mean fundamental frequency, peak fundamental frequency, fundamental frequency range, and duration were examined. However for discussion purposes (since so much of the literature uses the term "intonation") the elements of the fundamental frequency contour are often here referred to as the "intonation" contour.

Also, the terms prelinguistic and linguistic are used often in describing the stages of the children in the study as well as in discussing when and how children may begin to learn language. In this paper, _prelinguistic_ refers to the time when the child is using non-conventional vocalizations and gestures to convey meaning. _Linguistic_ period refers to when the children use language as: "a code whereby ideas about the world are represented through a conventional system of arbitrary signals for communication (Bloom & Lahey, 1978, p. 4).

REVIEW OF THE LITERATURE

There are several aspects to be considered when studying the development of intonation. Issues involving mother input, perceptual and productive development and physiological development must all be taken into consideration.

Laboratory studies suggest that almost from birth the child can discriminate intonational changes and produce utterances which resemble adult utterances in terms of intonational characteristics. Studies of maternal input to children make mention of the changes in pitch and intonation contour made by mothers to their infants and young children. Physiological development of the larynx has been associated with changes and variability of fundamental frequency after the first year of life.

Included in the following pages is a review of the work related to the development of intonation prelinquistically and during the early linguistic period. Topics that are covered include: the role of intonation in environmental input to the child, perception of intonation in the infant, productive studies of intonation and its acoustic correlates, intonation and how it relates to continuity, and the usefulness of using functional categories to understand the role of intonation in language development.

In addition, some information describing research in the area of the fundamental frequency, and the duration of young children's utterances in relation to the development of the larynx will be included. Although not a main point of the study, general data on fundamental frequency and duration of utterances are a by-product of this study and will be considered in terms of what changes may occur over time and how these changes interact with the functions of language.

Intonation in Environmental Input to Children

The following studies describe intonation and specific aspects of intonation that are involved in the early interactions of mothers and their babies. Mothers use several aspects of the fundamental frequency contour to communicate with their babies. Pitch, the subjective psychological sensation of sound frequency (Borden and Harris, 1980) is the term that some authors have used to describe fundamental frequency and will be used in some of the following papers.

Stern, Spieker, and Barnett (1983) examined the speech of six mothers to their infants at birth, four, twelve and twenty-four months. The mothers' language was analyzed for intonation contour, repetitiveness, timing, tempo, and complexity. Only the specific procedures for the study of intonation will be discussed here, although conclusions of how intonation interacts with the other analyses will be presented.

The mothers and their babies were video and audiotaped for 15 minute sessions. The mothers' first 100 utterances were acoustically analyzed by spectrograph. Four intonational events were recorded: a) terminal pitch change (amount of rise or fall measured in Hertz), b) transitional pitch change (change in Hertz between one utterance and the next), c) range (high - low = range), and (d) absolute high (peak). Stern et al. found significant age changes for all four intonational events with the four month age having the greatest (highest) mean fundamental frequency for each event. When mothers' speech to their babies was compared to their adult-directed speech at the four-month stage, mothers demonstrated a significantly greater degree of pitch change with their babies than with another adult.

Part of the general findings of the entire study supported the impression that certain prosodic features were used more with the four month olds than at the other ages studied. Co-occurring with the changes in intonation was the use of extensive and exaggerated sound repetition and less regular tempo. Pause duration was more elongated for newborns and duration of utterances and complexity of utterances was longest at twenty-four months. The authors discussed the fact that the four month period was one of face-to-face play. They hypothesized that the infant was interested in the human face and voice and the mother attempted to keep the infant alert, interested, and happy. Language features best suited for this time were ones which had attention-getting and holding value such as a greater range of intonational contours, variable rhythms and repetition.

In a related study, Stern, Spieker and MacKain (1982) speculated that in order for an infant to begin to communicate, she must be able to isolate recurring patterns. The pitch contour of the mother's utterance could be the recurring pattern that is the earliest unit of information about the mothers' motives, intentions and emotions. Since maternal speech to infants showed greatest pitch range around four months and previous research demonstrated that infants could discriminate intonation patterns (Kaplan, 1969 and Morse, 1972), they decided to examine pitch contour of mothers speaking to their babies at two, four and six months.

Three aspects of the mother's speech were analyzed at each of the above three ages: pitch contour, sentence type, and interactional context. They were able (by spectrographic analysis) to isolate five contour shapes: sinusoidal, bell, bell right, fall, and rise. The five most common sentence types were: commands, declaratives, yes/no, wh-questions, and interjections. Interactional contexts included: maternal utterance, maternal gaze, infant gaze, infant smile, and infant neutral.

Stern, et al. found that mothers used the rise significantly more when the infant was gazing away with neutral affect. All mothers used a sinusoidal contour when the infant was smiling or gazing at the mother's face. For sentence types, yes-no questions showed a terminal rise whereas declarations were more often sinusoidal rather than a terminal fall as had been expected from the adult model. Wh-questions were characteristically falls. From these data the authors suggested that the intonational contour may act as framework for later communication and may act as a unit to carry information to an infant about her mother's feelings and intentions. In addition, with the exception of declaratives, infants were exposed to the same contouring conventions based on sentence type that they would experience when learning adult language so that they might be extracting valuable information about speech directed to them. Finally, the authors stated: "The intonational envelope itself is among the earliest and most basic units of interpersonal signalling in the auditory domain" (p. 734).

Intonation and sentence type were also examined by Ryan

(1978). She attempted to clarify the relationship between rising intonation and syntactic form in adults' speech to children. Ten 12-month-olds and their mothers were videotaped and audiotaped for five minutes in a play situation. Perceptual judgments were made of each utterance (rise/non-rise). Twenty rises and non-rises for each mother were then retranscribed to a master transcription sheet of 400 unpuntuated utterances. The following results were reported based on social context, final intonation contours, and written transcriptions of syntactic form:

1) The social context of rises - When a mother began a rise she was more likely to be looking at her baby and less likely to be looking at a toy than when she began a nonrise. Also, when the mothers began a rising utterance there was likely to be a discrepancy between the focus of their attention and that of the baby.

2) Contour and syntactic form - Each mother's first 80 utterances were classified syntactically as a question, a declarative, or an imperative. Among rises there were significantly more declaratives and questions than imperatives. Among nonrises there were significantly more declaratives than either questions or imperatives.

3) Babies response to rise - There were three types of baby responses to rises:

a. Baby looked at mother - In this study, the babies were no more likely to look at their mothers after a rise than a nonrise, although with older children and adults one might expect another to focus attention on the person asking a question.

b. Baby vocalized - Fourteen percent of mothers' rises were followed by a baby vocalization and eleven percent of nonrises were followed by vocalizations; a statistically significant difference ($p < .05$). However, the majority of the mothers' utterances regardless of final contour were not followed by a baby vocalization.

c. Baby shifted attention - The babies were more likely to start looking at the toy their mothers were attending to after the mother had used a rise than after a nonrise.

Ryan suggested that mothers use rising intonation when talking to their preverbal children to encourage attention and contribute to the interaction. It was further suggested that children were capable of noting the redundancy between situation and intonation pattern and using a rising intonation to work out the meaning of what their mothers were saying. The differential use of rises and non-rises by the mother could be interpreted as meaning that a rising terminal contour had contrastive force and might be used to involve babies in an interaction.

Ryan concluded that an intonational pattern (in this case a rise), accentuated the end of a segment helping to break up speech into meaningful units for the child. She claimed that her data lent some support to a theory that children who do not yet speak show signs of understanding the meaning of a rise directed to them in a very broad sense; to attend and be part of a dyadic interaction.

Sachs (1977) reviewed the significance of linguistic input to prelinguistic infants. She found that in a wide variety of languages, adults seemed to use an overall higher pitch when speaking to infants. Exaggerated intonations have been reported from several languages. However, little work has been done in attempting to describe these intonational features. She concluded that the characteristics of input, such as pitch, to young children, may function to gain and hold an infant's attention, establish a bond between infant and caregiver, and allow a very early form of communication to take place.

In summary, it appears that several aspects of the intonation contour such as final contour, overall shape, range, and peak are involved when mothers communicate with their babies. It has been suggested that variations in contour may serve an attention-getting function, may help to mark the end of an utterance, may contribute to understanding what the mother means, and may increase the bond between mother and baby. Because only mothers' behaviors can be objectively analyzed and reasons for the babies' responses can only be inferred, the authors could only suggest possible reasons for the behavior they observed.

Perception of Intonation in the Infant

In the previous section, evidence was presented that mothers produce certain intonational patterns when speaking to their babies. The following studies have investigated how well the babies actually perceive or discriminate the intonation contours being presented to them.

Morse (1972) investigated the discrimination of place {[ba] vs. [ga]} and intonation (-BG vs +BG which is described as falling vs. rising intonation) in 40-54 day old infants. A non-nutritive sucking procedure was used to track high amplitude sucking behavior when there were shifts in the stimulus. He found that the children could detect two types of acoustic information in the speech signal: 1) variations in F_2 and F_3 transitions and 2) changes in fundamental frequency.

Morse suggested that these findings have far reaching implications since F_2 transition is probably the single most important carrier of information in the speech signal and variations in fundamental frequency could serve to segment speech for later syntactic and semantic development. He reported that it was clear from his research that prior experience in producing speech contrasts of place and intonation were not prerequisites for the ability to discriminate them.

Morse's claim of no prior experience in production being mandatory to perceive place contrasts may very well be true. However, evidence of children using contrastive elements of fundamental frequency have been reported from the second month and on (Yampol'skya, 1973; Stark, 1977) which make it difficult to assess whether prior experience is necessary for discrimination.

Also interested in an infant's attention to intonation, Sullivan and Horowitz (1983) designed a study to investigate a two month old infant's attention to a rising intonation contour. Specifically, their purpose was to see if a naturally produced female voice using a rising contour would elicit greater attention than the same female producing a falling contour. Second, an attempt was made, using synthetic speech, to isolate specific acoustic parameters that elicit greater infant attention. They used an infant-control auditory preference paradigm to obtain information concerning preferential infant attention.

Their results indicated that the infant selectively attended more to a rising intonation contour than to a falling contour in natural speech. To their surprise, in synthetic speech the infants attended more to the falling contour. They were unable to explain this unexpected phenomenon other than to say that in studying suprasegmental aspects of speech there is such a complex interaction of many factors (intonation being only one) that other prosodic features and paralinguistic features may also be involved and were not isolated in this study. They concluded that experience in this area of auditory attention is critical for subsequent acquisition of productive language. As early as two months, rising contour in mothers' speech may be used to gain and hold the infant's attention.

Rising and falling final contours were also investigated by Kaplan (1969) who studied forty infants to examine their ability to discriminate falling and rising terminal contours. There were 20 four month olds and 20 eight month olds. She presented natural speech patterns that varied in pitch alone and those with stress and pitch changes. "See the cat" was produced with a falling contour, a falling contour with stress, rising contour, and a rising contour with stress. A heart rate habituation-dishabituation paradigm was used in combination with an orienting response to determine when a child appeared to discriminate the stimulus.

By eight months of age, infants distinguished between rising and falling contours that were stressed. Thus, somewhere between four and eight months, the ability to discriminate stress and intonation contour was evident.

Kaplan concluded that a theory of language and perceptual development should include a theory of successive differentiation whereby discrimination begins at the most superficial level (like intonation, stress and juncture). This basic level should help in isolating more specific features such as phonemes, syllables, phrases, and sentences.

In contrast to the previous studies that identify the early saliency of the intonation contour, Kuhl and Miller (1975) found that vowel color (phonemic change) captured infants' attention more than pitch contour. They studied 4-16 week-old infants to see if the infants could detect a change in a target dimension if an irrelevant dimension was varied throughout the experiment (serving as a kind of distractor). A head-turning paradigm for a change in a stimulus was used.

The stimuli were two /a/'s and two /i/'s synthesized such that one /a/ and one /i/ had identical monotone pitch contours while the other /a/ and /i/ had identical rise fall pitch contours. The infants were able to detect a vowel change regardless of the distraction of a random change in pitch contour. In contrast, the infants detected a change in the pitch contour of a vowel when all other dimensions were held constant but did not respond to contour change when vowel color was randomly changed. Also, the infants responded for a significantly longer time before habituating when vowel color was changed than when pitch contour was changed. Kuhl and Miller concluded that vowel color captured the infants' attention more readily than pitch contour as both a target and a distractor.

In summary, research indicates that infants are sensitive to changes in fundamental frequency (pitch) at a very early age. Although it has been reported that they can discriminate the difference between rising and falling intonations with stress, it appears that rising terminal contours command more attention. One study has reported vowel color to be more salient to the infant than pitch contour.

Productive Studies of the Elements of Intonation

It has been reported that when adults speak to very young children elements of the intonation contour are exaggerated and it appears that infants perceive some of these elements. The infant also vocalizes and, in doing so, produces vocalizations that show intonational consistencies. The following studies explore the possibility that children convey meaning to others around them via contrasts in their intonation patterns even before they have spoken their first words.

Lieberman (1967) described the normal breath group as "a synchronized standard pattern of activity wherein the respiratory and laryngeal muscles act to produce phonation on the flow of expiratory air" (p. 39). He suggested that the first meaningful elements of speech behavior begin in the very first months of life. Even during the first minutes of life, children employ "meaningful," though not intentional, intonation signals. Cries are meaningful in that they have physiological reference and are innately determined.

According to Lieberman, the infant cry has a characteristic pattern; a rising-falling contour that lasts from one to two seconds. As the infant matures, the vocalizations differentiate. Some have an immediate physiological reference which can be satisfied by adult attention. Others, such as gurgles and babbles, do not seek immediate attention.

Lieberman tried to show that the infant's hypothetical innate referential breath group furnished the basis for the acoustic properties of the breath group that segmented speech into sentences. He described the initiation of phonation by an infant. The vocal cords were brought inward and air was expelled from the lungs. When the infant began phonation, the child did not have precise control over the laryngeal muscles. She merely maintained the tension that was there when phonation began. Even though esophageal pressure did not alone indicate what subglottal air pressure is, the esophageal pressure function indicated when subglottal air pressure was rising and falling. These pressure functions all had a similar shape for crying. The pressure rose from the start of phonations to a level or slightly falling plateau. Then the pressure abruptly fell at the end of expiration. The gross variations of fundamental frequency contour seem to be a function of subglottal air pressure during crying. The fundamental frequency would rise at subglottal air pressure buildup, remain level or slowly fall and at the end of expiration, would abruptly fall. At that point, respiratory reflexes induce inspiration.

According to Lieberman, children soon learned to associate more social referents to intonational signals. They responded differently to different tones of voice and began to mimic adult intonations. He observed a ten-month-old boy and a thirteen-month-old girl conversing with one parent and then the other. Their babblings were analyzed for fundamental frequency. It was found that the infants' pitch varied with the sex of the parent (higher for the mother and lower for the father). In addition, each child's pitch was higher in solitary play. Lieberman concluded that the infants controlled pitch differences even though they were prelinguistic because of their perceptions of their parents' voices. The results also indicated that the pitch of other people was discriminated before the onset of the first words.

He cited Leopold (1953) who discussed the single word sentence where the child used "interrogative intonation" to ask for information, request permission, or ask for the name of a thing. It's assumed that Leopold was referring to a rising intonation contour. Lieberman's point was that the child must first be producing falling fundamental frequency contours (the innate breath group) in order to make this first contrast.

Lieberman concluded that children come to use the innate referential breath-group as the phonetic marker of sentences. The breath-group becomes the basis of the unmarked (falling) breath-group. Eventually, a child learns the variation of the breath-group as the interrogative.

Several people have looked at intonation and some of its elements such as fundamental frequency in either a contextual (Delack, 1976, Furrow, 1984, D'Odorico, 1984), functional (Menn, 1976, Burton, Zerin and Shenaut), affective (Yampol'skya, 1973, Ricks, 1975) or syntactic

(Menyuk and Bernholtz, 1969) framework. Following are some of their findings.

Delack (1976) looked at nineteen infants from one to twelve months of age. Over 11,000 vocalizations were examined. These vocalizations were obtained under several different conditions such as the infant being alone, with its mother or with another adult. Then the infant was exposed to different types of sensory stimuli such as toys, bells, mobiles, etc. The utterances were analyzed spectrographically in terms of contour, duration and range.

Fundamental frequency remained fairly stable over the first year centering around 355 Hz. This was somewhat lower than what has been reported by other studies of children of approximately the same age (Laufer and Horii, 1977, Murray, 1980, Sheppard and Lane, 1968, Fairbanks, 1942). (These fundamental frequency differences will be discussed in greater detail in the section of this chapter entitled: "Other Acoustical Research Related to Intonation".) There was about a fifty percent increase in the duration of the vocalizations and the fundamental frequency range increased by twenty percent over the first year. Sex differences were noted such as a higher fundamental frequency for females and higher peak for males.

Delack noted trends of vocalizations in specific contexts. Children at four to five months and again at nine months were more apt to vocalize when alone. The infants did the most amount of vocalizing with their mothers at the beginning (seven weeks) and end of the study (forty-eight weeks). Visually stimulated vocalizations peaked between three and four months and nine and ten months. There was a peak at six months for the subjects with tactile and visual objects as well as tactile/visual/auditory objects.

Delack concluded that this study documented the capacity of the infant to vocally differentiate environmental events and was evidence that language acquisition must be discussed prior to the onset of the child's first words. He supported the hypothesis of continuity from babbling to speech.

D'Odorico (1984) recorded the cry and noncry vocalizations of four Italian infants who were four and five months of age at the onset of the study. The study continued until they were eight to nine-months old. The vocalizations were grouped according to situational contexts such as 1) presence or absence of an adult, 2) presence of an object, 3) interest or indifference to an object, 4) action performed by an adult to a child, 5) mimic or gestural indices accompanying a child vocalization. Sounds were catgegorized based on contextual analysis as: 1) discomfort sounds, 2) call sounds, and 3) request sounds.

Narrowband spectrograms were made of all utterances.

Analysis of the utterances included examination of the temporal structure, melodic patterns (fundamental frequency contour), average fundamental frequency, and average duration.

In terms of temporal structure, requests were primarily one-unit sequences, calls were one-unit and brief sequences, while discomfort sounds had longer sequences. Melodic patterns were grouped as level, falling and rising. Discomfort cues were prevalently level and falling patterns, requests were characterized by level and rising patterns. Call cues were variable. Call cries with a level melodic pattern always had a higher average fundamental frequency than discomfort cries. Call cries with rising melodic patterns also showed a longer duration than discomfort cries with the same pattern. Requests usually had an average fundamental frequency lower than the other categories and duration was shorter.

D'Odorico discussed her results in relation to the onset of intentional behavior. She felt that there was a need to follow longitudinally the process leading from call cries to request vocalizations and suggested that melodic structuring in both child vocalizations and infant cries could be the earliest kind of language structuring.

Furrow (1984) examined the relationship between prosodic variables (pitch, loudness, and pitch range) and children's social behavior [eye contact, other social (no eye contact but behavior involved another)], and [private speech (no social markings)].

He looked at 12 two-year-old children whose M.L.U.'s ranged from 1.34 to 3.02. Children were videotaped at home in a free play situation. Each utterance was rated on pitch, loudness and pitch range. The utterance then received a numerical prosody score from one (low) to three (high) for each of the three prosodic variables. For example, a score of nine would indicate a highly pitched, loud utterance with exaggerated pitch contour.

Results indicated that the children varied prosodic aspects of utterances dependent on the context in which the utterances were produced. Scores for utterances with eye contact were greater (higher prosody scores) than other social and private speech scores; other Social scores were greater than Private Speech. While prosody scores in Private Speech decreased with M.L.U. they remained basically unchanged in the Eye Contact context.

Furrow concluded that children use prosody selectively depending on whether speech was directed to themselves or others. Thus, utterances made with eye contact were on the average louder, higher and more variable in pitch. When there was no interpersonal behavior, utterances tended to be lower, less variable in pitch, and quieter.

Menn (1976) examined the "babble" of one child, Jacob, from 12-1/2 to 15 months of age. She derived functional categories for his intonated utterances based on consistencies in his behavior observed at home. For most of the functional categories established, she found some consistent intonation patterns by extracting fundamental frequency contour using computer pitch extraction or narrowband sound spectrogram.

Menn found that the patterns for greetings, curiosity noises (when peering into an empty room) and narratives (accompanying ongoing action) demonstrated Jacob's control of intonation for meaning. Curiosity noises were always moderate in pitch and had a rising contour. Greetings changed over time from a falling pattern to a rising one. Narratives were distinquished by consistently showing a falling pattern. When Jacob wanted an object, he used a rising contour with a very high peak fundamental frequency range (550-110 Hz.). When he wanted an adult, the peak of his rising contour was never over 450 Hz. It was as if he attempted to lower his pitch to one closer to an adult when he wanted something from an adult, but when he was involved with an object, he did not attempt to match the adult pitch.

Menn suggested that it was not realistic to attempt to match one type of utterance with a specific intonation contour since there were many more functions than distinguishable contours. It was also unrealistic to expect child to child consistencies in the relationship of contour to function. She expected there to be variability among children.

Since Menn only studied one child and documented relatively few examples of contours (34) she could not compare the patterns among children and her conclusions were tentative. In addition, contour was followed over a relatively short period of time which made it difficult to make any inferences about the stability of change in contour use. Menn was really the first to investigate contour in relationship to function and use a combination of acoustical measures and language observation techniques to detect patterns. Since intonation patterns were only a small part of a much larger dissertation, it was understandable that a more comprehensive account of intonation was not undertaken.

Another longitudinal functional analysis was performed by Burton, Zerin and Shenaut (undated manuscript) who studied the prosodic features of a child's (Allison) language over a period of time. They analyzed each of four tapes by repeated viewing but used no type of instrumentation in their analysis.

Pitches were designated as L (low), M (mid) or H (high) and drawings of contour shapes were made. Tape 1 revealed a high pitch for emotional contexts, a low pitch for personal vocalizations and a mid-pitch with searching behaviors and request before they became emotional. During Tape II, Allison's prosodic system was not as consistent but she did use low tones for mathetic functions and long vowels and falls for emphasis or contradiction. In Tape III, vowel contours became more predictable and narrative was described as a series of successive single word utterances. Finally, Tape IV revealed more use of stress.

Burton et al. suggested that the detailed description of the prosodic system of even one child could be helpful in discovering how the patterns of the prosodic system contribute to our understanding of word meaning, word acquisition, and grammar, and how prosody fits into a general theory of language development.

Affective behavior and intonation were studied in infants by Yampol'skya (1973). She studied 170 children including 30 infants (one to six months old) and 140 children up to two years old. A total of 534 utterances were acoustically analyzed. Observations and descriptions of each child's affective behavior during vocalizations were made by parents and nursery attendants.

Using objective means (the intonograph), she compared infant intonation with the structure of adult intonation. The intonograms revealed a gradual approximation of infant intonation to the intonational structure in adults.

In children, from the second to the seventh month the "indifferent" (sic) intonation of children was structurally comparable to adult assertion, enumeration, and comparison. During the seventh month, expressive calm cooing resembled affirmation in adults. An "insistent" intonation appeared at ten months and was similar to persuasion and insistence in adults. Intonations of happiness were acoustically similar to consternation in adults. Adults have both polite requests and emotional requests. From seven to twenty-four months, children employed an intonation similar to the emotional request. The questioning intonation that appeared during the second year was similar to the adult question intonation.

Yampol'skya concluded that speech development in children began with the development of intonation. Children acquired new forms of intonation on the basis of intonations employed by adults using an adult-child verbal-auditory feedback system. She pointed out that the intonations were not identical to adults but similar.

Tonkova Yampol'skya included little actual data on her report of intonation. It was difficult to understand whether there was much variation in utterance production. For example, were most child's utterance of happiness similar in structure to the adults of consternation or was it just some of them? Also, she made no mention of reliability or how affective category names were placed on utterances. It was also unclear whether mothers and caregivers labeled emotions on the spot or listened to recordings. There were few definitions of her affective categories. But this appeared to be one of the few major undertakings that attempted to look at infant intonation longitudinally, categorize it, and put it into a developmental framework.

Ricks (1975) looked at the babbling of English-speaking children who were normal, those who were autistic and children who were from a non-English speaking language environment. Initially he had six parents of normal infants record their children of six to eleven months when they babbled sounds that demonstrated 1) a request noise, 2) frustrated noise, 3) greeting noise, 4) a surprised noise.

Each mother was asked to identify the recorded signals of all six infants according to the above four categories. Then the mothers heard recordings that included a non-English speaking child and categorized those sounds.

Finally, six non-verbal, autistic children were recorded in the same type of situations. Their mothers attempted to categorize the vocalizations of each of the autistic children. Instead of identifying a non-English speaking child, a non-autistic, retarded child was used.

Results indicated that parents of normal infants found it easy to detect the message of each signal independent of the child's identity or language background. Parents of autistic children could recognize the message of their own child and the non-autistic retarded child but became confused about the messages of the other autistic children. Ricks concluded that the four noises of one normal infant are very much like those of another. Autistic children's noises were quite idiosyncratic in their relation to function. Each autistic child conveyed a message in a totally different way. Rick's study was the first study (other than Yampol'skya) that indicated that the prelinguistic vocalizations of normal children were similar and related to function. Previous to this, mention was made that each child's system might be different.

Sentence classifications of children's single word utterances were made by Menyuk and Bernholtz (1969). They looked at the prosodic features of the utterances of one child during the single word utterance stage. The utterances were recorded and then re-recorded so that they appeared in isolation. Two listeners attempted to classify these utterances as declaratives, questions, and emphatics. There was eighty-one percent agreement between the listeners on their categorization of the utterances. Spectrograms were then made of the utterances. Declaratives usually terminated with a falling fundamental frequency contour.

Questions had a rising terminal contour and emphatics had a sharp rise and then a fall.

They claimed that even though their data were limited, and not based on context or function, there were indications that the communicative functions of their utterances were more than naming or imitating. The children may have been using prosodic features to generatively create sentence types. This study was done almost 20 years ago. Since then, research has demonstrated that children's functional behavior prior to and during the single word stage consists of much more than naming and imitating. The claim that sentence types were being generatively created might be difficult to accept. Perhaps a more primitive form of syntactic behavior such as Dore's "presyntactic devices" (PSD) would be a more appropriate way to describe this type of behavior.

The studies described above have demonstrated patterns in the intonations of young children. In some cases, children used greater range, and higher pitch to differentiate contexts. In other cases, rising intonation was associated with greetings, curiosity noises, and requests. Attempts were made to compare the intonation contours of adults and children and some similarities were found. In other studies, adults were able to correctly associate babbled utterances with specific function or sentence types.

The research in this area is really still in its infancy. Inferences have been made about how the results demonstrated consistent patterns of intonation and function, how these patterns begin long before the onset of the first words, and how these patterns relate to later language development. More longitudinal, study is needed employing acoustical and statistical measures to be able to make some definitive statements about consistency in these patterns.

Intonation and How it Relates to Continuity

The past review implies that there is continuity in the development of intonation. It has been noted by many (Lieberman, 1967, Beven et al, 1971, Weir, 1963, Engel, 1973) that the use of intonation to convey meaning precedes other language forms.

Lewis (1936) and Wood (1976) both described intonation and its importance as following specific stages. Lewis distinguished three stages of development of intonation. It began during a prelinguistic stage with the child showing a gross discrimination (both perceptive and productive) between different patterns of intonation. When phonetic forms and intonation were combined, he felt that it was the intonation rather than the phonetic forms that dominated.

Eventually the phonetic forms became dominant features and intonation took a subordinate position. Yet, its role never vanished. Thus, he appears to support the position that intonation played a continuous role in the development of language.

Wood (1976), who defined intonation patterns as changes in pitch, described pitch in three stages just as Lewis did. Stage 1 began at about four months and involved general discrimination of pitch patterns of others. Stage 2 began at about eighteen months and involved a combination of words and intonation to communicate ideas with intonation carrying the bulk of the meaning. In Stage 3 (approximately 2-1/2 years), words, syntactic patterns and prosodic features work together to convey meaning. Just as Lewis did, Wood saw intonation contour and pitch taking a role in the development of language prior to the first words.

Functional Categories and the Study of Intonation

In order to study intonation in an organized manner and give it a perspective in the overall framework of language development, it is necessary to look at it in relation to a component of language. Language use contains two major aspects: (1) the goals or functions of language and (2) the influence of linguistic and nonlinguistic context (Bloom, Lahey, 1978, p. 19). Function and context have been used by many to study language. Two people in particular (Halliday, 1975, Dore, 1974) have used functional language analysis to study language and have included intonation contour in their analyses.

Halliday's study was done from immediate observation and written transcript which meant judgements on intonation needed to be made spontaneously without the benefit of replay. This is a very difficult task since some utterances are so brief. Dore had the benefit of videotape. In neither case was acoustic information about intonation contour available. Having a permanent acoustic record as well as a written transcript would have enabled them to make more objective observations and conclusions regarding the relationship of function and intonation.

Halliday indicated that the learning of language is well underway before a child has any words at all. At around six to nine months, the infant started to use vocal sounds consistently and began to use some kind of constant relationship between sound and meaning. These meanings could not necessarily be glossed in terms of adult meaning, but could be looked at as a means of fulfilling some fundamental goals for the child.

Halliday observed his own son, Nigel, from the ages of nine to twenty-four months. In his analysis he discussed in detail the child's vocalizations in terms of their functions and intonational contours. When Nigel developed a language system (9 to 10-1/2 months) it initially consisted of systematic functions, content systems, a vocalization and descriptive tone (intonation patterns of falling tones that were mid-low falling to low or mid-falling to low). These tone patterns became more varied and complex as his system developed.

He used the term "tone" to describe the intonation patterns used by Nigel in his utterances. He described the pitch of his utterances as well as the direction. (For example, "mid-low falling to low," "mid falling to low", p. 61).

Halliday stressed that even when the child did not have a lexicon, he produced sounds that he used to accomplish a particular end. The child went through "restructuring" phases in his language system until he became more aligned with the adult language system.

He identified four initial functions of language in Nigel: 1) instrumental - demand for objects, 2) regulatory - demands that another person do something, 3) interactional - greetings and attention getting vocalizations, 4) personal - expressions of feelings, participation, withdrawal, interest, pleasure, disgust, etc.

Not long after these, two other functions appeared: 5) heuristic - language used to question about the environment (such as a demand for a name), 6) imaginative - language used for creating his own universe. At first it was all sound but later develops to story and pretend.

Halliday indicated that the first restructuring of language occured when Nigel saw a distinction between "language as doing" and "language as learning". When Nigel was about 16-1/2 months old, he was able to differentiate the two uses of language into pragmatic (language as doing) and mathetic (language as learning).

Dore (1974) presented a theory that treated a child's one word utterances as Primitive Speech Acts (PSA). The PSAs contained a rudimentary referring expression (a word) and a primitive force (typically an intonation pattern). For example, a word such as "mama" could be a PSA of "labelling" if produced with a falling intonation and in a context where the child pointed to her mother or a picture of her mother. "Mama" could be considered a "calling" PSA if the child used a rise-fall contour when the mother was across the room and she was trying to get her attention.

In his study he recorded the utterances of a boy and girl over several months. He analyzed their utterances according to his Primitive Speech Acts Theory. He found that the girl produced more conventional words than the boy and Dore classified her as a "word-baby." The boy used prosodic features more than the girl and was labelled an "intonation-baby." He suggested that the learning of "words" and prosodic features may follow separate lines of development and may account for some of the variation in language development. In addition to this contrast in the number of linguistic forms used, there were also differences in the number and types of linguistic functions used by each child. The girl used fewer PSAs, and those she used were primarily representations of the world (labelling, repeating, and practicing). The boy used more types of PSAs and most of them were attempts to accomplish something and manipulate people. Thus, one child appeared to enter the language system with a form/content emphasis (words) while the other child entered the system using more of a form/use emphasis (intonation/PSAs).

Both Halliday and Dore presented a categorical framework of how children begin to convey meaning to others around them. They both looked at functions of language and both assocated these functions with specified elements of the intonation contour. To take this one step further, it would be helpful to have acoustical data available on intonation in order to make the associations between function and contour more objective and reliable.

Other Acoustical Research Related to Intonation

Intonation involves variations in fundamental frequency and any acoustical analysis of intonation provides information that is also relevant to an understanding of physical changes in the larynx. Fundamental frequency has been used over the years to make estimates of the physiological state of the glottis and the variability in vocal fold vibration. In turn, the stability of vocal fold vibration has been used as an indicator or laryngeal coordination. Presented below is a review of research related to fundamental frequency and duration primarily during the second year.

Until recently, much of the literature on fundamental frequency has been based on very young children from birth to one year (Ringel and Kluppel, 1964; Fairbanks, 1942; Laufer and Horii, 1977; Sheppard and Lane, 1968; Delack, 1976) or older children from three years through adulthood (Eguchi and Hirsch, 1969; Bennett, 1983). Kent (1976) compiled and summarized data on the developmental course of mean fundamental frequency from the first few days of life to adulthood. He found that fundamental frequency values dropped slightly during the first three weeks, then increased until about the fourth month, then stabilized for about five months. Beginning at one year, fundamental frequency decreased sharply until about three years then gradually declined until puberty. At puberty there were sharp differences between males and females in decline. Kent was quick to point out that none of the developmental trends were based on large populations. The variability of children, contexts, and means of stimulation must be kept in mind, especially if mean fundamental frequency would be used to make physiological assumptions about the state of the larynx.

Until very recently, there was a lack of information on fundamental frequency trends in children between the ages of one and three. McGlone (1966) studied six children between 13 and 23 months but only group averages were available on fundamental frequency (443 Hz.).

Recently, Robb and Saxman (1985) looked at the quantitative relationship between average fundamental frequency and fundamental frequency variability in 14 children, 11 to 25 months. They were interested in looking at how the onset of linguistic development interacted with the physiological development of the vocal mechanism. They found the overall mean fundamental frequency was 357 Hz. (quite different from McGlone) with a range of 164-1366. Overall onset fundamental frequency was 363 Hz. with a range of 158-1600. Overall segment duration was 357 milliseconds with a range of 120-531 milliseconds.

In general, they found a systematic decrease in fundamental frequency as a function of age. There was high fundamental frequency interutterance variability during the 11 to 16 month ages which corresponds to the onset of first words. This was where they felt that linguistic growth might interact with physical maturation.

Their point about non-physiological factors such as the onset of word meaning possibly causing variability is a valid one. To make any physical assumptions about fundamental frequency, it is necessary to know what other non-physical factors might influence fundamental frequency. Word meaning (content) is one possible influence. Another one could be communicative intent (use). As noted in earlier research, various patterns of intonation have been associated with different functions of language. If one can control for variables such as these, then a more accurate account of the physical factors of fundamental frequency can be made. Data from the present study could contribute to the understanding of these other variables. Although it is not the major purpose of this study, information on fundamental frequency variability during the second year of life will be presented.

Duration of prelinguistic vocalizations has been investigated but methodologies in reporting duration have differed which has made it difficult to make any comparisons about results. In some cases, syllables have been measured; in others segments divided by a specified amount of time, and other times an entire vocalization. The following are two studies that have looked at duration prior to the onset of the first words.

Duration of vocalizations during the first year of life was reported by Delack (1976). There was a mean increase in duration of fifty percent with duration for females increasing from 375 to 645 ms. with peaks at six months (775 ms.) and nine months (900 ms.) and for males 430 to 605 ms. with corresponding peaks of 805 and 815 ms. He found a developmental trend of an increase in duration.

Boysson-Bardies, Bacri, Sagart and Poizat (1981) studied the temporal organization of babbling in a French child between the babbling stage and the production of meaningful speech. They looked at the rate of articulation during this period and the relationship between timing and intonation contour. Their analysis focused on two, three, four and five syllable productions. They measured the duration of the sequence, syllable duration, terminal syllable duration, and fundamental frequency.

Results indicated that syllable duration increased as the child became older and closer to speaking her native language. (Mean for all 10 sessions was 231 msec with a range of 195 - 304 msec.) In ten taping sessions, articulation rate was more rapid during the first five sessions than in the last five sessions. They explained the faster rate as a result of the makeup of babbling where the child inserted rhythmically occuring syllables into a preprogrammed intonation contour and employed certain types of coarticulation for rapid articulation. The lengthening of syllabic duration during the last five sessions was explained as demonstrating a beginning of articulatory-oriented behavior where the child attempted to reach a precise target of the adult lexicon. They claim that their results supported the proposition that the temporal structure of late babbling may serve as an indicator of the transition from babbling to articulatory-oriented behavior.

Summary

It has been demonstrated that maternal intonational input assists in gaining and holding the infant's attention. In addition, it appears to transmit affect, mark boundaries, regulate social exchange, and is among the earliest basic units of interpersonal auditory signaling. Using both real and synthetic speech, researchers claim that somewhere between seven weeks and eight months, infants begin to discriminate intonation.

The child's production of intonation patterns which are responded to and interpreted by adults, have been traced back to early infancy. Elements of intonation in young children have been studied in relationship to infant affect, to context, to function, and to syntax. All studies claim that systematic patterns of intonation can be found prior to the first words.

In the past, there are those who have written about intonation as a continuous process starting in infancy and continuing throughout the development of language. Others have used intonation as an important element in their analysis of language functioning.

Accumulating information about fundamental frequency has been helpful in studying the development of the larynx from birth through adulthood. It has been reported that more data are needed during the second year of life. Information on fundamental frequency and its interaction with other non-physical factors such as meaning and function may help to explain the variability reported during this time period.

NEED FOR THE STUDY

From the previous review of the literature, we know that mothers utilize intonation as a means of interacting with their babies. We also know that infants can discriminate the different aspects of intonation (such as terminal contour) from an early age and that they produce intonation contours that are similar to those produced by adults. What we do not know is whether infants use intonation as a means of learning how the forms of language interact with the content or use of language.

Given the early input that they receive, the early ability to discriminate changes in intonation, and their early productions of intonations, it is possible that intonation may be the first introduction for the child about the interactions of conventional linguistic forms with aspects of meaning. Indeed, this possibility has been suggested by a number of researchers based on evidence that there is some association between the intonation patterns produced by some children and the meanings they appear to be expressing. However, there are problems with such data that need to be resolved before such a conclusion can be accepted.

First, many of the studies have relied on perceptual judgements of intonation. It has been pointed out by Menn (1976) that perceptual judgements of final contour are not always reliable when compared to acoustical judgements. Thus, it would seem that any study that attempts to make associations between intonational patterns with aspects of meaning should use some type of acoustical analysis in determining these intonational patterns.

However, studying intonation in very young children has always involved instrumentation difficulties. Audio recordings of moving infants have often been unanalyzable due to too much background noise (movement of clothing, banging of toys, bumping into microphone, etc.). Those utterances that could be isolated and were clean enough for spectrographic analyses needed to be hand measured to obtain the acoustic characteristics desired by the examiner. This is a very time-consuming and tedious process. There is a need for a more accurate, efficient means of studying the intonation of these young children. Such a procedure was devised for this study and will be discussed in detail in the methods section of this paper.

Even when acoustical analyses have been made, researchers have often presented only group data rather than individual child patterns over time. Since individual variation among children has been well documented (eg. Bloom, Lightbown, Hood, 1974; Nelson, 1979; Dore, 1974) it is possible that group data might mask patterns that may exist. In addition, it is likely that individual children may use different patterns of intonation for different functions. Therefore, it is important that patterns for individual children be presented. Futhermore, many of the studies that used acoustical analyses have not looked at the same children over a long period of time. If children do not use the same patterns of intonation for the same meanings through prelinguistic and early linguistic utterance, it would be difficult to conclude that intonation has served as a first introduction of form with meaning.

Since there are no longitudinal studies of intonation that have acoustically analyzed the young child's vocalizations and have related this analysis to some aspect of language content or use, it is impossible to support or reject claims that intonation is used by the child as an early introduction to the relationship between form and meaning. The following study was designed to provide evidence relevant to this issue. In this study, the vocalizations of three children were acoustically analyzed at three points in time (prelinguistic, 10 word vocabulary, 50 word vocabulary). Certain acoustic parameters derived from this analysis (final contour direction, mean fundamental frequency, peak fundamental frequency, range, and duration) were related to consistencies in context and function (referred to as contextual functions), derived from analysis of videotape interactions of each child and its mother.

In addition to providing evidence relevant to the possible role of intonation in the learning of the linguistic system, the data have yielded evidence relevant to developmental changes in fundamental frequency. While longitudinal data on fundamental frequency support the hypothesis that fundamental frequency decreases with age, variability during the second year of life has been reported by Robb and Saxman (1985). This variability could be related to linguistic factors such as the interaction of segmental phonology, content or use of language with physiological development of the larynx. There is a need to study the relationship of fundamental frequency to other aspects of language to see if this can account for variability. In this study, the possible relationship of intonation and function was examined.

RESEARCH QUESTIONS

Vocalizations of young children were examined beginning just prior to their first words and continuing until they had achieved a 50-word vocabulary. The purpose of this study was to answer the following questions:

1. Is there an interdependence between the following elements of an intonation contour and the contextual functions of specific utterances:

    a. final contour direction (rise/non-rise)

    b. mean fundamental frequency

    c. fundamental frequency range

    d. peak fundamental frequency

    e. duration?

2. If there is any interdependence, does it remain constant in children over the time examined?

CHAPTER TWO

METHODOLOGY

Subjects

Two second-born girls and one first-born boy were chosen as subjects. They were recruited from the local community by word of mouth. All of the children had normal birth histories. A letter was received from each child's pediatrician stating that all developmental milestones had been met within normal limits. The Denver Developmental Screening (1969) was used as part of the interviewing process with each mother and child. Each child demonstrated developmental skills within normal limits by passing all screening items normally passed by 90% of children at their particular age levels.

All children were considered prelinguistic at the onset of the study. They all vocalized using "meaningful" non-linguistic vocalizations. In this context "meaningful" was defined as non-crying vocalizations that could be targeted by an adult (the mother) as serving some type of function within a certain context. This was documented by diary data collected by the mother. She was asked to give 10 examples of vocalizations and then explain the reasons why she thought the child vocalized each time. (Sample sheet in Appendix A.1.)

All mothers were college graduates and were the primary caregivers for their children. They were not out of the home during the day for more than fifteen hours a week.

Procedures

Prior to the first taping, each mother was interviewed about her child. In addition to discussing her child's development, the exact procedures of the study were explained. Permission slips were signed at this time. Methods of collecting diary data were discussed and many sample diaries were included in the packet of materials that they received. Mothers were called at least twice a month to see if they had any questions concerning the data collection.

The mother/child dyads were videotaped and audiotaped in a room that was set up as a den or playroom.[1] A sofa, chairs, carpet, lamps, and a variety of toys and objects were available. Objects that remained in the room at all times included a toy kitchen area with a table and chairs, plates, cups, stove, sink, a shopping cart, a riding toy, and some age-appropriate books.

The other materials (toys) were divided in groups of five and were presented to the child in approximately 10 - 15 minute intervals during the taping session. In each

[1]The general procedure is similar to the procedure reported by Bloom, Beckwith, Capatides, and Hafitz (in press).

group there were some toys or objects that were self-initiating by the child and could be manipulated without help. The others required assistance from the mother. Both types of materials were put into each group to help vary the child's utterance types. Some toys were intended to elicit personal, noninteractive types of utterances while other objects were intended to elicit requests, frustrations, and interactive types of utterances. The materials list can be found in Appendix A.2.

Each mother was instructed to bring a few of her baby's own toys to the session to help her child feel more comfortable and at home in the surroundings. These were available to the child throughout the session. The mother was instructed to play with her child as she might do at home. She was told that she need not use all or any of the toys if she did not want to. After approximately five minutes of taping, the first set of materials was brought into the room in a plastic bag. After approximately ten minutes, those toys were put back into the bag except for the one(s) the child was playing with at that time. This was done because at this young age it was felt that an accumulation of too many objects might be overwhelming and distracting for the child. Next, a new set of toys was brought out for 10 more minutes. This was followed by a 10 minute snack period of juice and cookies and two more 10 minute play periods using two new bags of materials.[2] Each taping ran for approximately 55-60 minutes.

There were a few variations in these procedures, although it was felt that these changes did not interfere with the quality or context of the taping. Since all children seemed a bit uncomfortable in their new setting during the first taping and were less vocal than their mothers reported them to normally be, a four year old child was brought in for a few minutes of each child's taping. In one session, the older child stayed for almost the entire taping. He would try to play with the subject or demonstrate how to play with a toy. In each instance, the presence of another child got the subject to begin vocalizing. By Tape II, two of the children seemed comfortable in the setting and the older child participated for only one of the three subjects (RS).

For another subject, (AL) the researcher played a more active role, especially during Tape III. AL very often would throw a ball to her or request things of her, and she interacted with him whenever he initiated this type of behavior. Also, this same child found some crayons in the corner of the room during Tape III and requested to draw. He

[2]On a few occasions the snack period was not a clear-cut ten minute period. Instead, the child munched on crackers and drank juice well into the next two play periods.

was allowed to do so although these materials were not found or used by the other children.

Each mother/child dyad was taped a total of three times. Tape I was recorded prior to the onset of the single-word utterance stage. Mother interviews and the diary information indicated that each child produced vocalizations that were interpretable by their parents. The diary information included instances of non-linguistic utterances that the mother had observed and was able to specify a reason (function) for why the child vocalized. Examples of reasons for vocalizing included: showing off, wanting something, upset (but not crying), happy, curious, or "just felt like talking".

Tape II was made after the child had acquired at least 10 words. This 10 word vocabulary was determined by the mother's diary. She was required to submit five different instances of each of the 10 words on her list. Each instance indicated the context and who was present at the time.

Tape III was made when the child had achieved a vocabulary of approximately 50 words. At this time, all three mothers reported that their children were putting two words together.

A 10 word and a 50 word vocabulary were used to designate the early and late stages of the single word utterance period. The emphasis of this study was on the suprasegmental characteristics of intonation and not on segmental characteristics. Possession of a 10 and 50 word vocabulary were used only as time demarcations for taping. No analysis was made on the actual content of the vocabulary. In most instances, few of the vocabulary words listed on the mothers' diaries were actually heard on the tapes, especially during Tape II. The children tended to use less words on the tapes than the mothers reported that they used them at home.

The time periods and ages of each child for each taping are included in Table 2.1. A complete list of the first 50 diary words of each child are available in Appendix A.3.

Equipment

During each recording session the child wore a zippered vest with a 3" x 4" pocket located inside the vest at the back. The vest was an adaptation of the "telebib" developed by Dr. Hal Bauer of Ohio State University. Bauer's "telebib" had an FM wireless microphone attached onto a bib to achieve high quality recordings. A vest was used for this study since the microphone could be more securely bound to the neck when the vest was zippered. This almost totally eliminated the threat of the microphone moving during the

Table 2.1

Age (In Months and Days*) of Each Child During Each Taping Session

		Time 1	Time 2	Time 3
	AL	14-24	16-29	20- 5
Child	AB	12- 0	15-21	18-27
	RS	11- 9	15- 4	22- 5

* (11-9 = 11 months, 9 days old)

recording. In the pocket of the vest was the transmitter of a Realistic FM Wireless Microphone. The lapel microphone, attached to the transmitter, was clipped onto the inside of the vest at the neck to insure good quality recordings. The FM receiver was placed in another room next to the other recording equipment and plugged into the audio tape deck. The mother also wore a Realistic lapel microphone that was attached (by wire) to a mini-amplifier which was hooked to the audio recorder.

Audio recordings were made on a Sony Stereo Cassette deck (TC-FX22) using BASF and Sony tapes. The FM receiver of the wireless microphone was fed to the left channel of the deck. The mother's lapel microphone was connected to the right channel. Video recordings were made on a GE portable VCR deck (1CVD4020X) with a GE video camera (1CVA4035E). BASF and Memorex 120 minute videotapes were used.

Transcribing of Tapes

Video Analysis

Video recordings were transcribed using the transcription sheets in Appendix A.4. All child vocalizations were transcribed while only relevant mother utterances were transcribed. There were approximately 150-210 child vocalizations transcribed on each tape. Included was the following information:

<u>Mother's utterance previous and/or subsequent to the child's utterance</u> - The mother's prior and subsequent utterances were helpful in determining the contextual function of the child's utterance. For example, if the mother first asked a question, the contextual function of the child's following utterance might be considered "an utterance following a question." The mother's previous utterance was also helpful in finding the point on the audio tape where the child's utterance began in order to analyze it acoustically.

<u>Child utterance number</u> - This was used to compare utterances on the audio and video tapes.

<u>Child utterance</u> - Each child's prelinguistic vocalization were transcribed whenever possible. These utterances included all non-crying vocalizations made by the child. Some utterances, especially during Tape I of each child, were very difficult to transcribe using IPA. When IPA could not be used, combinations such as CV, VC, CVCV, etc. were used to denote the utterance. Once the child was using single words, utterance were transcribed using IPA with less difficulty.

<u>Gloss</u> - The examiner tried to write down the word or words that the child used when an interpretation could be made.

Context - This included a description of the setting or exactly what was happening to, after, or at the moment of the utterance. This description was used in making a determination about the contextual function of an utterance. Actions, gaze, facial expression, and description of the utterance (eg. cry, whine), were examples of the type of information recorded.

Contextual function - The contextual function was the researcher's interpretation of how the utterance functioned in a particular context. This method of categorizing data is considered a functional analysis. However, using a functional analysis usually implies an interpretation of communicative intent. In this study, definitions of the categories were based primarily on the context, the child's actions, and the mother's actions and reactions. That is, they were defined by observable behavior and an attempt was made to infer as little as possible.

Following is a list of the categories used and their definitions:

GENERAL COMMENT - The child vocalized while interacting with another person. She could also be playing with an object, or performing an action. There might have been a jargon-like quality to the vocalization while looking at another person, or the child may have been "pretending" using objects to represent other objects or talking on the telephone.

RESPONSE TO A QUESTION OR FOLLOWING A QUESTION - During Tape I, to qualify for this category, the child had to vocalize within two seconds of the mother's previous question. In later tapes, the mother might ask a question and then the child vocalized within two seconds or the child clearly responded to the question with a "yes," "no," or the name of something. In a pilot examination of 50 responses it was observed that responses to questions followed mothers' utterance by two seconds or less. An utterance was considered to be in this category if it followed with the above definition and would have fallen into the "general comment" category if the mother had not asked a question.

NAME - The child picked up an object, pointed to an object, or looked directly at an object and vocalized. During Tape I an utterance was considered naming if the mother's previous utterance included the name of the object or her subsequent utterance which might have included a comment of confirmation such as: "Yes, that's a ball." During Tapes II and III if the child named an object and the context did not fit the definition of "call attention to," "request," or "give," the utterance was categorized as naming.

CALL ATTENTION TO SOMETHING - The child vocalized and called, pointed, grabbed or looked at the mother or another person and the other person attended.

REQUEST - The child vocalized while looking at something and then pointed or reached for it. She might also have pointed to another location. The mother either complied or acknowledged what the child just did by saying somethig like: "Oh, you <u>want</u> ..."

GIVE - The child gave an object to another person and vocalized while doing so. The mother or other adult responded with "thank you" or something like: "Oh, you want me to have the cup!"

REQUEST TO GAIN AND CLARIFY INFORMATION - The child vocalized and the mother responded to the child's vocalization as if the child had just asked a question to gather some information or to request the name of something. For example, the child might point to lamp and say, /zal/ and the mother might say: "That's a lamp," or the mother might say something and the child might respond with "what?" followed by the mother's repetition of what she has just said.

COMMAND/REQUEST - The child said the name of something or some action in a louder than normal voice. The mother responded by performing some kind of action for the child immediately. If the mother did not respond immediately, the child would repeat the utterance.

PROTEST - The child vocalized when something was taken away from her, when she could not have something that she wanted, when she did not want to do something (e.g. mother tried to get her to play with a different toy), or did not want to have something done to her (e.g. diaper change). The child would sometimes be in a highly emotional state, and might whine, lunge at something or rock.

PERSONAL COMMENTS - The child gave no evidence of interacting with another person. Specifically, she did not look at, gesture to, or touch another person. The child might have vocalized while holding an object, looking at it or performing an action with it. She may have appeared to be talking to herself or may have produced a long string of jargon-like utterances that appeared to have no relationship to anything that anyone else had just said or done.

The following two categories were used as secondary contextual function categories. Some of the above categories were double coded with the following two categories. The categories were not used in the actual analysis of the data. They were used in order to explain certain patterns of contextual function and final contour direction which will be explained in the Discussion chapter of this paper.

IMITATION - The child vocalized within two seconds of her mother and the vocalizations appeared to be phonetically similar to the mother's previous utterance or might have been an exact repetition of one of the words that the mother had just said.

RESPONSE TO A YES/NO QUESTION - The child vocalized in response to a yes/no question. The question asked by the mother required an affirmative or negative response.

Reliability of Contextual Functions

Twenty percent of all child vocalizations were observed on videotape by a second judge, who was trained on approximately 30 utterances prior to the reliability sessions. The judge was given a contextual function list and asked to make a judgement about the category of each utterance. Overall agreement on an item by item comparison of contextual function categories was 88% with a range from 83% to 95%. These reliability scores were slightly higher than those functional categories reported by Longtin (1984) who found reliability on linguistic utterances from 78% to 85%, and slightly lower than those reported by McShane (1980) who's reliability ranged from 90% to 98%. Individual tape agreements for this study can be found in Appendix A.5.

Audio Analysis

Each recorded child utterance was passed through an Allison Laboratories Model 2BR band-pass filter. (See Figure 2.1). The filter was set to attentuate (36 db per octave) sound below 180 Hz. and above 720 Hz. The upper range was modified to a higher frequency for those utterances with a fundamental frequency above 720 Hz.

The output of the filter was then fed into the Kay Visipitch Model 6087. The Visipitch extracted and displayed fundamental frequency of an incoming signal on four ranges (A-D). Most utterances were displayed through range B (135-535 Hz.) but a few required the use of ranges C (200-760 Hz.) and D (450-1550 Hz.). Display time was four seconds. The Visipitch was periodically calibrated by an internal calibration tone and fundamental frequency readings were always within two to three Hertz.

Two signals were taken from the Visipitch. First was a varying D.C. voltage proportional to fundamental frequency. (See "pitch out" of instrumentation diagram.) This voltage was inputted to Analog input 0 of ISAAC (Cyborg Model 91A), a multi-channel data acquisition and control system designed to be used with the Apple II Computer.

The second signal was the band-pass filtered waveform. (See "audio out" on instrumentation diagram.) This waveform

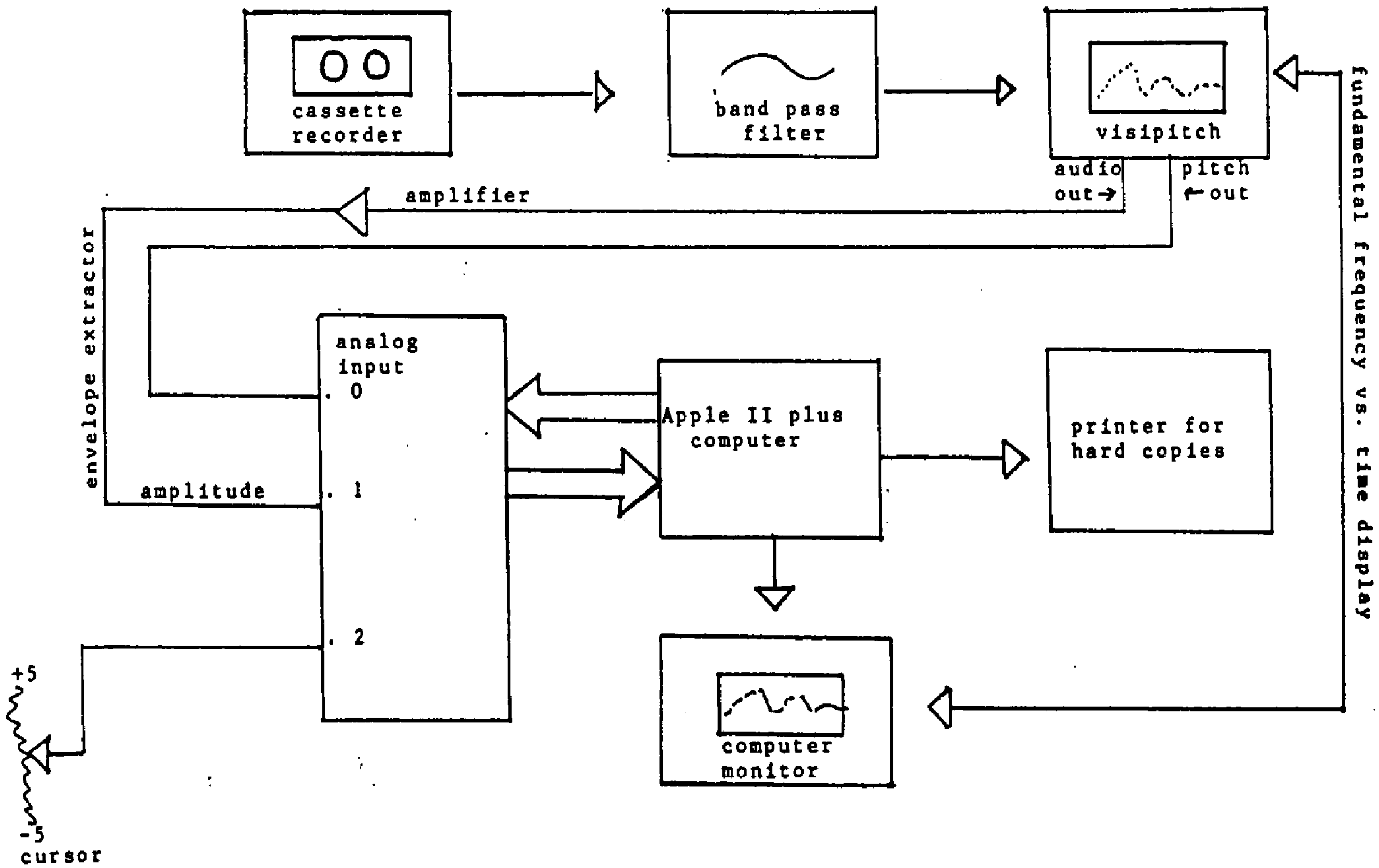


Figure 2.1 Instrumentation flow chart

was amplified and fed into a simple envelope extractor. The output of the envelope extractor was inputted to Analog Input 2 of ISAAC (Integrated System for Automated Acquisition and Control) and was reproduced on the computer monitor as an amplitude tracing. Amplitude was not analyzed as part of this study, but the tracings were extremely helpful in determining the onset and offset of an utterance when the tracing was "noisy."

A potentiometer was used to generate an operator-controlled D.C. voltage that was input to Analog I of ISAAC and used to control a cursor on the fundamental frequency versus time display.

Labsoft, an extended version of Basic with special instructions for ISAAC, was used to write a program to capture, display, and analyze acoustical information about each utterance. This program was written by Arthur Boothroyd of the Department of Speech and Hearing Sciences, City University of New York. It stored and displayed the fundamental frequency contour generated by the Visipitch. Specific points were designated with the cursor and the fundamental frequency values were taken from these points.

In this study fundamental frequency was sampled every 10 milliseconds for a total of 279 data points. These data points were then used to generate a fundamental frequency versus time contour on the computer screen. By using the cursor, specific points in the contour could be selected and printed out such as: onset and offset of the utterance, high point and low point of the utterance, and any other point that seemed to be significant to a particular utterance.

The completed hard copy of the computer display was printed on the Epson MX printer with Graphtrax. The print-out included an intontation contour, the time in milliseconds of each data point analyzed and the fundamental frequency of that data point. (Refer to Figure 2.2.)

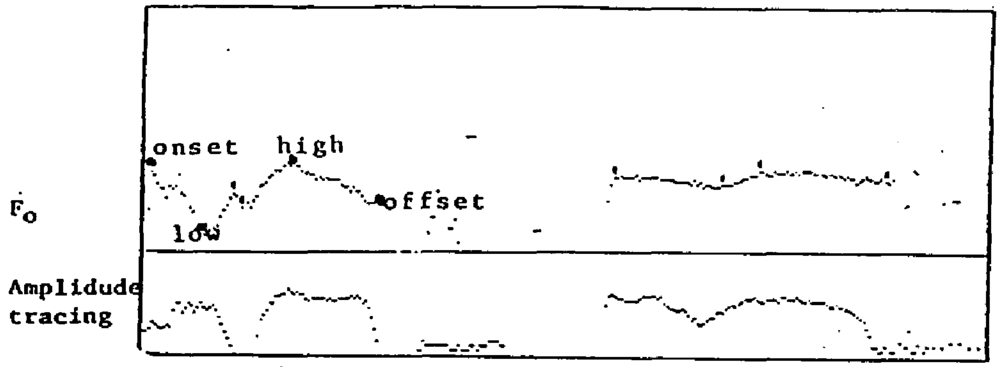
The data from each print-out was placed on an audio analysis work sheet which can be found in Appendix A. The information found on the sheet included:

Utterance number - This was taken directly from the video transcription sheets.

Contextual function and secondary contextual function - The previously described contextual function categories were placed here.

Linguistic/Non-Linguistic - Each vocalization was labeled linguistic based on some type of form/content consistency. During Tape I, all vocalizations were labeled non-linguistic since all mothers reported that their children were not saying "words" at this time and the examiner did not find evidence of conventional single words in the tapes. Most times, in Tapes II and III however,

Figure 2.2- Sample Visi-pitch print-out



UTTERANCE: 28 TAPE 2A
NAME:
OTHER INFO: SCALE B

	MARK #	MSEC		HERTZ	
	1	37	duration	315	
	2	198		207- low	
	3	303		279	high-low=range
	4	338		254	
	5	498		326- high	
	6	788		259	
new utter.	7	1563		305	
	8	1913		295	
	9	2037		319	
	10	2453		302	
		(duration)		(F_o)	

there was an obvious production of either a conventional word or a word that could not be interpreted. Sometimes a phonetic form was used consistently in a certain context. If it was consistently recognized by the examiner or mother as having a specific meaning, it was considered linguistic. Other vocalizations were considered non-linguistic and transcribed in a manner similar to Time 1. Table 2.2 shows the number of linguistic and non-linguistic utterances produced by each child.

Onset fundamental frequency - This was the fundamental frequency of the first data point of each analyzed utterance.

Offset fundamental frequency - This was the fundamental frequency of the last data point of each analyzed vocalization.

High - This was the highest fundamental frequency point of each vocalization.

Low - This was the lowest fundamental frequency point of each vocalization.

Duration - The duration in milliseconds of each vocalization from the onset to the offset points.

Final Contour - The final contour of each vocalization was judged to be a rise, fall, or flat. During a pilot examination of the data, it was determined that changes in fundamental frequency of less than 40 Hz. and durations of

Table 2.2

Numbers of Linguistic and Non-Linguistic Vocalizations Produced By Each Child

CHILD		Time 1	Time 2	Time 3	Total
AL	(L)	0	81	140	221
	(N)	180	80	39	299
AB	(L)	0	57	144	201
	(N)	149	88	43	280
RS	(L)	0	54	137	191
	(N)	169	115	57	341
	(L)	0	192	421	
	(N)	498	283	139	

L = linguistic
N = non-linguistic

less than 150 milliseconds could not be perceptually discriminated by two judges. Therefore, final contour direction was labeled fall, flat or rise based on the final part of the vocalization being longer than 150 milliseconds and greater than 40 Hz. (This was later changed to rise and non-rise as explained in the next section.) These criteria for contour direction were appropriate for this age group only. When working with younger children with higher fundamental frequencies different criteria for contour direction might be required (Dr. Rachel, personal communication).

Preparation for Analysis

All data were prepared for statistical analysis on the VAX mainframe computer. Most of the data remained in the same form as on the Audio Analysis sheet. However, contour shape was omitted since it was not directly used in analysis and the categories of final contour and linguistic/non-linguistic were given number values. Final contour direction was reclassified from rise, fall, flat to rise and non-rise. This was done since during preliminary chi-square analysis of all the data, rises were significantly differentiated from falls and flats. At that point, only falls and flats were analyzed and there were no significant differences between these two categories. Based on these results, "falls" and "flats" were combined into a category called "non-rise". Hereafter, all further analysis done on contour direction was referred to as either rise or non-rise.

In addition, the secondary contextual function categories were separated from the primary contextual function categories. Two new variables were created. One called "range" was created by subtracting the low point fundamental frequency from the high point fundamental frequency. Mean fundamental frequency was derived by taking the mean of the range.

Statistical Analysis

Two-way and three-way ANOVA procedures were used for statistical analysis of the data. The following relationships between contextual function and specific acoustical correlates of intonation were examined for each child:

1) Contextual function and final contour direction,
2) Contextual function and mean fundamental frequency,
3) Contextual function and fundamental frequency range,
4) Contextual function and peak fundamental frequency,
5) Contextual function and duration.

For all of the ANOVAS only the three most frequently used categories (called "common" categories from now on) were used. For the other categories, there were instances where a specific time and child had only a few or no cases in a cell and did not meet a criterion for productivity discussed in the following chapter. Hereafter, results will always be reported as being from the "common" categories or from "all" the categories.

For final contour direction, proportions of rises for the common categories underwent an arc sine transformation so that the proportions would meet the distributional assumptions of analysis of variance. Then two-way ANOVAS were performed using the transformations to see if there were significant differences and interactions among contextual function categories, children and times.

In order to have an equal number of cases in each cell for an analysis of contextual function and its relationship to mean fundamental frequency, peak fundamental frequency, fundamental frequency range, and duration, the data were truncated at random. That is, for each of the common contextual function categories, for each child and each time, nine cases were chosen at random from the total number in that category for the three-way analysis of variance.

CHAPTER THREE

RESULTS

This chapter reports results of analyses of the interdependence between contextual functions and several different elements of the fundamental frequency contour over time (final contour direction, mean fundamental frequency, peak fundamental frequency, fundamental frequency range and duration). A contextual function category was considered productive if during a taping session for each child the category was used at least five times. This criterion is based on the content/form interaction assessments used by Bloom, 1970, and Bloom, Lifter and Hood (1974).

Using this criterion, three of the ten contextual function categories in the study were productive for all of the children; the request (RQ), response to or following a question (RESP), and the general comment (COMM) categories. For child AL, there were a total of six productive categories; for AB five were productive; and for RS four were productive. Table 3.1 shows the number of times a contextual function category was used for each child during each time. The categories productive for each child are in bold face. There were two categories (COM/RQ and ATTENT) that could not be investigated over time for any child since they did not meet the criterion for productivity over all three times. Some categories will be presented later on in

Table 3.1

Number of Contextual Function Cases in Each Cell

Child and Time	Contextual Function	RQ	RESP	COMM	GIVE	RQINFO	NAME	PRO	ATTENT	PERS	COM/RQ
AL	T_1	46	21	50	24	9	23	-	5	2	-
	T_2	11	34	52	8	7	25	2	14	8	-
	T_3	45	42	29	8	27	6	12	-	-	10
AB	T_1	11	13	78	-	-	-	9	1	37	-
	T_2	12	14	71	3	2	9	17	-	12	5
	T_3	9	15	54	-	17	55	5	11	10	11
RS	T_1	47	17	59	3	-	1	21	7	12	2
	T_2	27	25	62	2	1	5	34	3	1	9
	T_3	19	68	31	-	25	1	36	4	-	10
Total/Child											
	AL	102	97	131	40	43	54	14	19	10	10
	AB	32	42	203	3	19	64	31	12	59	16
	RS	93	110	152	5	26	7	91	14	13	21
Times											
	1	104	51	187	27	9	24	30	13	51	2
	2	50	73	185	13	10	39	53	17	21	14
	3	73	125	114	8	69	62	53	15	16	31
All Data		227	249	486	48	88	125	136	45	82	47

BOLD = Categories considered productive for each child

T_1 = Time 1

T_2 = Time 2

T_3 = Time 3

\- = Category not productive at this time this chapter since there were consistencies that existed within a child and among children once the category became productive for an individual time.

For the statistical analysis of the data, only the three categories that were productive for all of the children were used (RQ, RESP, COMM). Following this initial statistical analysis, a proportional analysis of the productive categories for each individual child will be presented in the discussion of final contour direction.

The section of this chapter that deals with the other elements of the intonation contour (mean, peak, range, and duration) will include a statistical and graphic analysis of the three common contextual function categories. It will be followed by a graphic analysis of all ten contextual function categories using all the data. The criterion for productivity will not apply here since mean group data only are being reported and no attempt has been made to make any hypothesis about these results over time for each child.

Because of the small number of children in the study, no attempt will be made to generalize the results to the entire population, although using three children will allow discussion about some variation among the children.

Table 3.2 gives the abbreviations of the contextual function categories used on all the following graphs. In the text, the categories will be referred to by name and

Table 3.2

<u>Contextual Function Category Abbreviations</u>

RQ	=	Request
RESP	=	Response to a question following a question
COMM	=	General comment
GIVE	=	Give
RQ INFO	=	Request to gain and clarify information
NAME	=	Name
PRO	=	Protest
PERS	=	Personal comments
COM/RQ	=	Command/request
ATTENT	=	Call attention to something

abbreviations. The graphs and tables will only include the abbreviations.

Final Contour Direction

Statistical Analysis of the Common Categories

As mentioned in the previous chapter, an arc sine transformation was performed on the proportional use of rises allowing a TWO-WAY analysis of variance to be performed on the data. Results as shown in Table 3.3, indicated that the main effect of contextual function on the use of rises was highly significant ($p<.001$). There was also a significant main effect for child ($p<.005$) but no significant main effect for time. No significant interactions were found between child and contextual function, tape and contextual function or tape and child.

Figure 3.1 illustrates the proportional use of rises for specific contextual functions over time. It appeared that the children used final contour direction (rise vs. non-rise) differentially based on the contextual function of the utterance. The children used rises much more frequently for the request (RQ) category than for the response to or following a question (RESP) or the general comment (COMM) categories. The use of rises was not significantly different from the prelinguistic stage (Time 1) through the early linguistic period (Time 3). Thus,

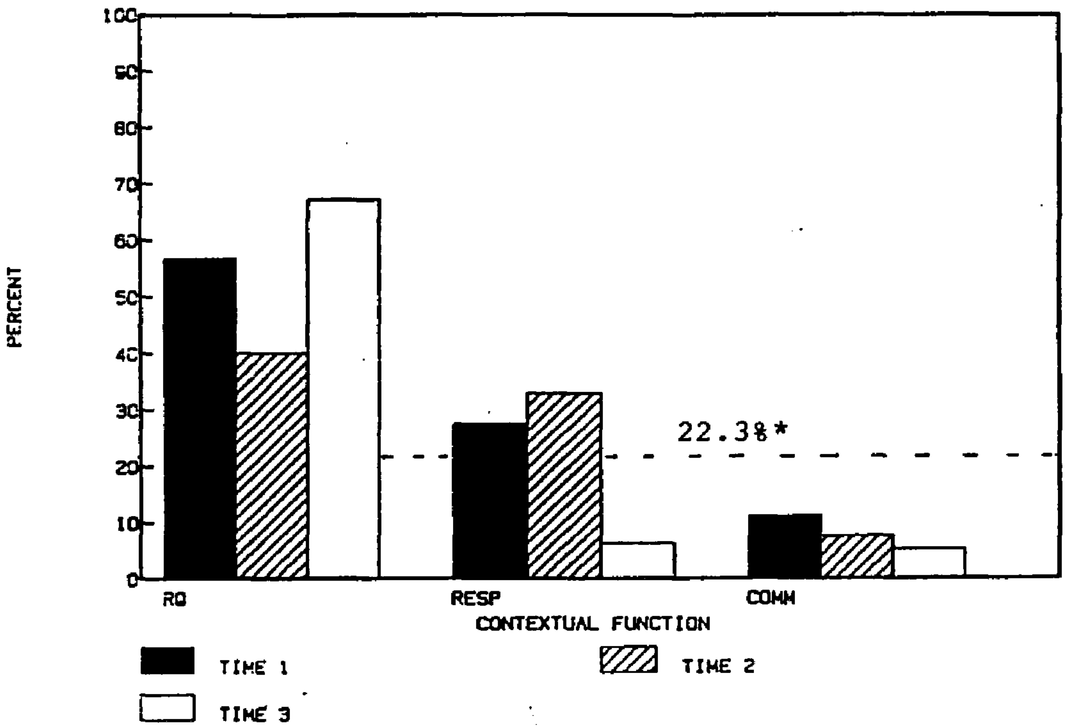
Table 3.3

Analysis of Variance of Final Contour Direction

by Contextual Function, Time and Child

SOURCE	SUM OF SQUARES	df	MEAN SQUARE	F	SIG. OF F
MAIN EFFECTS	3.874	6	0.646	20.852	0.000
Contextual Function	2.492	2	1.246	40.238	0.000*
Time	0.089	2	0.045	1.439	0.293
Child	1.293	2	0.647	20.879	0.001*
TWO-WAY INTERACTIONS	0.880	12	0.073	2.368	0.114
Contextual Function/ Time	0.209	4	0.052	1.688	0.245
Contextual Function/ Child	0.409	4	0.102	3.302	0.071
Time/ Child	0.262	4	0.065	2.113	0.171
EXPLAINED	4.754	18	0.264	8.529	0.002
RESIDUAL	0.248	8	0.031		
TOTAL	5.002	26	0.192		

* = $p < .005$



<u>Figure 3.1</u> Proportional use of rises over time for the three common contextual function categories

*=mean percent rises used by all children for the three common contextual function categories

there is no support for the hypothesis that final contour direction changed with time.

Proportional Results for the Productive Categories

Individual Patterns

Table 3.4 shows the percent rises used by each child for the productive contextual function categories. The percentages in parentheses () are those catetories that were partially productive during individual times but did not meet the criterion for productivity over all three times. A brief discussion of these categories will be included following this section entitled "Other Patterns." Also available in the table is each child's mean use of rises.

Figure 3.2 illustrates the percentage of rises for the six productive contextual function categories for AL during each time. AL used a much higher overall proportion of rises than the other children (54%). Consistencies can be seen in his use of rises over time for the request (RQ), GIVE, and request for information (RQINFO) categories. At the same time he consistently used non-rises for the general comment (COMM) category. His initially higher use of rises for the response to or following a question (RESP) category is related to his differential response to yes/no questions. During Time 1, 67% of the RESP category consisted of

Table 3.4

Percent Rises of the Productive Categories for Each Child

Child and Time		Contextual Function										Overall Rises
		RQ	RESP	COMM	GIVE	RQINFO	NAME	PRO	ATTENT	PERS	COM/RQ	
	T_1	91.3	61.9	22.0	91.7	100.0	91.3		(100.0)			
AL	T_2	81.8	61.8	9.6	75.0	85.7	52.0		(7.1)	(12.5)		54.2
	T_3	82.2	7.1	6.9	87.5	88.9	33.3	(16.7)			(0.0)	
	T_1	45.5	7.7	9.0				11.1		10.8		
AB	T_2	66.7	7.1	8.5				23.5		8.3	(0.0)	13.6
	T_3	55.6	0.0	5.6		(47.1)	(12.7)	80.4	(0.0)	0.0	(0.0)	
	T_1	25.5	0.0	5.1				23.8	(14.3)	(0.0)		
RS	T_2	11.1	8.0	4.8			(0.0)	5.9			(0.0)	11.7
	T_3	36.8	7.4	3.2		(80.0)		25.0			(0.0)	

*Criterion for productivity: > or = 5 cases per cell for each time

( ) = percent rises for categories that were productive for individual times but not considered for graphic analysis since they did not meet criterion for productivity over all three times.

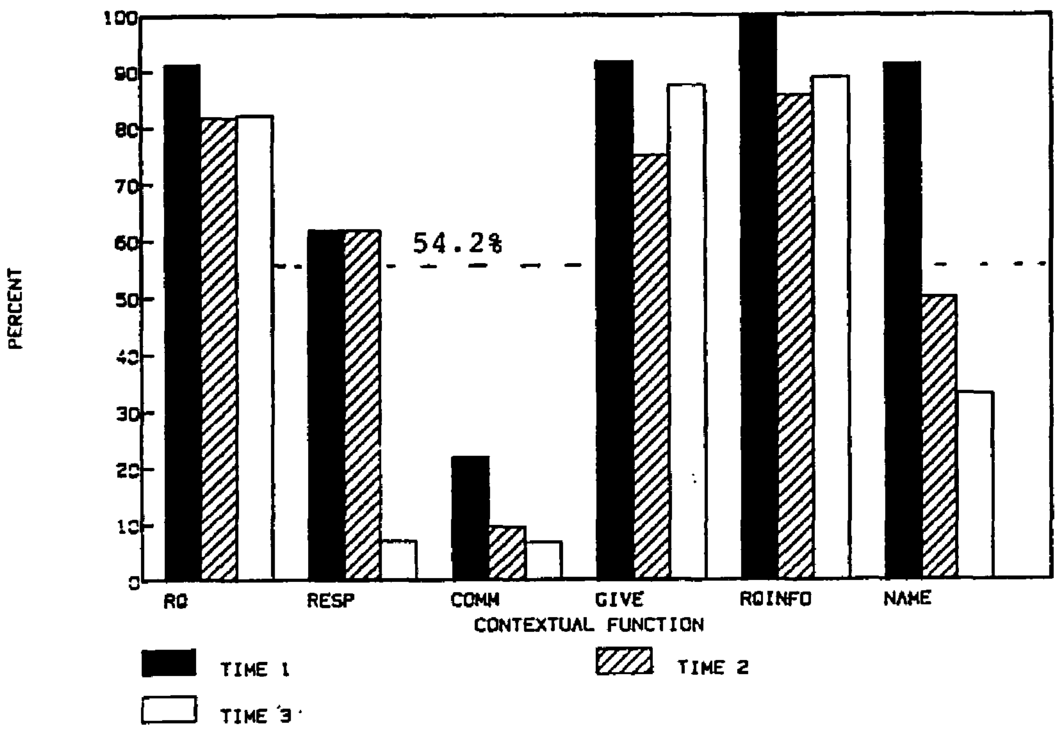


Figure 3.2 Proportional use of rises for Child AL for his productive contextual function categories

*=mean percent rises for AL's productive categories

responses to yes/no questions which were predominantly rises. This behavior decreased markedly by Time 3 where he began to use predominantly non-rises to respond to other's questions. At the same time the number of yes/no responses decreased to 29% and were predominantly non-rises. The NAME category also began with a rise and slowly fell to predominantly a non-rise by Time 3. This initial use of a rise for naming (NAME) has been cited in the literature (Pike, 1944) and will be discussed in the following chapter.

Figure 3.3 illustrates AB's use of rises for all three times for her productive categories. She consistently used predominantly rises for the request (RQ) category and non-rises for the response to or following a question (RESP), general comment (COMM) and personal comment (PERS) categories. The protest (PRO) category progressively changed form a non-rise to a rising final contour. This can be explained by the change in protesting behavior. Initially most of her protests were long in duration and flat in contour. They later changed to a simple short "no" that had a final rise.

RS used the least amount of rises of all three children (11.7%) and appeared to be the least consistent in her use of rises. Figure 3.4 illustrates this use. More rises were used in the requests (RQ) and protests (PRO) categories than the response to or following a question (RESP) or general

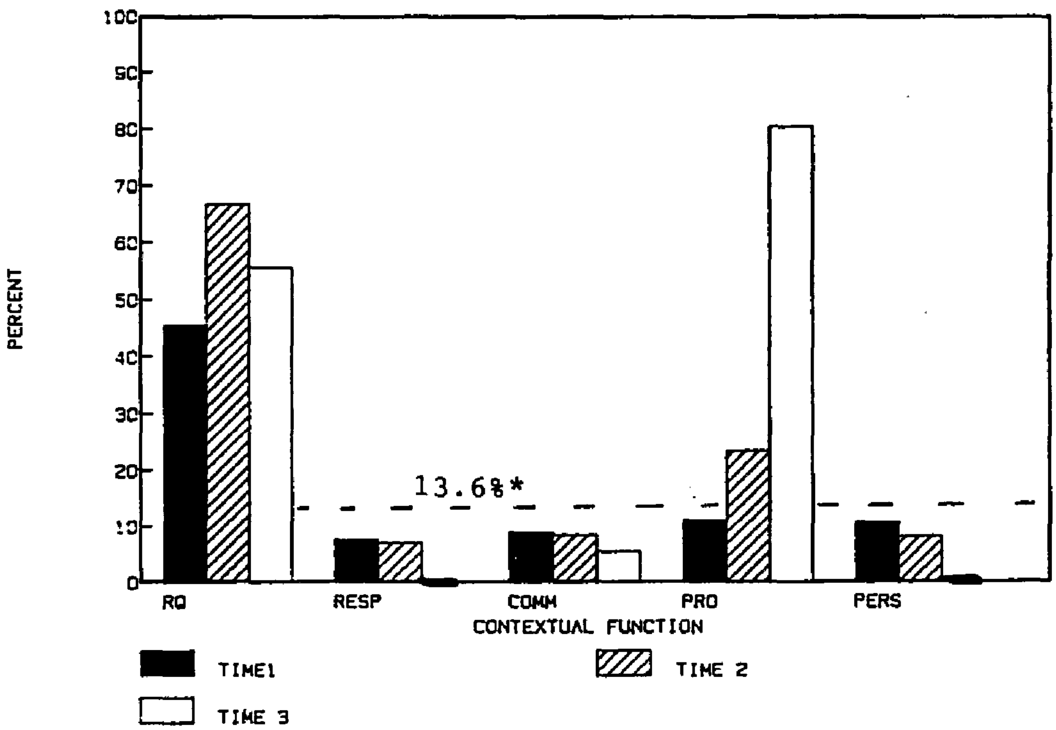


Figure 3.3 Proportional use of rises for Child AB for her productive contextual function categories

*=mean percent rises for AB's productive categories

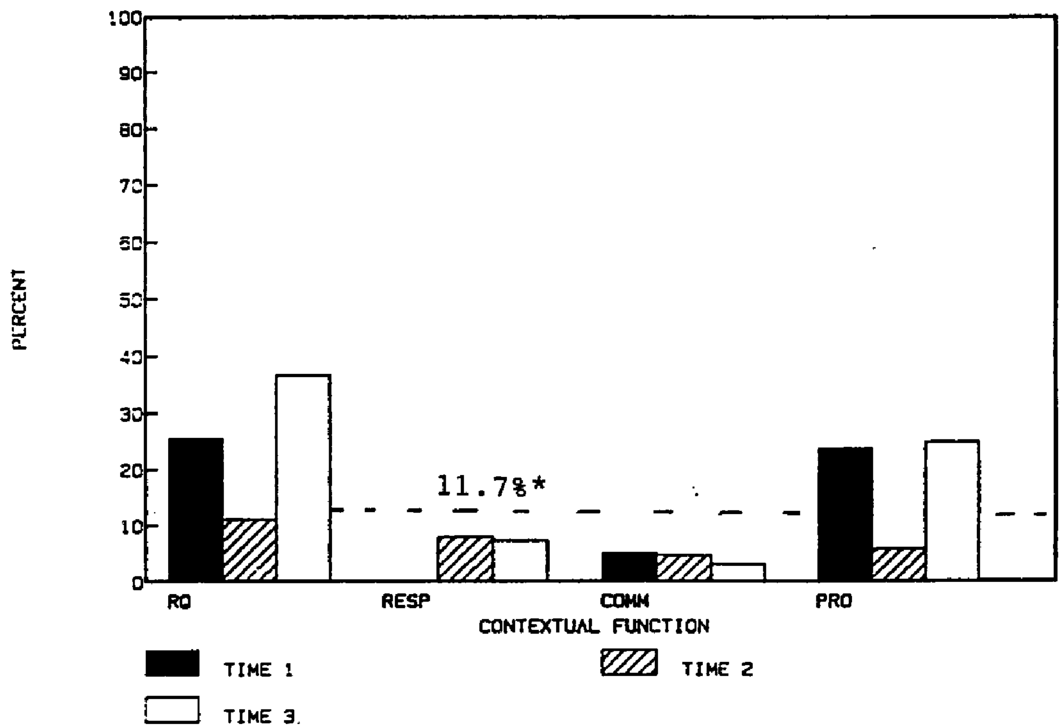


Figure 3.4 Proportional use of rises for Child RS for her productive contextual function categories

*=mean percent rises for RS's productive categories

comment (COMM) categories. Yet in both these categories (RQ and PRO) there was a tendency to decrease the number of rises during Time 2. Although the command/request (COM/RQ) category could not be used in analysis since it was not productive in all three times, it was productive during Time 2. It is possible that many of RS's requests may have resembled command/requests (COM/RQ) during this time but were categorized as requests (RQ) based on the contextual function definitions. The response to or following a questions (RESP) and the general comment (COMM) categories were fairly stable in their use of non-rises.

In summary, there is evidence that all the children used rises in the same relationship for all three productive categories, although they differed in their proportions of rises versus non-rises.

AL demonstrated consistency over time in his use of rises for requests (RQ), GIVE, requests for information (RQ/INFO) and consistency in his use of non-rises for general comments (COMM). AB was fairly consistent over time in her use of rises for requests (RQ) and use of non-rises for response to or following a question (RESP), general comments (COMM), and personal comments (PERS). RS demonstrated consistency in her use of non-rises over time for the response to or following a question (RESP) and general comment (COMM) categories.

There was variability among the children in their overall use of rises. AL used many more rises than the other two children for all categories. Such variability has been reported in many aspects of language development.

These data provide evidence that some consistencies exist in the use of rises for specific contextual function categories and in some cases these consistencies do not change over time.

Other Patterns

There were some contextual functions categories that did not meet the criterion for productivity over all three times but were worth noting because of their consistencies within one time or over two times. For instance, according to Table 3.4, the command/request category demonstrated a great deal of consistency. Although not produced by all children, all times, it was consistently produced with a non-rise by all children when used. In addition, AL used primarily non-rises for the protest category (Time 3) and personal category (Time 2). AB used primarily a non-rise for naming (Time 3) and all non-rises for calling attention to something (Time 3). RS produced primarily rises for the request for information category (Time 3) and used primarily non-rises for naming (Time 2) and personal comments (Time 1).

Other Elements of the Intonation Contour

In this section the data on mean fundamental frequency, peak fundamental frequency, fundamental frequency range and duration will be reported in relationship to the contextual function categories. Statistical analyses of the three common categories will be presented followed by an analysis of all the categories.

Even though results for each one of these elements will be discussed separately, one might expect there to be some interdependence among some of the variables. An intercorrelational matrix was performed on the common categories as well as on all of the data. The results are available in Tables 3.5 and 3.6. As evidenced in both tables, there was a high correlation between mean fundamental frequency and peak fundamental frequency, and between peak fundamental frequency and range and a moderate correlation between mean fundamental frequency and range. Low but significant correlations were found for other variables.

Since mean, peak, and range were correlated their results will be discussed together. Duration was not highly correlated with any of these variables and will be discussed separately.

At the end of this section, overall means and standard deviations are presented. These data, although not directly

Table 3.5

Correlation Coefficients of the Intonation Variables Of the Three Common Contextual Function Categories

	Mean Fo	Peak Fo	Fo Range	Duration
Mean Fo	---	.94*	.57*	.12
Peak Fo		---	.82*	.19*
Fo Range			---	.26*
Duration				---

* = P < .01.

Table 3.6
Correlation Coefficients of the Intonation Variables for all of the Data*

	Mean Fo	Peak Fo	Fo Range	Duration
Mean Fo	---	.91	.37	.09
Peak Fo		---	.79	.12
Fo Range			---	.22
Duration				---

* - all correlations significant at .001.

related to the issues of this paper, are valuable in discussing variability in fundamental frequency during the second year of life.

Mean, Peak and Range

Mean fundamental frequency

Statistical analysis of the common categories

A three-way analysis of variance of mean fundamental frequency by contextual function, child and time revealed a main effect for contextual function ($p<.001$) and a significant interaction of child and time ($p<.001$)(See Table 3.7). Although, the mean fundamental frequency of the children's vocalizations differed based on the contextual function, there was no significant change over time (prelinguistic through early linguistic) or across children.

Figure 3.5 illustrates the changes over time for mean fundamental frequency of the three common categories for all children. Since there was an interaction of time and child, a post-hoc analysis using pooled error variance was performed and revealed that the effect of time was significant for AL [$F(2,839) = 15.17$, $p < .001$] and AB [$F(2,839) = 8.18$, $p < .001$] but not for RS. Figure 3.5a illustrates the mean fundamental frequency of each child for each contextual function at each time. For AL there was a general decrease in fundamental frequency over time as one

Table 3.7

Analysis of Variance of Mean Fundamental Frequency By Contextual Function, Time and Child

SOURCE	SUM OF SQUARES	df	MEAN SQUARE	F	SIG. OF F
MAIN EFFECTS	27808970.45310	1	27808970.45370	8867.95	0.0000
Contextual Function	84867.13580	2	42433.56790	13.53	*0.0000
Time	14453.45062	2	7226.72531	2.30	0.1023
Child	1083.19136	2	541.59568	0.17	0.8415
TWO-WAY INTERACTIONS					
Contextual Function/ Time	14279.96914	4	3569.99228	1.14	0.3393
Contextual Function/ Child	10535.45062	4	2633.86265	0.84	0.5012
Time/ Child	99952.02469	4	24988.00617	7.97	*0.0000
THREE-WAY INTERACTION					
Contextual Function/ Time/ Child	49869.62963	8	6233.70370	1.99	0.0592
ERROR	677353.94444	216	3135.89789		

* = p < .001

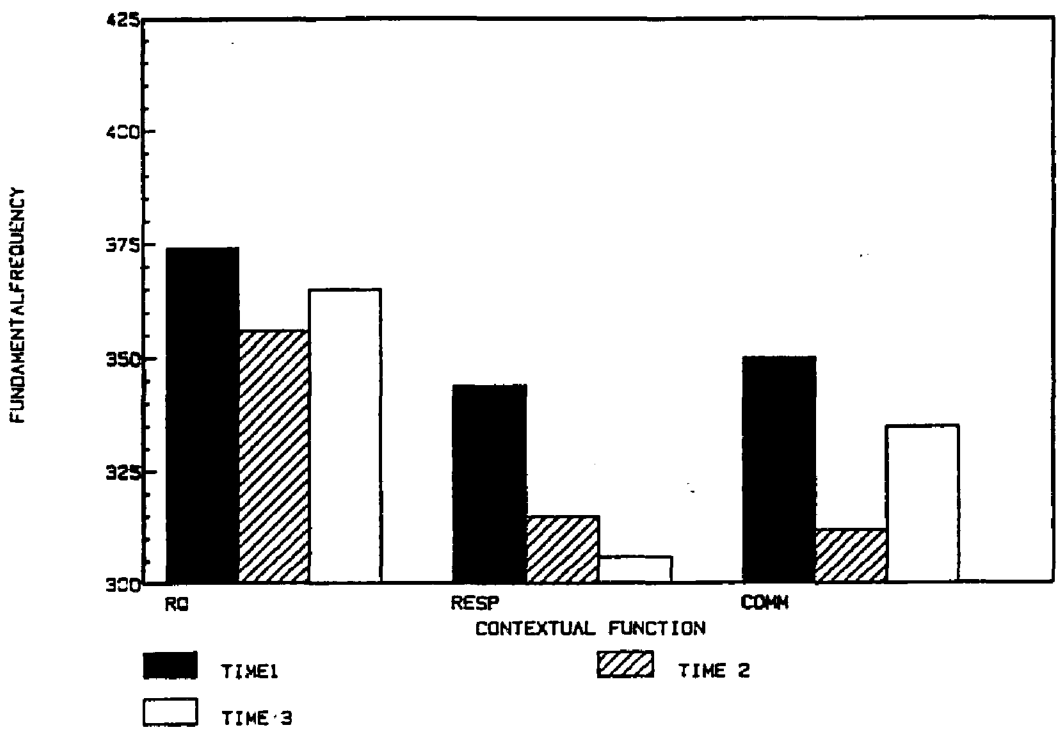


Figure 3.5 Mean fundamental frequency by time for the three common contextual function categories

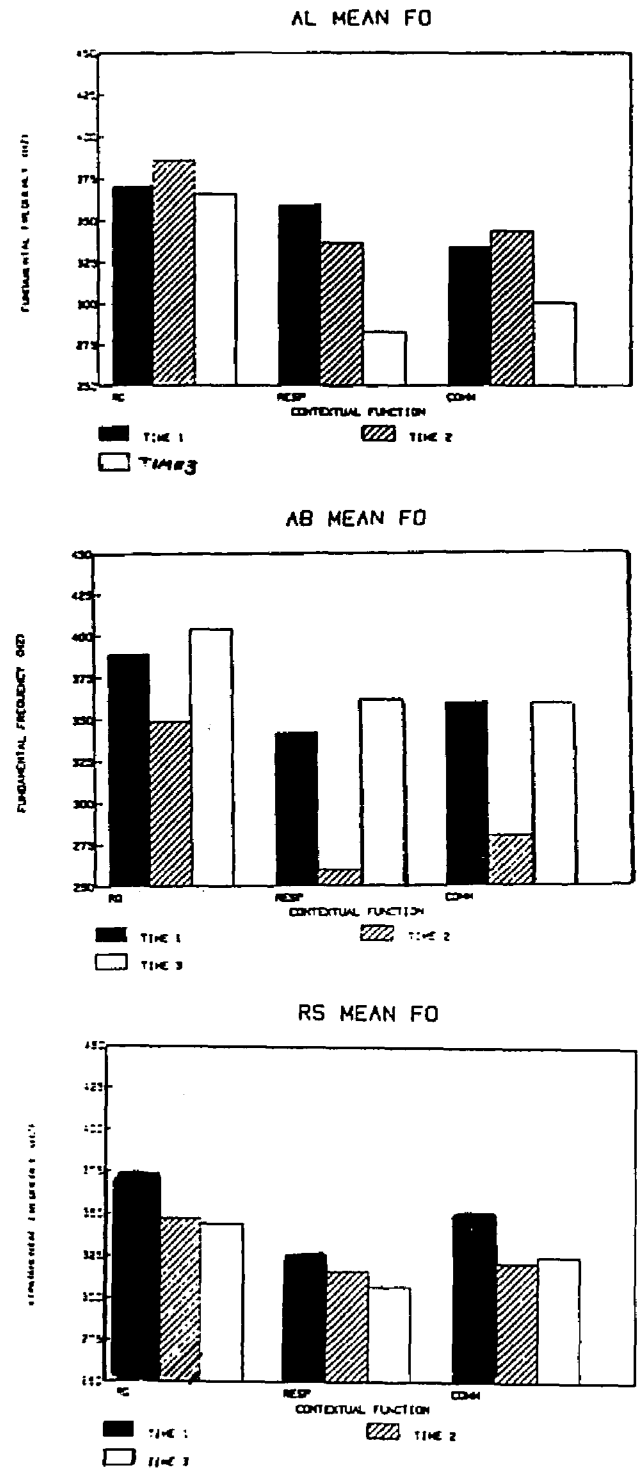


Figure 3.5a Mean fundamental frequency by time for individual children

might expect from overall maturation of the larynx. This, however, was not the case for AB where here lowest mean fundamental frequencies were found during Time 2. Possible reasons for this drop in mean fundamental frequency could include the interaction of emerging single word utterances with fundamental frequency, variable use of language functions, or it might very well have been an artifact of unusual vocal behavior or affect during just this one taping session. Resolution of these possible explanations would require further investigation and will be discussed in the following chapter.

Analysis of all the contextual function categories

Figure 3.6 illustrates the mean fundamental frequency over all children and taping sessions for all contextual function categories. It can be seen that some contextual function categories are different from others and different from 348 Hz. which was the mean fundamental frequency over all the data.

It appears that categories with emotional content such as protests (PRO) and calling attention to something (ATTENT) have a higher mean fundamental frequency. Response to or following a question (RESP) is of a lower fundamental frequency; many utterances in this category were yes/no responses with little emotional content. Likewise, personal comments (PERS) required no interaction with another person

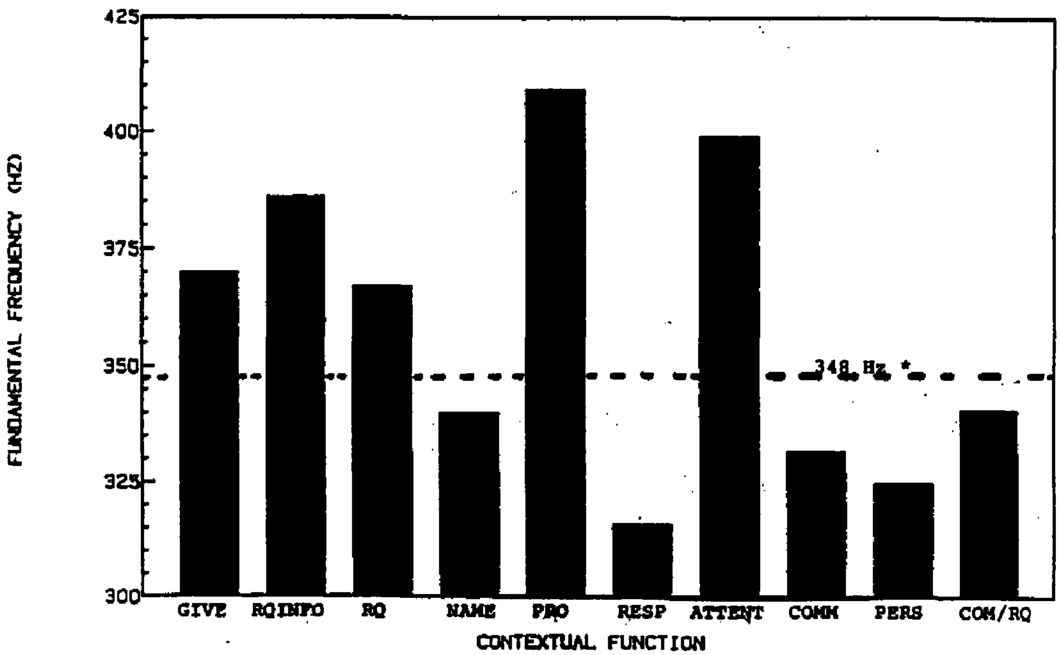


Figure 3.6 Mean fundamental frequency of all contextual function categories for all children all times

*= mean fundamental frequency of all contextual function categories

and were of lower fundamental frequency.

Peak fundamental frequency

Statistical analysis of the common categories

As with mean fundamental frequency, peak fundamental frequency results reflected a main effect for contextual function ($p < .001$), and a significant interaction of child and time. The ANOVA results are available in Table 3.8.

It appears that the children produced discriminably different peak fundamental frequencies for different contextual functions. Figure 3.7 shows the mean peak fundamental frequencies over the three times. From this figure, one can see the differences in the contextual functions with the response category having the lowest peaks.

As with mean fundamental frequency, a post-hoc analysis was performed on peak fundamental frequency to investigate the child/time interaction. Pooled error variance was used again and revealed similar results. The effect of time was significant for AL [$F(2,839) = 29.52$, $p < .001$], and AB [$F(2,839) = 6.06$, $p < .005$], but not significant for RS.

Figure 3.7a illustrates the peak fundamental frequency of each child for each contextual function at each time. As with mean fundamental frequency, AL's graph illustrates more of a descending pattern (although Time 2 is somewhat erratic), while AB's graph illustrates a less consistent

Table 3.8

Analysis of Variance of Mean Peak Fundamental Frequency By Contextual Function, Time and Child

SOURCE	SUM OF SQUARES	df	MEAN SQUARE	F	SIG. OF F
MAIN EFFECTS	38269614.63374	1	39269614.63374	5805.79	0.0000
Contextual Function	202299.66255	2	101149.83128	15.35	*0.0000
Time	11632.15638	2	5816.07819	0.88	0.4153
Child	15355.76132	2	7677.88066	1.16	0.3139
TWO-WAY INTERACTIONS					
Contextual Function/ Time	21517.39918	4	5379.34979	0.82	0.5161
Contextual Function/ Child	19901.72016	4	4975.43004	0.75	0.5558
Time/ Child	261030.93004	4	65257.73251	9.90	*0.0000
THREE-WAY INTERACTIONS					
Contextual Function/ Time/ Child	78654.62551	8	9831.82819	1.49	0.1616
ERROR	1423793.11111	216	6591.63477		

* = $p < .001$

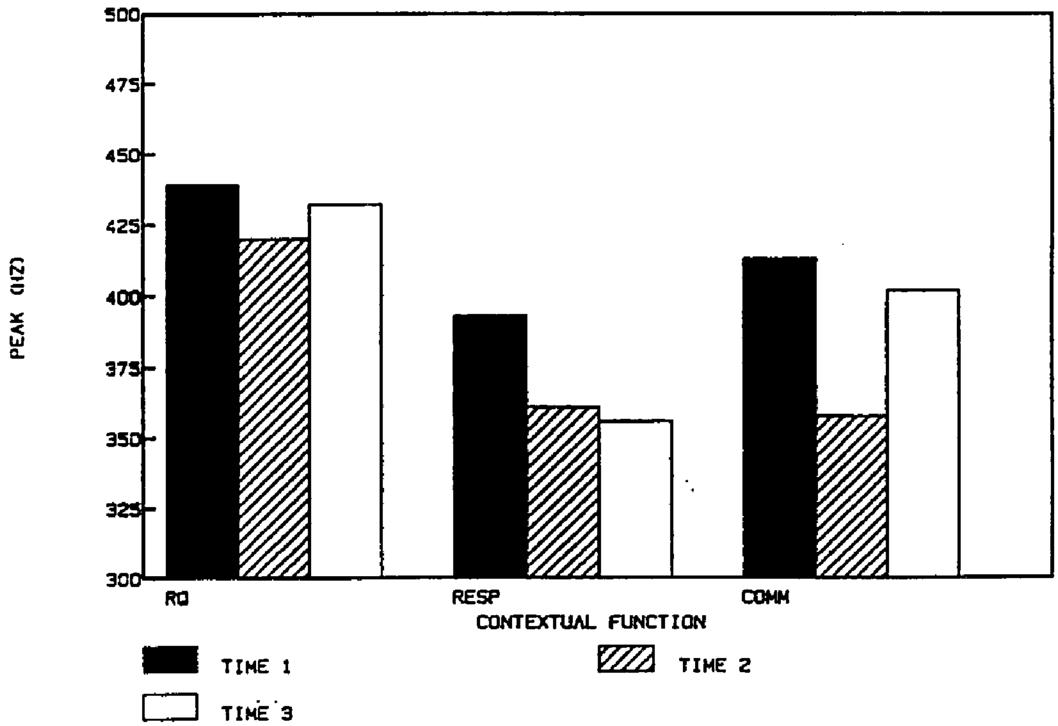


Figure 3.7 Mean peak fundamental frequency by time for the three common contextual function categories

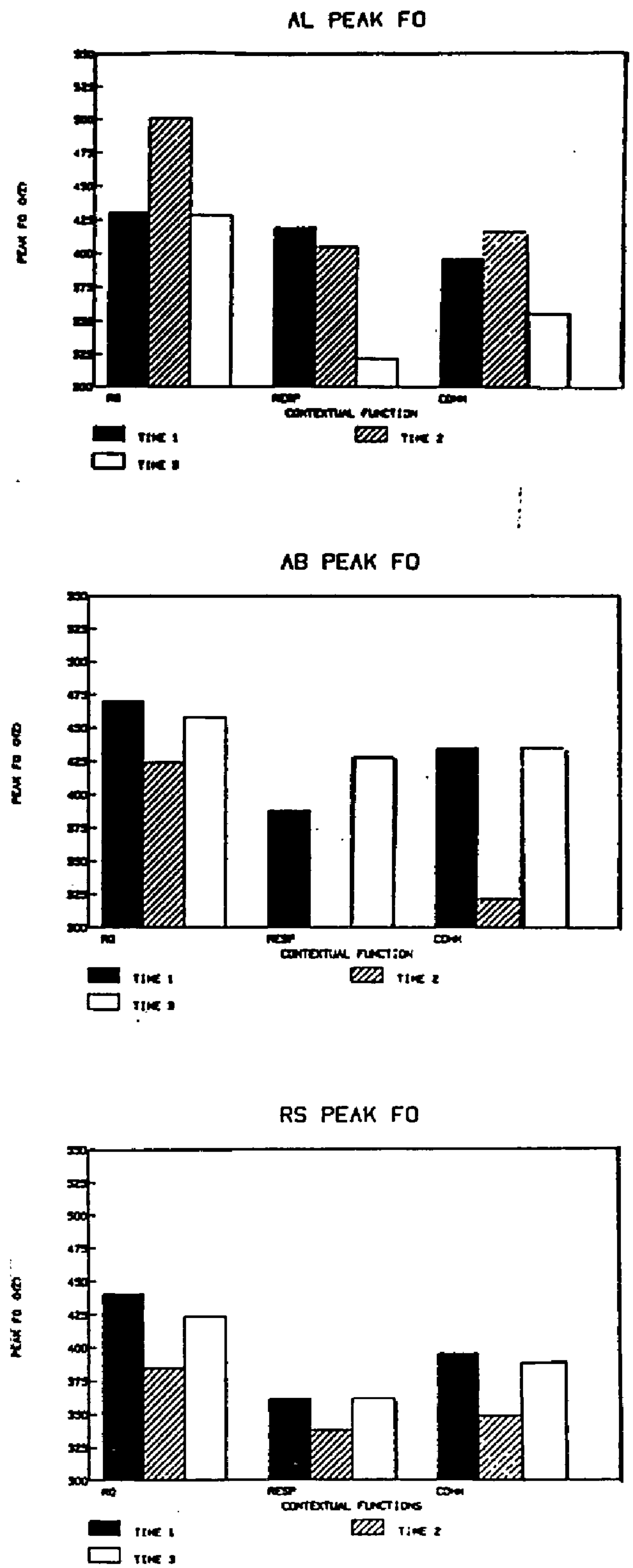


Figure 3.7a Mean peak fundamental frequency by time for individual children

pattern. As before, further discussion is needed to investigate what role the emergence of single words, the variable use of functions and the possibility of sampling behavior plays in this unusual pattern.

Analysis of all the contextual function categories

Figure 3.8 illustrates the mean peak fundamental frequency over all children and times for all 10 contextual function categories. There are some very visible differences in peak for specific contextual function categories. As with mean fundamental frequency, those categories which are associated with higher affect (the protest (PRO) and calling attention to (ATTENT) categories) have a much higher peak fundamental frequency than the other categories. Likewise, categories such as response to or following a question (RESP), name, and personal comments (PERS) which had a lower peak fundamental frequency usually do not have as much emotional force behind them.

Fundamental frequency range

Statistical analysis of the common categories

Like the prior analyses of fundamental frequency and peak fundamental frequency, a main effect for contextual function ($p<.001$) and a significant interaction of child and time ($p<.001$) was found. Unlike the other analyses, there was also a main effect for child ($p<.05$).

Since range was correlated with both mean and peak one

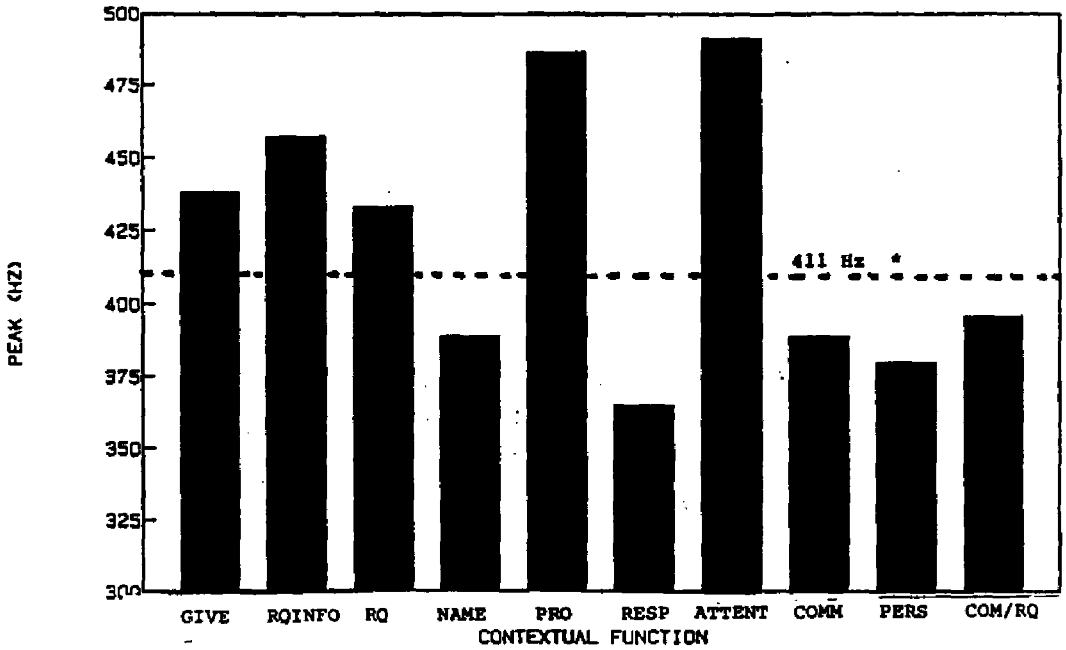


Figure 3.8 Mean peak fundamental frequency for all contextual function categories for all children and all times

*= mean peak fundamental frequency of all contextual function categories

might expect the same types of significant differences. A possible explanation of a significant main effect for child might be that although all children were similar in their average use of mean fundamental frequency and peak, they may have differed in the amount of range within an utterance to achieve these means and peaks. For example, one child might have utterances with basically higher fundamental frequencies and peaks throughout the utterance which would increase mean and peak results but reduce range. Another child might have a great deal of exaggerated contouring which might increase range but might contain more level means or peaks.

Figure 3.9 illustrates the range of the three common categories over time. Although there were significant differences among the contextual function categories, they were not as pronounced graphically as they were in the analysis of mean and peak.

Because of the child/time interaction, a post-hoc analysis using pooled error variance was performed and revealed that the effect of time was significant for p < [$F(2,839) = 43.5$, $p < .001$] and RS [$F(2,839) = 15.55$, $p < .001$] but not for AB.

By looking at Figure 3.9a one can see no clear cut descending pattern of range for AL or RS as one might expect from normal physical maturation of the larynx. Again, as

Table 3.9

Analysis of Variance of Mean Fundamental Frequency Range By Contextual Function, Time and Child

SOURCE	SUM OF SQUARES	df	MEAN SQUARE	F	SIG. OF F
MAIN EFFECTS	3332982.22634	1	3332982.22634	633.58	0.0000
Contextual Function	118489.90947	2	59244.95473	11.26	*0.0000
Time	1445.19342	2	722.59671	0.14	0.8717
Child	36704.94650	2	18352.47325	3.49	*0.0323
TWO-WAY INTERACTIONS					
Contextual Function/ Time	16517.52263	4	4129.38066	0.78	0.5360
Contextual Function/ Child	14947.99177	4	3736.99794	0.71	0.5856
Time/ Child	217514.93004	4	54378.73251	10.34	*0.0000
THREE-WAY INTERACTIONS					
Contextual Function/ Time/ Child	46456.27984	8	5807.03498	1.10	0.3617
ERROR	1136278.00000	216	5260.54630		

* = $p < .05$

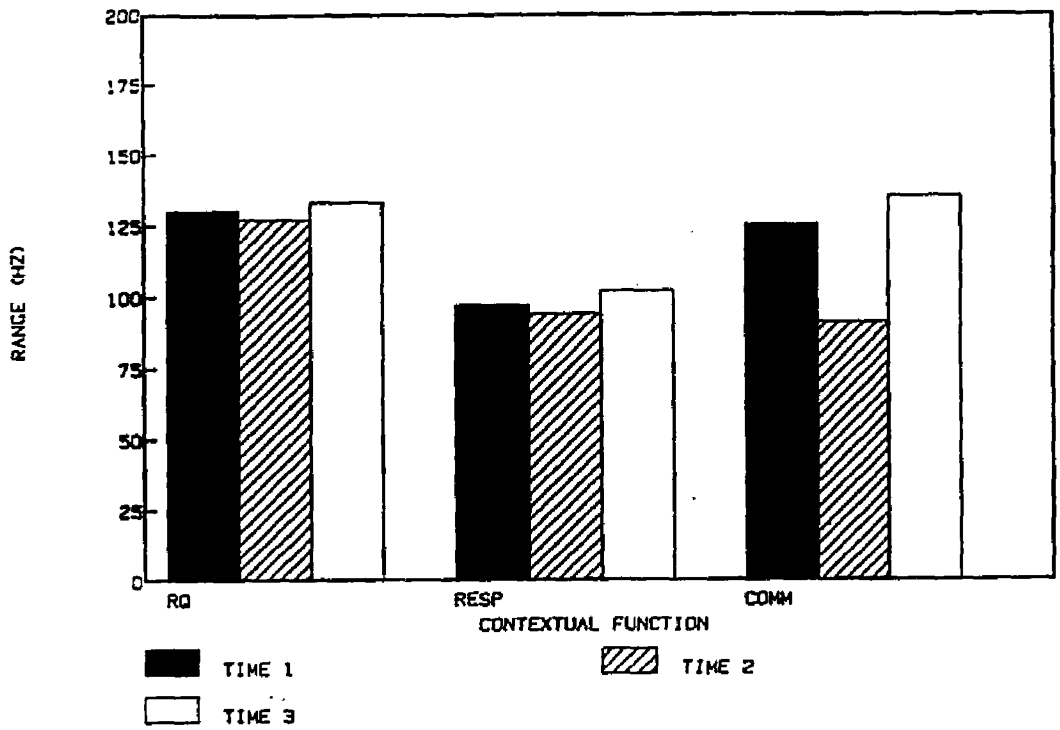


Figure 3.9 Mean range by time for the three common contextual function categories

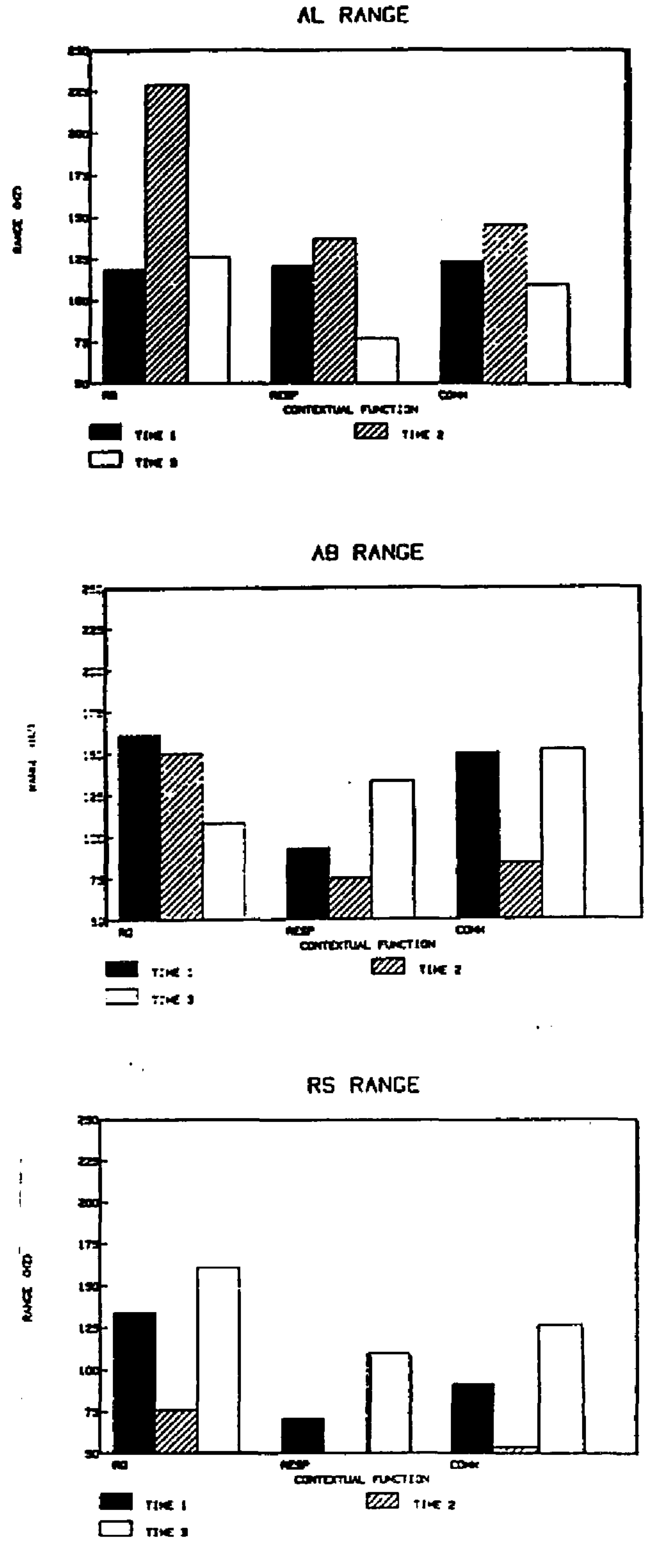


Figure 3.9a Mean range by time for individual children

with mean and peak other causes for these types of patterns will be discussed in the following chapter.

Analysis of all the contextual function categories

Figure 3.10 illustrates the mean fundamental frequency range of all 10 contextual function categories. Although many of the categories seem to hover close to the mean (125 Hz.) the response to or following a question (RESP) appears considerably lower and the calling attention to (ATTENT) seems notably higher. Remembering the lower peak and mean fundamental frequencies for the RESP category and the fact that mean, peak and range are correlated, these results are not surprising. One might expect a higher fundamental frequency range for the ATTENT category since variation in intonation seems like a logical way to get someone's attention. Certainly, in the mother/child literature, variable contouring has been cited as a means of addressing a young child (Sachs, Brown and Salerno, 1976; Remick, 1971; Garnica, 1977). Likewise, one might expect less range for a response to a question since it was often a yes/no response or just a single word.

Duration

Statistical Analysis of the Common Categories

There was a significant main effect of duration for contextual function ($p < .001$), a significant two-way inter-

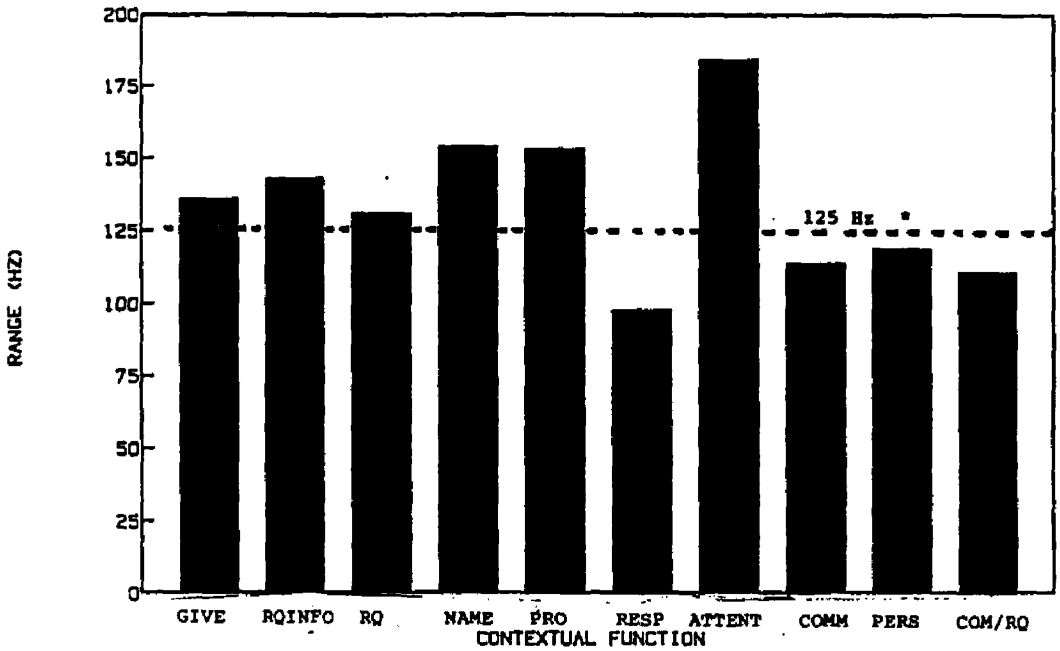


Figure 3.10 Mean range of all contextual function categories for all children all times

*= mean fundamental frequency range of all contextual function categories

Table 3.10

Analysis of Variance of Mean Duration By Contextual Function, Time and Child

SOURCE	SUM OF SQUARES	df	MEAN SQUARE	F	SIG. OF F
MAIN EFFECTS	69775413.04115	1	69775413.04115	450.55	0.0000
Contextual Function	4598205.93416	2	2299102.96708	14.85	*0.0000
Time	144845.95885	2	72422.97942	0.47	0.6271
Child	288514.37860	2	144257.18930	0.93	0.3955
TWO-WAY INTERACTIONS					
Contextual Function/ Time	784145.54733	4	196036.38683	1.27	0.2844
Contextual Function/ Child	998511.34979	4	249627.83745	1.61	0.1724
Time/ Child	2696873.25103	4	674218.31276	4.35	*0.0021
THREE-WAY INTERACTIONS					
Contextual Function/ Time/ Child	3004053.09465	8	375506.63683	2.42	*0.0158
ERROR	33451544.44444	216	154868.26132		

* = $p < .05$

action of child and time ($p<.005$) and a significant three-way interaction of contextual function, child and time ($p<.05$).

It is not surprising to find that durations differed over contextual functions, as well as in interactions with the other independent variables. Different amounts of jargon versus single words could be used during specific taping periods for different children and this would alter the duration of their utterances. Nor would one expect duration of utterances to be similar at different stages of linguistic development for different children. Prelinguistically, one child could use a great deal of lengthy jargon while another might use shorter utterances. Similarly, during the early linguistic period, one child might use only short single words while another may use a combination of jargon, presyntactic devices (Dore, et al., 1976) and single words. Figure 3.11 shows the differences in duration for the three common categories for each child. Overall, the general comment (COMM) category appeared to be the longest in duration while the response to or following a question (RESP) appeared to be the shortest.

Figures 3.12a, 3.12b, and 3.12c contain mean durations for each child during each time. AL appeared to have his shortest utterances in the RESP category. Earlier in the chapter it was reported that he had a great deal of yes/no

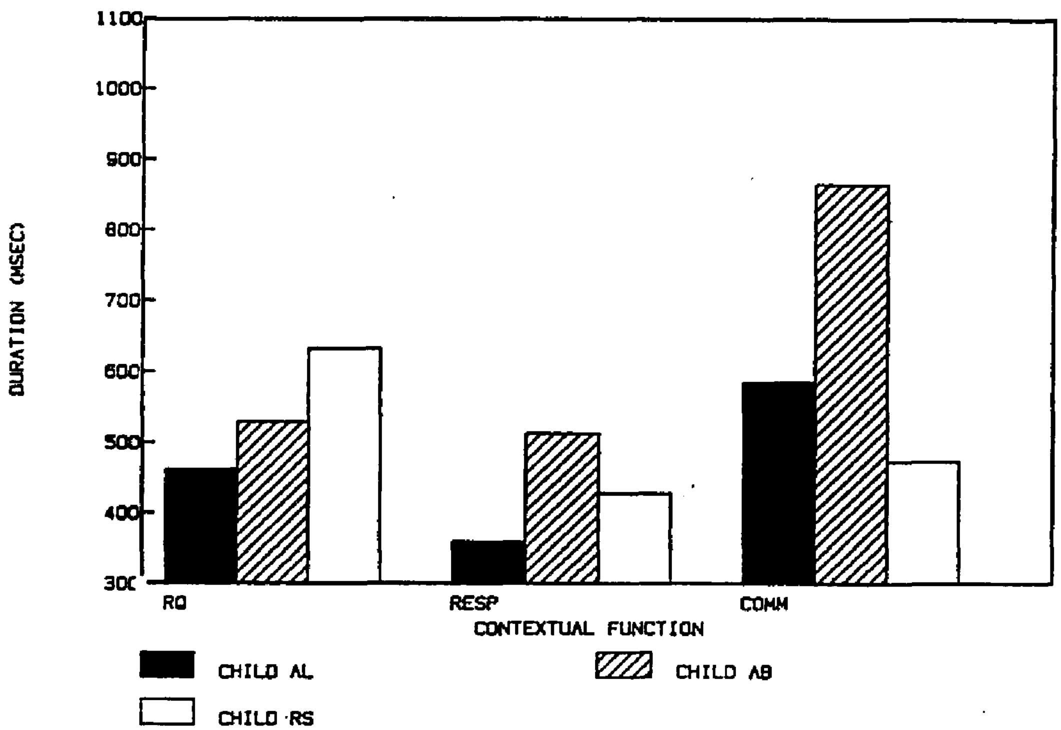
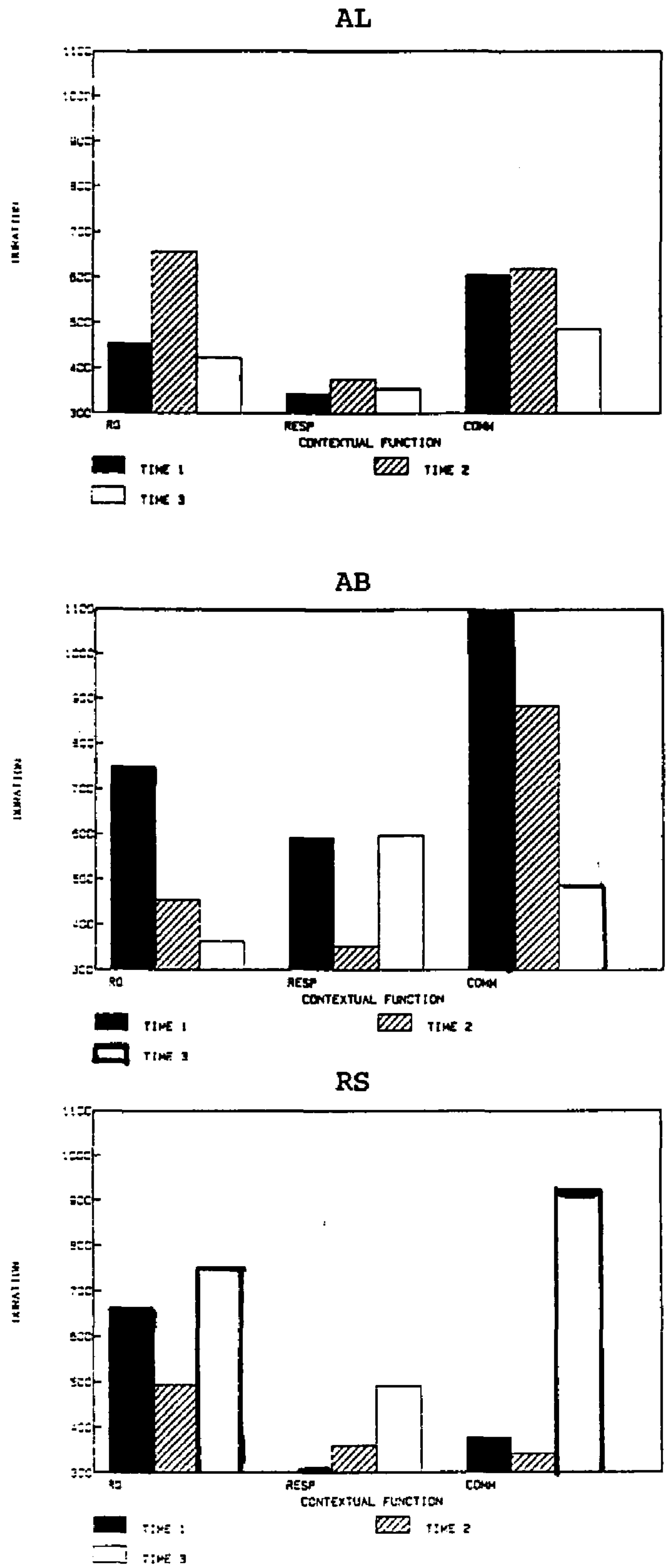


Figure 3.11 Mean duration of the three common contextual function categories for each child over all times



<u>Figures 3.12a, 3.12b, 3.12c</u> Mean duration for each child by time for the common contextual function categories

responses in this category and these yes/no responses might account for these very short durations. AB's (Fig. 3.12b) used a great deal of jargon in the general comment (COMM) category initially and this becomes evident here. For RS all categories appeared to increase in duration by Time 3. This might be attributed to her increased use of single words with presyntactic devices as well as two word phrases.

Analysis of all the contextual function categories

Figure 3.13 represents the differences in duration for all 10 contextual function categories. The GIVE and response to or following a question (RESP) categories appear much shorter in duration than the other categories. The GIVE category was usually a very brief utterance that signified an exchange of an item, something to the effect of "Take?" The RESP category was almost always either a yes/no response or a single word.

On the other hand, the PRO and PERS categories appear considerably longer than the others. The PRO category was one of high affect and were usually of longer duration. The PERS category included a great deal of jargon which often contained multiple syllables.

Tables 3.11a, 3.11b, 3.11c, and 3.11d present overall means and standard deviations of mean, peak, range and

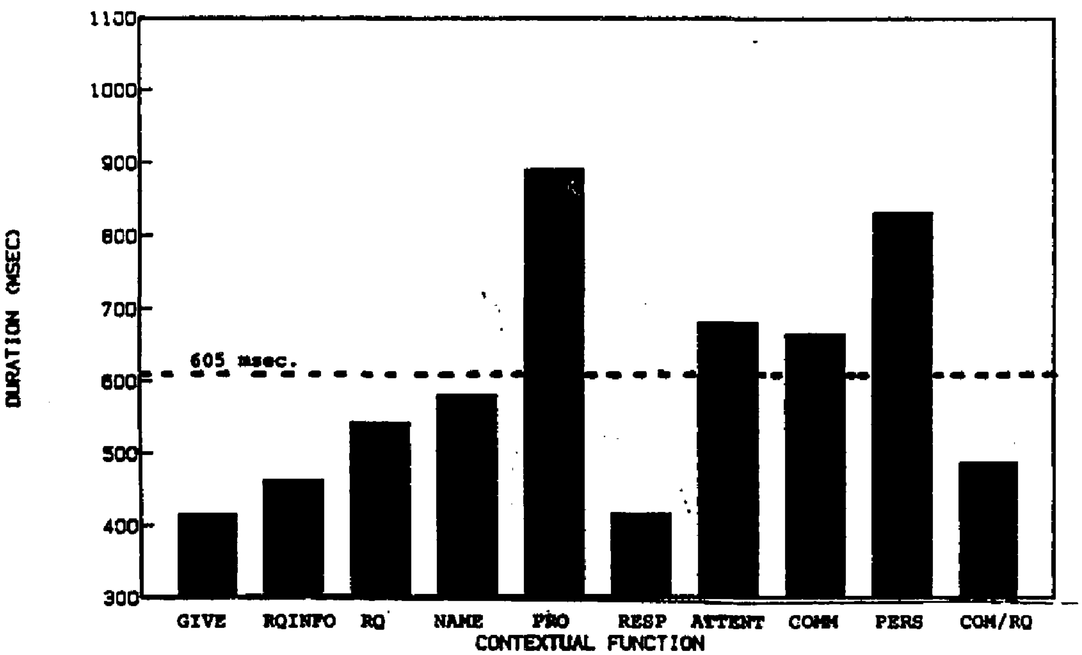


Figure 3.13 Mean duration of all contextual function categories for all children and all times

*= mean duration of all contextual function categories

Table 3.11a
Mean Fundamental Frequency for Each Child During Each Time

		Time 1	Time 2	Time 3	
Child	AL	**355** (50)	**368** (99)	**327** (53)	**350** (72)
	AB	**355** (79)	**300** (56)	**362** (70)	**341** (74)
	RS	**370** (64)	**350** (66)	**342** (69)	**354** (68)
		360 (65)	**341** (82)	**344** (66)	**348** (71)

Bold = Mean Fundamental Frequency in Hz.

( ) = Standard deviation

Table 3.11b
Peak Fundamental Frequency for Each Child During Each Time

		Time 1	Time 2	Time 3	
Child	AL	**419** (70)	**461** (159)	**382** (72)	**419** (111)
	AB	**423** (120)	**351** (79)	**431** (90)	**405** (103)
	RS	**427** (87)	**431** (90)	**412** (99)	**408** (91)
		423 (93)	**401** (122)	**408** (90)	**411** (102)

Bold = Mean Peak Fundamental Frequency in Hz.
( ) = Standard deviation

Table 3.11c

Mean Fundamental Frequency Range for Each Child During Each Time

		Time 1	Time 2	Time 3	
Child	AL	**127** (61)	**185** (129)	**108** (59)	**139** (93)
	AB	**137** (100)	**102** (63)	**139** (75)	**127** (82)
	RS	**113** (74)	**71** (59)	**140** (81)	**109** (77)
		125 (79)	**119** (102)	**129** (74)	**125** (85)

Bold = Mean Fundamental Frequency of range in Hz.

( ) = Standard deviation

Table 3.11d

Mean Duration of Utterances (in msec.) For Each Child During Each Time

		Time 1	Time 2	Time 3	
Child	AL	**544** (458)	**576** (348)	**418** (264)	**511** (372)
	AB	**1057** (788)	**769** (603)	**516** (346)	**760** (630)
	RS	**498** (482)	**503** (503)	**655** (488)	**557** (496)
		682 (632)	**609** (503)	**533** (392)	**605** (518)

Bold = Mean Duration in msec.
( ) = Standard deviation

duration. Few consistent time patterns can be found for mean, peak and range. One might naturally expect fundamental frequency values to decrease over time but it is not the case here. The fact that there is variability for all the children could be attributed to the interaction of physical maturation, level of language development and use of language functions. This issue will be discussed in the following chapter.

Since there was a main effect for contextual function for all the acoustical elements analyzed in this section, multiple comparisons were made on both the three common categories and on all 10 contextual function categories. Pairwise comparisons were made using the Least Significant Difference Test (LSD) and then the more conservative Scheffe at the .05 and .01 levels. The ANOVAS reported overall differences. The multiple comparisons made it possible to compare individual categories with one another. Tables of the contextual function categories that can be discriminated from other categories based on mean fundamental frequency, peak fundamental frequency, fundamental frequency range and duration are available in Appendix B.1.

Also available in Appendix B.2 are tables that enumerate all of the data collected on final contour direction, mean fundamental frequency, peak fundamental frequency, fundamental frequency range, and duration in relation to contextual function. The data are presented by individual child/time, by child, by time, and in its entirety.

In summary, mean fundamental frequency, peak fundamental frequency, and fundamental frequency range all reflected a statistically significant main effect for contextual function and a significant interaction of child and time. In addition, there was a significant main effect of child for range. In analyzing all the contextual function categories, those with higher affect such as the protest (PRO) and calling attention to (ATTENT) tended to have a greater mean, greater peaks, and a greater range. Categories requiring less emotional force such as the response to or following a question (RESP) and the personal comment category (PERS) usually had a lower mean and peak.

For duration, there was a main effect for contextual function as well as significant interactions of child and time and child, time and contextual function. These types of results are not surprising for duration since all children seem to vary in the amounts of jargon, single and two word utterances they use during this period.

General Summary

To answer the question as to whether or not there is an interdependence between final contour direction and contextual function, it appears that for the children in this study, a significant effect was found for final contours and the three common contextual function categories. Although the patterns of use for each child differed, some consistencies did exist across children such as a predominant use of rises for requests as well as a use of non-rises for general comments. This use of final contour direction did not significantly change over time. Proportional data on individual children revealed some other very consistent patterns such as predominantly rises for the GIVE and RQ categories and non-rises for the PERS category.

In addressing the question of an interdependence between mean fundamental frequency, peak fundamental frequency, and fundamental frequency range and contextual function, it appears that children in this study used different means, peaks and ranges based on the contextual function of the vocalization. Those categories with high affect such as the protest (PRO) and calling attention to (ATTENT) categories tend to be higher in mean, peak, and range. The category of response to or following a question (RESP) tended to be lower in mean and peak and range, while the personal comment category tended to be lower for mean and peak only.

There was a statistical interdependence between duration and contextual function as well as interactions of child and time and of child, time and contextual function. There was greater variability overall in duration than in the other variables since children naturally vary in the amounts of jargon, single, and two-word phrases they use during this period. The statistical results are summarized in Table 3.12.

Table 3.12

Summary of Statistical Analyses

Source	FCD	Mean Fo	Peak Fo	Fo Range	Duration
Contextual Function	*	*	*	*	*
Time					
Child				*	
Interaction Time/Child	*	*	*	*	*
Child/Time/ Contextual Function					*

* = significance

FCD = final contour direction

fo = fundamental frequency

DISCUSSION

The evidence found in this study suggests an interdependence between specific elements of intonation and the function of young children's utterances. Some of these relations show consistency over time while others do not.

This discussion will be organized in a similar manner to the preceding chapter. The interdependence of final contour direction and contextual function will be discussed first, followed by a discussion of the interdependence of the other elements of the fundamental frequency contour to contextual function. A general discussion will then be presented that looks at the role of intonation in the development of language and how this role may be variable among children.

Final Contour Direction

Relationships were found between final contour direction and certain contextual functions. Statistical analyses provided evidence that the request (RQ), general comment (COMM), and response to or following a question (RESP) categories could be differentiated by the existence of a rising or non-rising terminal contour. The RQ category had proportionally more rises than either the COMM or RESP categories. Yet, there was not a one-to-one invariant relationship between a rise and a request. There were several instances of requests having a non-rise final contour and categories other than RQ terminating in a rise. In fact, for one of the children (AL), the GIVE category, not RQ, had the highest proportion of rises. For this same child, the NAME category also had a high proportion of rises. (This will be addressed later on in the chapter.)

The high proportion of rises in the GIVE category could possibly be related to the adult's use of a rise when giving something to a child as suggested by Menn (1976). She studied functional intonation in one child (Jacob) and found that Jacob used a rise for "give" which she termed "offering" behavior. She hypothesized that a child's offering behavior could take a questioning form (rise) since that may be the form that the adult is using when offering something to the child. For example, if the caregiver said: "Do you want some toast?", she most likely had the toast in her hand and gave it to the child at that very moment; not waiting for a yes/no response. In a post hoc review of the videotapes, it became apparent that there were several instances where a mother would rhetorically ask her child if she wanted something (using a final rising contour) as the thing was being handed to the child.

There were other similarities between Menn's findings and those of this study. Besides the GIVE and "offering" categories being similar, Menn described an attention getting category that was characterized by a rise. For AL the call attention to (ATTENT) category was characterized by a predominantly rising final contour initially (Time 1). This category was not included in his graphic analysis since it did not meet the criterion for productivity in all three sessions. Yet it was productive during Time 1. Jacob (Menn's study) and AL were approximately the same age when she made this observation. Menn observed that Jacob's use of rises usually involved vocalizing to another person. Falling contours were associated with accompanying ongoing action. In this study the general comment (COMM) and personal comment (PERS) categories which included vocalizations accompanying activities was predominantly non-rises right from the beginning whereas requests (involving another person) were predominantly rises.

At about 15-1/2 months (approximately Time 2 in this study) Menn found that Jacob used a rise to request the names of things. This was also true of the children in this study. The request for information (RQINFO) category did not exist for two of the children until Time 2 and therefore was not included in the analysis over time. Yet, all utterances in this category were predominantly rises.

Unfortunately, Menn's data, though longitudinal, only included intonation contours for about a three month period, so there could be no real comparisons of data over time. Yet, even from these few months, there were enough similarities in use of rises by Jacob and the children in this study to support the claim that rises and non-rises were used differentially by all the children to express different functions. Both Jacob and AL used primarily a rise for "offering" or "giving" as well as in calling attention to something. Non-rises were associated with accompanying ongoing action for all children while requests which involved vocalizing to another person were predominantly rises. Requesting the names of things was characterized by rises for all the children.

The high proportion of rises in the NAME category for AL during Times 1 and 2 might be related to his mother's use of rises when naming objects to him. This kind of behavior was observed by Pike (1944) in her own child. Pike deliberately attempted <u>not</u> to use a rising contour in naming objects to her child. Although her efforts were initially rewarded by her daughter's naming of objects in a non-rising contour, this disappeared when her daughter was left in the care of people who named things for her using a rising contour. As with AL, the use of the rise diminished in time with Pike's child. Since the rise is a documented characteristic of motherese and has been described as a means of gaining and holding a child's attention, it is possible that the rise might be a feature that some children pick up in an interactive situation and globally associate with other interactive features (such as eye contact, need, etc.). With later development the rise may be used more selectively for only certain interactive functions. Since this behavior of a rise in naming was not observed in the other children in the study, it is possible that this global association occurs with only some children.

Another hypothesis is that some mothers use more rises than others when naming objects. AL's mother used rises when naming objects for him but so did the other mothers. Since the role of imitation was not analyzed in this study, no account was made of the number of rises the mothers used overall or the number or the number of rises they used when naming objects for their children. Thus, at this time it cannot be judged whether AL's mother used more rises when naming objects than the other mothers did, nor can it be determined if AL imitated more than other children.

Different kinds of observations about contour direction were made by Halliday (1975). In studying the development of language functions in his son, Nigel, he made little mention of rising intonations in the earlier stages of Nigel's language. During the period of Nigel's development that might be comparable to Time 1 of this study, there was almost no mention of rising tones and no mention at all of final rises. In fact, there was no evidence that initially Nigel used a function that resembled a request at all, by

Halliday's definition. When Nigel wanted something, he used an instrumental (demand) or a regulatory (command) function. Later on, requests fell into the pragmatic category.

In the present study, RS used fewer rises for requests than the other two children. Perhaps the request (RQ) really took the form of a command for her as it did with Nigel and by definition of the present functional category her utterances became requests rather than command/requests (COM/RQ). For example, if RS pointed to something and vocalized once it would be a request. The definition of a command/request required a louder voice and perhaps a repetition of the vocalization.

When Nigel reached Halliday's Phase II of functional development (somewhere between Times 2 and 3 of this study), Halliday separated Nigel's utterances into serving a pragmatic or a mathetic function. Pragmatic functions included satisfying his own needs and controlling and interacting with others developed from the Phase 1 categories of instrumental, regulatory, and interactional. Mathetic functions were for the purpose of learning and arose from the earlier personal and heuristic functions. Halliday noted that a pragmatic function which required a response had a rising tone while a mathetic function, which did not require a response, had a falling tone. Although Halliday did not refer to final contour, specifically, it appeared that when he referred to a falling, rising or flat tone, he was referring to the final contour. He did not discuss intonation in terms of it being continuous or discontinuous from some prelinguistic to linguistic point. He was more concerned with the transformation of functional categories.

In the present study categories were not divided by whether or not they required a response. Yet, there were some categories such as request (RQ) and GIVE that would be considered pragmatic and had a predominantly rising final contour. The category, request for information (RQINFO) might be considered both pragmatic and mathetic since it fit the definitions for the use of language for learning yet it was also interpersonal in that it required a response. The response to or following a question (RESP), general comment (COMM) and personal comments (PERS) categories would probably be mathetic by Halliday's definition since they usually did not require a response. Like Nigel, the children in this study used primarily a non-rising final contour for such functions.

It's possible to make some comparisons between Dore's (1974) "primitive speech acts" (PSAs) and the contextual function categories in the present study. In his description of utterances of a child, he included perceptual judgments of intonation and related them to function. His "requesting an answer" category contained a rising contour while "requesting an action" had a constant or flat contour. "Calling" included an abrupt rise-fall. In the present study, requests were not broken down by action and answer, yet the similarity in the rising final contour for the request (RQ) and request for information (RQINFO) were evident. Dore's "calling" category and the call attention to (ATTENT) category of this study both had a final non-rise.

It appears that the acoustical descriptions made in the present paper support some of the perceptual judgments made by Halliday and Dore in relating certain functions of language with the use of rising and non-rising final contours.

In the present study there was no statistical evidence that rises and non-rises changed significantly over time. Even though no statistical assumptions can be made about continuity in the use of rises and non-rises from non-significant results, for discussion purposes it suggests that the use of a rise for requests (RQ) and non-rises for responses to or following a question (RESP) and general comments (COMM) demonstrate some continuity over time.

For further evidence, it might be useful to look at the behavior of younger children reported in the literature to see if similarities can be found in final contour directions. D'Odorico (1984) grouped the crying and non-crying vocalizations of 4-8-month-olds into level, falling, and rising terminal contours. A high proportion of rises were found in the cries of the children when mothers left the room. These call cries and request vocalizations might be the precursors to the request (RQ) category in the present study where requests (RQ) were predominantly rises.

In the present study the mean proportional use of rises for all of the data was 27% while during Time 1 (mean age = 12.7 mos.) it was 33%. Kent and Bauer (1985), who studied the syllable structure, phonetic properties and fundamental frequency in 13 month olds found only 10% of all vocalizations had a rising contour. There are two possible reasons for this discrepancy in results. It was not clear how a rising intonation was defined by Kent and Bauer. In this study, the definition of a rising contour included a change of at least 40 Hz. over a 150 msec. long period. Perhaps the requirements for Kent and Bauer involved a greater change in frequency or a longer duration; reducing the number of utterances that would qualify as rises. Furthermore, there might not have been as much variability in the use of rises among the children studied by Kent and Bauer. Remember that AL used many more rises in the beginning than the other two children in this study. The mean proportion of rises during Time 1 for RS and AB together was only 14% which was much more in line with Kent and Bauer's findings.

To sum up, the use of a rising contour has been associated with various forms of requesting, giving, calling attention to something and requiring a response. Non-rises have been associated with general commenting, vocalizations not requiring a response, and demanding something. These associations have been documented from 4 months to almost two years. Prior to the onset of the first words, it appears children contrast certain aspects of content by means of variations in rising and non-rising contour direction. Many of the patterns seen very early appear to remain through the early linguistic period.

This study has added to the data available on final contour direction in several ways. Final contour direction has been followed longitudinally from a prelinguistic to an early linguistic level allowing one to observe continuity in the association of certain contextual functions with final contour direction. In contrast to other studies, these data were gathered using objective, acoustical means, on a large body of data, rather than on isolated acoustical examples.

Mean Fundamental Frequency, Peak Fundamental Frequency, Fundamental Frequency Range, and Duration

Mean fundamental frequency, peak fundamental frequency, fundamental frequency range, and duration were statistically differentiated based on their contextual functions. There have been few studies done that help to corroborate these results. In some studies, the children were much younger and in others the methods and categorization systems differed.

The following discussion will first address research on mean peak and range and will then be followed by a brief discussion of duration.

Mean, Peak and Range

Fundamental frequency and range were perceptually examined by Furrow (1984) who used a perceptual rating score for pitch, loudness, and range of utterances of children who were approximately the same age as the children in this study. If his "pitch" could be interpreted as mean fundamental frequency and his "range" as the amount of difference between high and low points, then similarities in results can be discussed. Furrow reported the highest "prosodic" scores were in his "eye contact" category. These utterances were the loudest, had the greatest range and highest pitch. While the present study did not categorize utterances by eye contact, the call attention to (ATTENT) category had eye contact as a major component of its definition. Further, the ATTENT category was second highest in mean fundamental frequency and highest in peak and range of all the categories suggesting similarities of results between the two studies.

In another study done on younger children (4-8 months) it was also possible to see some similar trends. D'Odorico (1984) found that her "call cries" and "discomfort cries" had a mean fundamental frequency higher than request vocalizations. If "call cries" could be compared to the ATTENT category in this study, "discomfort cries" to the protest (PRO) category, and "request vocalizations" to the request (RQ) category, then some similar patterns can be seen. In the present study, the ATTENT and PRO categories were both higher in mean fundamental frequency than the RQ category.

Peak fundamental frequency was used in conjunction with a rise by Menn (1976) to differentiate certain types of requests. She found that when Jacob requested an object he used a much higher pitch range (550-1100 Hz.) than when he wanted a person to do something for him (more moderate pitch up to 500 Hz.) In general, the peak fundamental frequencies were much lower for all the children in this study than those Menn reported for Jacob. Mean peak fundamental frequency for the GIVE, RQINFO, and RQ categories from the data of the present study were in the 430-460 Hz. range (more like Menn's moderate pitch). These peaks are more in line with Kent and Bauer who found peak fo in their 13 month olds at 300-500. In this study during Time 1, peaks ranged from 393-493 Hz. for all categories.

Related to Menn's findings were those of Lieberman (1967) who found that as young as 10 months, children adjust their fundamental frequency to the levels of those around them. When observing a 10 month old boy and a 13 month old girl, he found the infant's pitch varied with the sex of the parent; being higher for the mother and lower for the father.

Universal descriptions of prosodic elements (Frick, 1985) in adults have revealed that one of the prosodic features of anger is increased pitch. Anger could be interpreted as a characteristic emotion of protest (PRO) in the present study, which was indeed characterized by a high mean fundamental frequency.

As just mentioned, those functional categories with high affect such as the protest (PRO) and calling attention to (ATTENT) categories tended to be higher in mean fundamental frequency, peak and range. These same categories were not nearly as productive as those categories with a more neutral affect such as the general comment category (COMM) and the response to or following a question category (RESP) which had a lower mean, peak and range. Bloom and Capatides (in press) who reported that during the single word period, the children they studied used primarily neutral affect when first using single word utterances; in the present study the majority of utterances produced fell into somewhat "neutral" contextual function. Even though the children used higher means, peaks and ranges for non-neutral affective categories, the majority of their vocalizations were more neutral.

Although there is a need to look at fundamental frequency averages during the second year, it is difficult to compare the general patterns found when studies in the area have used different techniques for obtaining acoustical data. Yet, there are enough similarities in a few studies that fundamental frequency data can be compared and analyzed. McGlone (1966) studied fundamental frequency in 6 children between 12-24 months and found a mean fundamental frequency of 443 Hz. It is difficult to say why there was such a disparity in results between McGlone's study and the present study. He chose only six utterances per child and these utterances involved naming pictures, so there was not much variability in the functions associated with the words produced. Yet the mean fundamental frequency of the NAME category in the present study was 340 Hz. It is possible that the adult spoke first and perhaps the adults intonation pattern influenced the child's production.

Robb and Saxman (1985) found fundamental frequency during the second year to average at 357 Hz. with a standard deviation of 105. This was slightly higher than the results of the present study where the mean was 348 Hz. with a standard deviation of 71. They did not find a steady decline in fundamental frequency as one might expect. Considering the differences in methodologies for obtaining fundamental frequency in the present study and the study done by Robb and Saxman, the results are strikingly similar. There are two possible explanations that might account for the differences that do exist. First, means for the present study were based on only three children while Robb and Saxman used 14 children in their study. Second, the method they used for obtaining mean fundamental frequency differed from the procedure used in this study. They used the mean of approximately 700 data points extracted from approximately 70 utterances per child. In their study, they found onset fundamental frequency highly correlated with mean fundamental frequency (onset mean = 363 Hz., S.D. = 101 Hz.) and felt comfortable that either method would be reliable way to assess fundamental frequency.

In the present study, the mean of the high and low points of each utterance were used to calculate mean fundamental frequency. A post hoc analysis of onset fundamental frequency in the present study revealed similar findings for onset and mean fundamental frequency. Using onset fundamental frequency, the overall mean was 340 Hz. compared to 348 Hz. using the mean of the high and low points. The standard deviation of onset fundamental frequency was 69 compared to 71 for the mean of high and low points. Thus, the results of this study support the conclusion of Robb and Saxman that the use of onset fundamental frequency is one possible method of estimating average fundamental frequency of young children's utterances.

The fact that Robb and Saxman found a great deal of interutterance variability in fundamental frequency during the 11-16 month period of their study might be related to the interaction of the onset of language and the natural lowering of fundamental frequency over time as they pointed out. For individual children during this period, language production can vary from prelinguistic utterances (like babble or jargon) to utterances containing several morphemes. In the present study there was no statistical effect for time for mean fundamental frequency although there was an interaction of time and child. For Robb and Saxman a one-way ANOVA was performed with age as the factor and was nonsignificant. In addition, the differences in mean fundamental frequency of linguistic and non-linguistic utterances during Times 2 and 3 were minimal. In a post hoc analysis it was found that during Time 2 the mean fundamental frequency of linguistic utterances was 343 Hz. while the mean for non-linguistic utterances was 340 Hz. During Time 3 the mean fundamental frequency of linguistic utterances was 344 Hz. while non-linguistic utterances was 345 Hz.

Perhaps this interutterance variability found can be viewed as not only the variability in the development of words but variability in the development of words and functions. The results of this study have already demonstrated variability during this period in mean, peak and range by the fact that the RQ, COMM and RESP categories could be statistically differentiated by their contextual functions. In addition, graphic representation of the categories as well as LSD and Scheffe analyses comparing individual categories (see Appendix B.1), revealed discriminable differences among several of the categories. Based on the present results it is not unrealistic to assume that variability in language functions during this period could play a crucial role in the variability seen in average fundamental frequency reported by Robb and Saxman.

Further, it has been reported that approximately 50% of laryngeal growth occurs during the first three years of life (Kaplan, 1971). This increased growth in vocal fold length, size and mass should result in a lowering of fundamental frequency. Since the variability in overall physical growth during this period as well as any other time in a child's development the differences in physical maturation along with functional language development during this time could also contribute to fundamental frequency variability.

Duration

In the present study contextual functions could be discriminated by their duration. Other studies that have examined durations have differed so greatly in either age of the children or in methodology that it is quite difficult to make comparisons. None have compared duration and function. Menn (1976) listed some durational examples of Jacob's utterances but not enough were available for each of her functional categories to draw any conclusions or compare functional categories by duration.

Although Robb and Saxman studied duration in children of the same age they looked at duration of segments and not utterances. Segments were defined as CV VC or CVC sound segments, while utterances in the present study often consisted of several sound segments by their definition. Robb and Saxman found mean duration of segments to be 357 msec. compared to 605 msec. for duration of a vocalization in this study.

Similarities in duration of vocalization were found between the present study and that of Delack's (1976) data on younger children. However, it was not clear how his durations were calculated. He found that during the first year of life mean durations of vocalizations ranged from 375-645 msec. for girls and 430-605 msec. for boys. The higher end of this range corresponded to the 605 msec. mean duration of the present study.

In summary, in this study and in other research those language functions that involve higher affect (calling, eye contact, calling attention to, protests, anger) tended to be higher in mean fundamental frequency, peak and range. Variability in overall fundamental frequency during this period has been reported and it has been suggested that the interaction of laryngeal growth, onset of the first words and the variable use of language functions may all play an active role in creating this variability.

The present study has statistically corroborated some past research done on mean, peak, range, and duration. Further, it has corroborated the fundamental frequency data made available by Robb and Saxman (1985) and helped to verify the use of onset fundamental frequency as a way of obtaining reliable mean scores. Analyzing fundamental frequency by separate functional categories suggests that we need to look at variability in fundamental frequency development through language functions.

Major Issues

There are three recurring issues in this dissertation. These issues are related to the research questions in which the author has investigated the relationship of elements of the intonation contour to specific contextual functions over time. These issues are: (1) the relationship of intonation contour to specific contextual function categories; (2) the continuity or discontinuity of the development of intonation from some predetermined prelinguistic level to an early linguistic level; and (3) the role that intonation plays in helping the child to learn her native language system.

Relationship of Intonation to Function

From the results and previous discussion, there is considerable evidence that there are relationships between some elements of the intonation contour and some specific contextual functions. Although categorization systems differ, several researchers have found relationships between specific elements of intonation and language functions and there is consistency among studies.

Continuity of Intonation

Whether or not the patterns found are continuous from a prelinguistic period through the early linguistic period has been partially answered by this and other studies. In the present study there were two types of continuity being addressed. First there was the continuity that existed for all children over time. Although all children differentiated contextual function categories by final contour, mean, peak, range and duration, there were no main effects for time for all of these intonational elements. For example, for final contour direction, all children used proportionally more rises for requests and proportionally more non-rises for general comments.

The second type of continuity was the continuity seen within each child. Each child used some of his productive categories fairly consistently over time. For example, in addition to the common categories, AL showed consistencies in his use of rises for the GIVE category, while AB was consistent in her use of a non-rise for personal comments. There were also some individual behaviors that were discontinuous. For example, AL initially responded to questions (RESP), especially yes/no questions, with primarily a rising final contour. By Time 3, his RESP category was primarily a non-rise. The same kind of behavior was seen for naming. For this category, AL used primarily a rise initially which later became primarily a non-rise, resembling the patterns of the other two children.

More evidence of continuity can be found by looking at the contour patterns of younger children as in the study of D'Odorico (1984). Consistencies were found between the kinds of final contours used by her very young infants (4-8 mos.) and the contours produced by the children in the present study.

Aside from the experimental evidence in the previous papers, other authors have talked about the continuity of language using elements of the intonation contour as a basis for their hypothesis.

Delack (1976) concluded his study by stating:

> We hold that there exists sufficient evidence to refute the parochial view that linguistic acquisition can only be discussed relevantly when the child's segmental phonetic repertoire begins to resemble that of the adult standard. In other words, we strongly support the hypothesis of continuity from babbling to speech. (p. 109)

Although his statement does not directly mention intonation, his study was based on the element of fundamental frequency and duration. D'Odorico (1984) claimed that as a result of her own study of intonation, melodic patterns seem to be the earliest kind of linguistic structuring. Tonkova-Yampol'skya (1973) concluded her paper with the statement: "Speech development in children begins with development of intonation." (p. 137)

The data from this study support the hypothesis that there is continuity in the use of intonation from a late prelinguistic point through the single word period. Yet, it is not the belief of the author that the intonation patterns associated with specific functions that begin prelinguistically are identical precursors to those patterns the child uses as she develops a complete adult language system. There are indeed similarities in patterns to the adult system. Yampol'skya (1973), for example, has based an entire study on the similarities of affective behavior and intonation in the young child and adult. Yet, there are probably many more patterns that are dissimilar since adults may use different patterns to convey a particular idea. An adult does not always use a rise for a request. It can be a rise-fall pattern ("Can I have this?") or an indirect request ("I really need that pen."). When an adult calls attention to something, she may use a higher fundamental frequency or greater range. On the other hand, she may just say: "Look at this" in a flat mid-tone.

Initially, intonation may one of the features the child extracts from the endless speech signals she is being exposed to each day. Awareness of intonation has been evidenced by the research of people like Morse (1972) and Kaplan (1969). As early as 2 and 8 months (respectively) they found infants discriminating a rising intonation.

Since elements of the fundamental frequency contour becomes contrastive in terms of their meaning to others so early it is a natural form for the child to use to express the feelings, intentions, and meanings that begin to develop during the second half of the first year of life.

The Role of Intonation in Language Development

Consistent patterns of intonation and contextual functions have been examined and discussed. Evidence for some of these patterns being continuous and explanations of these patterns have been presented.

The important question is whether intonation actually aids the child in learning language. If so, to what degree does it aid the child in conjunction with semantic and syntactic development, and is there variability in the amount of aid given? As with other aspects of language development, some patterns remained somewhat stable (e.g. from Time 1, there were acoustical consistencies in the ATTENT, GIVE, RQINFO, and COM/RQ categories), while other patterns slowly change (e.g. AL's RESP and NAME categories). Likewise, during semantic development, some word meanings first become either over or under generalized before they stabilize. For example, the word "mommy" may apply to all women or the word "cat" might apply only to the family pet and no other felines. In grammatical development, there are also overgeneralizations in form.

For example, after learning the plural form "s" any children will apply "s" to all nouns to pluralize them as in the case of "foots".

Perhaps this same overgeneralization holds true for intonation contour (but it begins earlier than either semantic or syntactic development). The child extracts certain elements (rise, higher or lower fundamental frequency, etc.) from the fundamental frequency contour and combines some element with a feeling, an intention, or meaning. As long as this association gets results (mother looks, child gets what she wants, etc.) and the child has not yet developed the physical skill (form) or cognitive (content) capacity to convey her meaning in another way, she continues to use her intonation forms consistently. One could speculate that when the child develops the ability to produce phonetic contrasts meaningfully (phonemically), she uses what she already knows about signaling through intonation in conjunction with words.

Lewis (1986) and Wood (1976) both spoke of the stages of intonation and defined intonation as taking a subordinate position once semantic and syntactic development emerge. This may be true for the preschool child who is learning varying degrees of form, but once the child has the basic elements of the adult language system, intonation provides the child with a means for expressing very subtle, sophisticated thoughts such as indirect requests (I want book, now), sarcasm and irony comments ("That's great"), and attitudes described by Crystal (1969), such as excited, haughty, angry, puzzled, amused, etc.

Perhaps for intonation the discontinuity begins with the onset of the syntactic period. Is it possible that once the child combines words to convey meaning, her manner of using fundamental frequency interacts with word order in a way quite different than previously observed.

There is a need to continue to follow intonation beyond the early linguistic period to see if there is continuity into the adult language system or to see if there are abrupt changes once the child begins to use syntax (Wode, 1980).

Bloom (1973) cited Lahey's (1972) observations about the use of prosody in one child, Allison, during the late single-word and early two-word period. According to Lahey, when Allison combined the presyntactic form "widə" with other words, she produced what might be compared to "sentence prosody". When she began to combine words syntactically ("Baby Allison comb hair") these combinations were produced with more equal stress and did not resemble sentence prosody. Later on (28 months) when syntactic forms had been used for a while, sentence prosody was used. Lahey concluded that perhaps children learn sentenial prosodic patterns after they learn to code the basic grammatical distinctions by word order, and that the sentence prosodies they use prior to this time may be mimicked adult patterns.

It is certainly possible that the consistencies found in final contour direction in the present study were learned imitations of adult patterns but they were not just mimicked contours. Final contours were associated with aspects of context. For example, when asked a question by the mother with a rise, the child's response would primarily be a non-rise (and not an imitated rise), or when the child requested something, she would primarily use a rise. A meaning association was made. Thus, something more than intonation contour alone was learned prior to syntax although it might not qualify as sentence prosody.

When discussing the role of intonation in language development, the issue of child variability must be addressed. Just as there was continuity among children and within one child, so there may also be variability among children as well as within the same child. Although not a direct issue or question of the present study, there was evidence of variability in the behaviors of the children for final contour direction. For example, overall AL used many more final rising contours than the other children. Specifically he initially used a rise for the RESP category, when it was almost never evident in the other children. In addition, the fact that the productive categories for each child differed was another example of this variability and might be an example of differing language learning styles among these children.

Differences in semantic development have been cited by Nelson (1973) (referential vs. expressive) and Bloom and Lahey (1978) (relational vs. substantive). There has also been research to indicate that different styles of language learning involve varying uses of intonation.

For example, Peters (1977) studied one child named Minh, who at about 11 months, began to use specific intonation contours to convey certain meanings. Although his single word vocabulary began at 14 months, the child had two distinct styles of conveying meanings. His "Gestalt" style was used for conversationally defined contexts such as requesting, free play, social control, or the categories that Halliday (1976) might define as pragmatic. It was characterized by target phrases (not single words) that had very characteristic intonation contours where the intonation ("melody" in her terms) was unique enough so that the meaning could be recognized even if the phonemic aspects were badly mumbled. He used an "Analytic" style for referential contexts such as naming and labelling. Utterances were single words and the intonation patterns used in the Gestalt style were not evident during "analytic" speech.

Likewise, Dore (1974) reported differences in language learning styles for the two children he studied. One child used a larger number of words to convey meaning while the other child used fewer words but used prosodic features in more ways than the other child. He named these children "word-baby" and "intonation baby" and suggested that children may progress at different rates and use different styles to acquire language.

In the end, all children who are developing normally learn their native language and speak using meanings and forms that are considered acceptable for their language. Children may vary in semantic and syntactic development. Likewise, there may be variability in the amount and kinds of intonation they use and the way they use it to learn language.

In the future, the role that caregiver's speech plays in the development of intonation should be examined. Both Menn (1976) and Pike (1944) inferred that caregiver's intonation style might influence the intonational characteristics of the child. In this study, AL used considerably more rises than the other children. An attempt might be made to investigate the mother's style of interaction to see if she used considerably more questioning tones than the other mother.

Actually, after a cursory post hoc review of all the tapes, it appeared that although AL's mother used a great deal of questioning, with a rise, RS's mother used a far greater amount of exaggerated contours which included many final rises.

Limitations and Future Research

In the present study every attempt was made to classify utterances by their contextual function definitions. It is true that if a rise is there, it is impossible not to hear it, but the examiner and the person who aided in the reliability study both attempted to classify strictly by definition. In the future, perhaps the audio portion of the video tapes could be removed and contextual function classifications could be made to see if utterances would still be classified the same based only on context as per definitions.

In speaking of contextual function definitions, the functional categories for this study were primarily emic in that they were derived strictly from the data. Dore (1974) and Halliday (1976) were used as a foundation, but there was no one-to-one match between their catetegories and these. It is certainly possible that if different categories were used or certain categories were collapsed, results might have been different. Furthermore, in this study there was a heavy reliance on the mother's reactions and interpretations of the child's utterances. Although this greatly eliminated the number of inferences made, it was possible that child vocalizations were being classified incorrectly if the mother misinterpreted her child's vocalizations.

Since one of the objectives of this study was to examine the possible functions of intonation in a child's environment, it would have been helpful to have the child in his own home environment. Because of the time and space necessary to set up all of the audio and video equipment, it was unrealistic to bring all of it to the child's home. The "playroom" studio was an attempt to make a room as "homelike" as possible. In addition, it was feared that some of the toys or objects in the child's home would interfere with the audio recordings and the FM microphone (T.V., bells, refrigerator, clanging toys, etc.). This in turn might have distorted the Visipitch displays. These things were more controlable in a studio playroom. It would have been interesting to use some other everyday activities such as bathing and dressing, but the need for the vest and microphone precluded this. The snack-time and the wide variety of toys and objects was an attempt to overcome this.

Another limitation was the fact that some cells could not be statistically analyzed due to the small number of cases that occurred for specific contextual functions. Possible ways to overcome this might include: setting up a few contrived situations during the taping sessions that might provoke certain types of utterances that were infrequently produced during the taping sessions, and further redefining and collapsing categories to make the cells larger.

Most recorded child vocalizations were clean enough to pass through the Visipitch, yet there were a few that were difficult to read due to background noise, microphone movement or unusually high fundamental frequencies. Although the amptitude tracings were helpful in these cases in determining onset and offset of the vocalization, there were some questions concerning the actual contour. Future research should include perfecting some of these types of instrumentation difficulties.

In the future the intonation contours of mother utterances should also be examined. In this way it might be possible to find some relationships between the children's and mother's intonation patterns. For example, one might look at the proportional number of rises used by the mother versus the number used by the child. One could also look at the dyadic pattern of the mother and child to see how many times a mother rise is followed by a child non-rise and vice-versa. Furthermore, one might look at whether or not the mother is rewarding one type of intonation pattern more than another. Does the child tend to get more attention, more things that she wants, and more verbal reinforcement for using one pattern (ex.: rise, high peaks, etc...) than another?

There is a need to continue following intonation development longitudinally. As Wode (1980) pointed out, once the child is speaking in phrases and sentences his intonation patterns become more complex as they interact with syntactic development. Following intonation beyond single words would allow researchers to determine exactly when these patterns begin to take more exact forms of native language.

Cross-linguistic studies are needed in this area to see if any universal types of trends can be seen. In addition, the development of tone language (where intonation plays a syntactic role from the start) would be interesting to study and might be helpful in looking at how syntax and intonation interact.

This study involved only three children. In order to make any generalizations about intonational development in all children, much more data is needed. Now that computer assisted acoustical instrumentation is available to make this type of study more accurate and efficient, it is possible.

Summary and Conclusions

Evidence from the present study suggests that there are some consistent patterns between elements of the intonation contour and specific contextual functions. Some of these patterns continue from at least the late prelinguistic stage to the early linguistic stage.

In both the present study and in previous research studying children as young as four months, the use of a rising contour has been associated with various forms of requesting, give, calling attention to something and requiring a response. Non-rises have been associated with general commenting, vocalizations not requiring a response, and vocalizations demanding something.

Other elements of the intonation contour (mean fundamental frequency, peak, and range) have been studied by several people and although methods and subjects have varied, some consistencies in findings do exist. Higher fundamental frequency has been associated with eye contact and calling attention to something, requests, and protests. Lower fundamental frequency has been associated with general comments and responses to questions.

Overall mean fundamental frequency during the second year was also examined. The present finds concur with those of Robb and Saxman (1985). However, they also looked at the interutterance variability that exists during the 11-16 month period. The present study suggests that this variability might be due in part to the variable use of functions during this period in addition to laryngeal growth and the onset of words.

Three major issues have dominated this paper. First is the issue of consistent patterns between elements of the intonation contour and specific contextual functions. Evidence from this and other studies has revealed some consistent patterns. The second issue dealt with the continuity of these patterns over time. Group data which revealed a differentiation for contextual functions while no effect for time was one type of continuity presented. In addition, individual consistent patterns over time within a child were also evidence for continuity.

The third issue dealt with how these patterns of intonation might aid the child in learning language. Several possible explanations were presented. Children may first overgeneralize intonation patterns the same way they overgeneralize semantic and syntactic patterns. It is also possible that intonation patterns remained consistent through the early linguistic period and adult-like patterns emerged during the syntactic period. Another possibility is that there was variability in the importance of intonation in language development among children as well as variability within a child based on what particular language function she was trying to convey.

The present study has added to our knowledge of intonation by comparing it to another aspect of language (use) using objective acoustical measures on a large body of longitudinal data.

Appendix A.1 Diary for functions of prelinguistic vocalizations and actions

"Gloss" Your interpretation of what he/she said: (Ex: "I don't want that!")	Sounds said or pointing etc. (Only if you can write it down - like "da" - otherwise don't worry)	Imitated? Did he/she try to imitate what you just said?	Who was present in room: (M, F, S, B etc.)	Why did she/he vocalize? - tell what was happening at time, the function (See function explanation) why he/she said it.
I'm glad to see you... ake me out of this crib	(grunt sounds)	no	mom	she is standing in her crib in the morning. She sees me and as I approach her crib she seems to (A) want to get out of the crib and (B) want me to hold her and interact with her.
Bye-Bye	Ba-Ba waves her arms in appropriate 'good-bye' motion	yes	MOM, dad, sister	I am going out the back door (or Jay, or Jessica) and I say Bye-Bye or I put on my coat and as I exit she says "Ba-Ba." (C)
Take me up into your arms	Grunt sounds or, more recently (6/1/84) says "Up"	no	MOM	She is sitting on the floor and I am standing. She stretches out her arms to me and wishes to be picked up (B)
I want that ereal or that bottle that I see you re paring.	grunt sounds	no	mom	She is sitting in her sassy seat at the breakfast table, when she sees me take the cereal box and the milk out of the pantry she vocalizes until she receives the food. (A)
Then she wants her uddly bear (security object)	"Brrr"	no/yes; sometimes if I say Bear? she'll then say "Brrr"	MOM	She's tired; she is playing on the floor and she needs to cuddle with her bear and suck her finger. She needs calm, to be comforted and soothed. (D)

Appendix A.2

Objects used for Videotaping

Remaining in the room at all times

Toy kitchen with cooking utensils and food
Table and chairs with plates, forks, cups, etc.
Tomy riding car - Changed to larger car during Tape III
Shopping cart with food
Age appropriate books

Bag #1

Baby and bottle
Sping around activity box
T.V. rhymes
Stacking cups

Bag #2

Ladybug pull toy
Telephone
Busybox
Snoopy stuffed animal
Rocker stacker

Bag #3

Teddy pull toy
Push and go train
Xylophone and sticks
Shape sorter
Rattle

Bag #4

Teddy Bear
Bus with people (During Tape III changed to larger bus)
Discovery Pop-up toy (Omitted during Tape III)
Mother Goose Says
J&J Clickety Clank Toy
Cash Register (Added for Tape III)

Appendix A.3

Vocabulary List - First 50 Words as reported by each mother

AL	AB	RS
upstairs	telephone	more
bottle	powder	cookie/cookie
clean	pillow	monster big bird
mommy	cream	pop
daddy	toys	socks
baby	towel	baby
cookie	boy	mama
goodbye	hug	daddy
pillow	nite-nite	bear
door	bye	bottle (first 10
book	see	words)
T.V.	B.M.	toast
button	toes	teeth
blanket	jacket	tissue
apple	juice	juice
peach	mine	apple
soap	purse	shoe
wash	bib	daddy
broom	more	yes
bird	eat	coat
paper	ball	eat
rock	cry	Jessica
chair	hold it	Teresa
crayon	cup	pizza
pen	book	nite-nite
jacket	bunny	bye-bye
fork	thank you	hat
hotdog	fall	hot
turkey	outside	wet
outside	hat	Piggy
crying	daddy	thank-you
funny	mommy	crayon
hammer	me	up
ball	car	swing
shoe	hi	eye
brush	dog	diaper
diaper	what's this	Sesame Street
bear	airplane	right
sleeping	light	egg
peg	eyes	dirty
pocketbook	shirt	wash
apple juice	baby	all done
cut	good girl	gum
hat	sock	pen
shovel	cold	donut
bucket	brush	wait
careful	comb	mine
sit	no	brush
phone	pee pee	no
grandma	that	alright
		o.k.

Mother's previous or sub. utterance	child utter. #	child utterance	Gloss	Context	Contextual Function
Bee-beep					
	7	bo	broke	steering wheel comes off car again. A holds out to show m e vocalizes	comment
Yeah. It's broke					
That's how you get out of the car					
				A continues to play w/ car. wheel comes off again. A holds out e vocal. as looking at M.	
	8	o no	oh no		comment
It's O.K. It's ok				m takes wheel + A	
	9	bok	broke	looks at m e vocalizes	quest. to gain info
Broke? Yeah. It's broke.					
You want to get out of				A continues to sit in car	
the car?				Then A pt. to wheel when	
	10	dIS	this	asked to get out of car	resp. of the question
How about this one. Oh					
here's another one	11			A sees m playing w/ toy, wants to get out. Asks m for help	
		IrE-IrE	in there m-Cheu		request

Appendix A.5

Reliability of Contextual Function Categories

		TIME			
		1	2	3	
	AL	.83	.90	.89	.87
CHILD	AB	.93	.87	.84	.88
	RS	.95	.86	.84	.88
		.90	.88	.86	.88

Appendix A.6 Sample Audio Analysis Sheet

utterance #	cont. funct.	ling./ non	onset f_0	offset f_0	high f_0	low f_0	duration	final contour
1	2,17	L	287	279	287	252	189	→
2	7	L	354	297	419	287	505	↓
3	7	L	319	207	399	207	410	↓
4	7	L	297	236	297	236	193	↓
5	18	L	315	217	315	199	504	↓
6	7	L	283	254	374	254	292	↓
7	7	L	319	231	319	231	212	↓
8	6	L	295	205	305	205	467	↓
9	4	N	390	485	485	390	92	↑
10	4	L	331	480	480	331	149	↑
11	11	L	394	510	510	394	262	↑
12	18	L	319	223	319	223	264	↓
13	4	L	321	432	432	321	566	↑
14	4	L	295	297	354	262	483	↑
15	4	L	290	399	399	290	510	↑
16	4	L	326	414	414	326	198	↑
17	4	N	344	394	424	344	269	↑

Appendix B.1 Statistically Discriminable Contextual Function Categories based on Mean Fundamental Frequency - Common Categories

Contextual Function	LSD .05	Scheffe .05	Scheffe .01
COMM	RESP	RESP	RESP
RQ	RESP COMM	RESP COMM	RESP COMM

Appendix B.1 Statistically Discriminable Contextual Function Categories based on Mean Fundamental Frequency - All Categories

Contextual Function	LSD .05	Scheffe .05	Scheffe .01
COMM	RESP		
NAME	RESP		
COM/RQ	RESP		
RQ	RESP PERS COMM NAME COM/RQ	RESP PERS COMM	RESP PERS COMM
GIVE	RESP PERS COMM NAME COM/RQ	RESP	RESP
RQ/INFO	RESP PERS COMM NAME COM/RQ RQ	RESP PERS COMM NAME	RESP PERS COMM NAME
ATTENT	RESP PERS COMM NAME COM/RQ RQ GIVE	RESP PERS COMM NAME COM/RQ	RESP PERS COMM NAME
PRO	RESP PERS COMM NAME COM/RQ RQ GIVE RQ INFO	RESP PERS COMM NAME COM/RQ RQ	RESP PERS COMM NAME COM/RQ RQ

Appendix B.1 Statistically Discriminable Contextual Function Based on Peak Fundamental Frequency - Common Categories

Contextual Function	LSD .05	Scheffe .05	Scheffe .01
COMM	RESP	RESP	RESP
RQ	RESP COMM	RESP COMM	RESP COMM

Appendix B.1 Statistically Discriminable Contextual Function Categories based on Peak Fundamental Frequency - All Categories

Contextual Function	LSD .05	Scheffe .05	Scheffe .01
COMM	RESP		
COM/RQ	RESP		
NAME	RESP PERS COMM	RESP	RESP
RQ	RESP PERS COMM COM/RQ	RESP PERS COMM	RESP COMM
GIVE	RESP PERS COMM COM/RQ	RESP	RESP
RQ/INFO	RESP PERS COMM COM/RQ NAME RQ	RESP PERS COMM	RESP PERS COMM
PRO	RESP PERS COMM COM/RQ NAME RQ GIVE RQ INFO	RESP PERS COMM COM/RQ NAME RQ	RESP PERS COMM COM/RQ NAME RQ
ATTENT	RESP PERS COMM COM/RQ NAME RQ GIVE RQ INFO	RESP PERS COMM COM/RQ NAME	RESP PERS COMM COM/RQ

Appendix B.1 Statistically Discriminable Contextual Function Categories based on Fundamental Frequency Range - Common Categories

Contextual Function	LSD .05	Scheffe .05	Scheffe .01
COMM	RESP	RESP	
RQ	RESP COMM	RESP COMM	RESP

Appendix B.1 Statistically Discriminable Contextual Function Categories based on Fundamental Frequency Range - All Categories

Contextual Function	LSD .05	Scheffe .05	Scheffe .01
COMM	RESP		
RQ	RESP COMM	RESP	
GIVE	RESP		
RQ INFO	RESP PERS COM/RQ COMM	RESP	
PRO	RESP PERS COM/RQ COMM RQ	RESP COMM	RESP COMM
NAME	RESP PERS COM/RQ COMM RQ	RESP COMM	RESP COMM
ATTENT	RESP PERS COM/RQ COMM RQ	RESP PERS COM/RQ COMM	RESP PERS COMM

Appendix B.1 Statistically Discriminable Contextual Function Categories based on Duration - Common Categories

Contextual Function	LSD .05	Scheffe .05	Scheffe .01
COMM	RESP RQ	RESP RQ	RESP RQ

Appendix B.1 Statistically Discriminable Contextual Function Categories based on Duration - All Categories

Contextual Function	LSD .05	Scheffe .05	Scheffe .01
RQ	RESP		
NAME	GIVE RESP RQ INFO COM/RQ RQ	RESP	RESP
ATTENT	GIVE RESP RQ INFO		
PERS	GIVE RESP RQ INFO COM/RQ RQ NAME COMM	GIVE RESP RQ INFO RQ	RESP RQ INFO
PRO	GIVE RESP RQ INFO COM/RQ RQ NAME COMM ATTENT	GIVE RESP RQ INFO COM/RQ RQ NAME COMM	GIVE RESP RQ INFO COM/RQ RQ NAME

Appendix B.2

PERCENT RISES FOR EACH CONTEXTUAL FUNCTION

Contextual Functions	Child AL: ALT_1	Child AL: ALT_2	Child AL: ALT_3	Child AB: ABT_1	Child AB: ABT_2	Child AB: ABT_3	Child RS: RST_1	Child RS: RST_2	Child RS: RST_3	Child AL All times	Child AB All times	Child RS All times	Time T_1 (All children)	Time T_2 (All children)	Time T_3 (All children)	ALL DATA
RESP (Response following a question)	61.9 / 13 / (21)	61.8 / 21 / (34)	7.1 / 3 / (42)	7.7 / 1 / (13)	7.1 / 1 / (14)	• / (15)	• / (17)	8.0 / 2 / (25)	7.4 / 5 / (68)	38.1 / 37 / (97)	4.8 / 2 / (42)	6.4 / 7 / (110)	27.5 / 14 / (51)	32.9 / 24 / (73)	6.4 / 8 / (125)	18.5 / 46 / (249)
RQ (Request)	91.3 / 42 / (46)	81.8 / 9 / (11)	82.2 / 37 / (45)	45.5 / 5 / (11)	66.7 / 8 / (12)	55.6 / 5 / (9)	25.5 / 12 / (47)	11.1 / 3 / (27)	36.8 / 7 / (19)	86.3 / 88 / (102)	56.3 / 18 / (32)	23.7 / 22 / (93)	56.7 / 59 / (104)	40.0 / 20 / (50)	67.1 / 49 / (73)	56.3 / 128 / (227)
GIVE	91.7 / 22 / (24)	75.0 / 6 / (8)	87.5 / 7 / (8)	X	100.0 / 3 / (3)	X	33.3 / 1 / (3)	• / (2)	X	87.5 / 35 / (40)	100.0 / 3 / (3)	20.0 / 1 / (5)	85.2 / 23 / (27)	69.2 / 9 / (13)	87.5 / 7 / (8)	81.3 / 39 / (48)
PRO (Protest)	X	• / (2)	16.7 / 2 / (12)	11.1 / 7 / (9)	23.5 / 4 / (17)	80.4 / 4 / (5)	23.8 / 5 / (21)	5.9 / 2 / (34)	25.0 / 9 / (36)	14.3 / 2 / (14)	29.0 / 9 / (31)	17.6 / 16 / (91)	20.0 / 6 / (30)	11.3 / 6 / (53)	28.3 / 15 / (53)	19.9 / 27 / (136)
RQ INFO (Request for Information)	100.0 / 9 / (9)	85.7 / 6 / (7)	88.9 / 24 / (27)	X	100.0 / 2 / (2)	47.1 / 8 / (17)	X	100.0 / 1 / (1)	80.0 / 20 / (25)	90.7 / 39 / (43)	52.6 / 10 / (19)	80.8 / 21 / (26)	100.0 / 9 / (9)	90.0 / 9 / (10)	75.4 / 52 / (69)	79.5 / 70 / (88)
COM/RQ (Command/Request)	X	X	• / (10)	X	• / (5)	• / (11)	• / (2)	• / (9)	• / (10)	• / (10)	• / (16)	• / (21)	• / (2)	• / (14)	• / (31)	• / (47)
ATTENT (Call attention to)	100.0 / 5 / (5)	7.1 / 1 / (14)	X	• / (1)	X	• / (11)	14.3 / 1 / (7)	• / (3)	• / (4)	31.6 / 6 / (19)	• / (12)	7.1 / 1 / (14)	46.2 / 6 / (13)	5.9 / 1 / (17)	• / (15)	15.6 / 7 / (45)
PERS (Personal Comment	• / (2)	12.5 / 1 / (8)	X	10.8 / 4 / (37)	8.3 / 1 / (12)	• / (10)	• / (12)	• / (1)	X	10.0 / 1 / (10)	8.5 / 5 / (59)	• / (13)	7.8 / 4 / (51)	9.5 / 2 / (21)	• / (10)	.07 / 6 / (82)
NAME	91.3 / 21 / (23)	52 / 13 / (25)	33.3 / 2 / (6)	X	• / (9)	12.7 / 7 / (55)	• / (1)	• / (5)	100.0 / 1 / (1)	66.7 / 36 / (54)	10.9 / 7 / (64)	14.3 / 1 / (7)	87.5 / 21 / (24)	33.3 / 13 / (39)	16.1 / 10 / (62)	35.2 / 44 / (125)
COMM (General Comment)	22.0 / 11 / (50)	9.6 / 5 / (52)	6.9 / 2 / (29)	9.0 / 7 / (78)	8.5 / 6 / (71)	5.6 / 3 / (54)	5.1 / 3 / (59)	4.8 / 3 / (62)	3.2 / 1 / (31)	13.7 / 18 / (131)	7.9 / 16 / (203)	4.6 / 7 / (152)	11.2 / 21 / (187)	7.6 / 14 / (185)	5.3 / 6 / (114)	.08 / 41 / (486)

T_1 = Time 1
T_2 = Time 2
T_3 = Time 3

Bold = Percent rises
Middle = N rises in cell
(___) = Total N in cell

X = Category not productive during this time
• = No rises in that cell

Appendix B.2

MEAN FUNDAMENTAL FREQUENCY OF EACH CONTEXTUAL FUNCTION

Contextual Functions	Child AL: ALT_1	Child AL: ALT_2	Child AL: ALT_3	Child AB: ABT_1	Child AB: ABT_2	Child AB: ABT_3	Child RS: RST_1	Child RS: RST_2	Child RS: RST_3	Child: AL All times	Child: AB All times	Child: RS All times	Time: T_1 (All children)	Time: T_2 (All children)	Time: T_3 (All children)	ALL DATA
RESP (Response following a question)	300 / 47 (21)	337 / 66 (34)	283 / 34 (42)	342 / 57 (13)	260 / 22 (14)	362 / 51 (15)	326 / 39 (17)	316 / 38 (25)	307 / 45 (68)	319 / 59 (97)	322 / 63 (42)	312 / 43 (110)	344 / 49 (51)	315 / 58 (73)	306 / 48 (125)	316 / 53 (249)
RQ (Request)	371 / 40 (46)	386 / 70 (11)	366 / 42 (45)	389 / 93 (11)	349 / 34 (12)	404 / 45 (9)	374 / 51 (47)	347 / 44 (27)	344 / 52 (19)	371 / 45 (102)	378 / 66 (32)	360 / 51 (93)	374 / 52 (104)	356 / 50 (50)	365 / 48 (73)	367 / 51 (227)
GIVE	326 / 27 (24)	427 / 100 (8)	341 / 46 (8)	3 X	366 / 30 (3)	X	423 / 28 (3)	353 / 14 (2)	X	367 / 60 (40)	366 / 30 (3)	395 / 43 (5)	363 / 34 (27)	401 / 85 (13)	341 / 46 (8)	370 / 51 (48)
PRO (Protest)	X	713 / 26 (2)	312 / 44 (12)	342 / 73 (9)	387 / 48 (17)	442 / 61 (5)	457 / 43 (21)	443 / 61 (34)	389 / 96 (36)	389 / 151 (14)	383 / 65 (31)	425 / 79 (91)	422 / 75 (30)	435 / 83 (53)	376 / 91 (53)	409 / 88 (136)
RQ INFO (Request for Information)	355 / 32 (9)	370 / 47 (7)	376 / 42 (27)	X	401 / 44 (2)	416 / 81 (17)	X	233 / 0 (1)	396 / 48 (25)	371 / 40 (43)	414 / 84 (19)	390 / 57 (26)	355 / 32 (9)	362 / 77 (10)	383 / 57 (69)	386 / 59 (88)
COM/RQ (Command/Request)	X	X	307 / 34 (10)	X	290 / 34 (5)	398 / 72 (11)	304 / 14 (2)	350 / 57 (9)	320 / 49 (10)	307 / 34 (10)	364 / 80 (16)	339 / 53 (21)	304 / 14 (2)	329 / 57 (14)	343 / 68 (31)	341 / 63 (47)
ATTENT (Call attention to)	326 / 25 (5)	443 / 98 (14)	X	406 / 0 (1)	X	372 / 59 (11)	401 / 111 (7)	349 / 54 (3)	300 / 58 (4)	430 / 86 (19)	375 / 57 (12)	379 / 87 (14)	399 / 80 (13)	426 / 97 (17)	389 / 57 (15)	389 / 83 (45)
PERS (Personal Comment)	348 / 38 (2)	291 / 27 (8)	X	339 / 77 (37)	287 / 41 (12)	328 / 58 (10)	343 / 15 (12)	284 / 0 (1)	X	302 / 36 (10)	326 / 70 (59)	338 / 21 (13)	340 / 66 (51)	289 / 34 (21)	328 / 58 (10)	325 / 62 (82)
NAME	354 / 43 (23)	309 / 90 (25)	301 / 36 (6)	X	267 / 0 (9)	332 / 52 (55)	306 / 0 (1)	303 / 29 (5)	319 / 0 (1)	364 / 73 (54)	323 / 53 (64)	306 / 24 (7)	352 / 43 (24)	330 / 91 (39)	328 / 51 (62)	340 / 65 (125)
COMM (General Comment)	336 / 67 (50)	344 / 100 (52)	301 / 36 (29)	360 / 81 (78)	280 / 37 (71)	389 / 76 (54)	350 / 57 (59)	321 / 40 (62)	325 / 50 (31)	331 / 78 (131)	332 / 77 (203)	333 / 51 (152)	350 / 71 (187)	312 / 67 (185)	335 / 66 (114)	332 / 70 (486)
Mean for Column	355 / 50 (180)	338 / 99 (161)	327 / 53 (179)	355 / 79 (149)	300 / 56 (145)	362 / 70 (187)	370 / 64 (169)	350 / 66 (169)	342 / 69 (194)	350 / 72 (520)	341 / 74 (481)	354 / 68 (532)	360 / 65 (498)	341 / 82 (475)	344 / 66 (580)	348 / 71 (1533)

T_1 = Time 1
T_2 = Time 2
T_3 = Time 3

Top = mean fundamental frequency
Middle = standard deviation
( ) = N for cell

X = Category not productive during this time

Appendix B.2

MEAN PEAK FUNDAMENTAL FREQUENCY OF EACH CONTEXTUAL FUNCTION

Contextual Functions	Child AL ALT$_1$	ALT$_2$	ALT$_3$	Child AB ABT$_1$	ABT$_2$	ABT$_3$	Child RS RST$_1$	RST$_2$	RST$_3$
RESP (Response following a question)	420 79 (21)	405 107 (34)	322 47 (42)	388 76 (13)	297 38 (14)	428 85 (15)	362 53 (17)	338 38 (25)	362 66 (68)
RQ (Request)	431 60 (46)	501 101 (11)	429 63 (45)	470 142 (11)	424 48 (12)	458 37 (9)	441 64 (47)	385 57 (27)	424 70 (19)
GIVE	410 37 (24)	540 166 (8)	383 47 (8)	X	472 76 (3)	X	523 57 (3)	409 21 (2)	X
PRO (Protest)	X	991 12 (2)	377 78 (12)	462 98 (9)	460 77 (17)	501 28 (5)	532 58 (21)	498 79 (34)	487 142 (36)
RQ INFO (Request for Information)	415 32 (9)	457 92 (7)	433 63 (27)	X	503 174 (2)	506 103 (17)	X	266 0 (1)	469 67 (25)
COM/RQ (Command/Request)	X	X	373 61 (10)	X	358 73 (5)	449 79 (11)	466 11 (2)	389 88 (9)	374 80 (10)
ATTENT (Call attention to)	473 43 (5)	597 166 (14)	X	379 0 (1)	X	438 62 (11)	465 125 (7)	400 88 (3)	436 81 (4)
PERS (Personal Comment)	413 9 (2)	339 36 (8)	X	402 116 (37)	324 48 (12)	398 86 (10)	384 24 (12)	302 0 (1)	X
NAME	441 71 (23)	506 134 (25)	356 64 (6)	X	317 24 (9)	397 68 (55)	346 0 (1)	344 34 (5)	399 0 (1)
COMM (General Comment)	397 88 (50)	407 157 (52)	356 48 (29)	435 126 (78)	322 51 (71)	436 107 (54)	396 84 (59)	349 45 (62)	389 63 (31)
Mean for Column	419 70 (180)	461 159 (161)	382 72 (179)	423 120 (149)	351 79 (145)	431 90 (187)	427 87 (169)	386 82 (169)	412 99 (194)

Contextual Functions	Child AL All times	AB All times	RS All times	Time T$_1$ (All children)	T$_2$	T$_3$	ALL DATA
RESP (Response following a question)	372 90 (97)	372 88 (42)	357 59 (110)	393 74 (51)	361 89 (73)	356 70 (125)	365 78 (249)
RQ (Request)	438 69 (102)	449 90 (32)	421 67 (93)	439 74 (104)	420 81 (90)	432 63 (73)	433 72 (227)
GIVE	431 97 (40)	472 76 (3)	478 75 (5)	422 53 (27)	504 140 (13)	383 47 (8)	438 94 (48)
PRO (Protest)	464 234 (14)	480 84 (31)	501 106 (91)	493 93 (30)	504 125 (53)	463 131 (53)	486 122 (136)
RQ INFO (Request for Information)	433 64 (43)	505 105 (19)	461 77 (26)	415 32 (9)	447 116 (10)	464 80 (69)	457 82 (88)
COM/RQ (Command/Request)	373 61 (10)	420 86 (16)	389 82 (21)	466 11 (2)	378 82 (14)	400 80 (31)	396 80 (47)
ATTENT (Call attention to)	564 153 (19)	433 62 (12)	443 103 (14)	462 95 (13)	562 171 (17)	437 64 (15)	491 133 (45)
PERS (Personal Comment)	354 44 (10)	386 105 (59)	377 32 (13)	398 100 (51)	328 43 (21)	398 86 (10)	380 91 (82)
NAME	462 114 (54)	385 69 (64)	352 34 (7)	437 72 (24)	442 139 (39)	380 68 (62)	417 98 (125)
COMM (General Comment)	396 117 (131)	396 113 (203)	375 69 (152)	413 106 (187)	358 100 (185)	402 90 (114)	389 103 (486)
Mean for Column	419 111 (520)	405 103 (481)	408 91 (532)	423 93 (498)	401 122 (475)	408 90 (560)	411 102 (1533)

T_1 = Time 1   **Bold** = mean peak fundamental frequency   X = Category not productive during this time

T_2 = Time 2   Middle = standard deviation

T_3 = Time 3   ( ) = (#) N for cell

Appendix B.2

MEAN FUNDAMENTAL FREQUENCY RANGE FOR EACH CONTEXTUAL FUNCTION

Contextual Functions	Child AL ALT_1	Child AL ALT_2	Child AL ALT_3	Child AB ABT_1	Child AB ABT_2	Child AB ABT_3	Child RS RST_1	Child RS RST_2	Child RS RST_3
RESP (Response following a question)	121 / 75 / (21)	137 / 93 / (34)	77 / 50 / (42)	93 / 67 / (13)	75 / 43 / (14)	133 / 79 / (15)	71 / 51 / (17)	46 / 25 / (25)	110 / 66 / (68)
RQ (Request)	119 / 58 / (46)	229 / 77 / (11)	126 / 57 / (45)	161 / 113 / (11)	150 / 70 / (12)	108 / 72 / (9)	134 / 70 / (47)	76 / 58 / (27)	161 / 70 / (19)
GIVE	108 / 51 / (24)	227 / 148 / (8)	83 / 26 / (8)	X	212 / 94 / (3)	X	201 / 58 / (3)	112 / 71 / (2)	X
PRO (Protest)	X	556 / 28 / (2)	129 / 84 / (12)	121 / 81 / (9)	146 / 73 / (17)	118 / 69 / (5)	152 / 76 / (21)	109 / 84 / (34)	196 / 111 / (36)
RQ INFO (Request for Information)	119 / 47 / (9)	174 / 96 / (7)	115 / 57 / (27)	X	204 / 61 / (2)	178 / 91 / (17)	X	67 / 0 / (1)	147 / 67 / (25)
COM/RQ (Command/Request)	X	X	132 / 67 / (10)	X	136 / 80 / (5)	101 / 69 / (11)	163 / 7 / (2)	77 / 75 / (9)	109 / 69 / (10)
ATTENT (Call attention to)	153 / 53 / (5)	308 / 141 / (14)	X	53 / 0 / (1)	X	132 / 39 / (11)	129 / 45 / (7)	103 / 74 / (3)	153 / 104 / (4)
PERS (Personal Comment)	129 / 95 / (2)	96 / 29 / (8)	X	127 / 96 / (37)	72 / 45 / (12)	140 / 71 / (10)	82 / 53 / (12)	36 / 1 / (1)	X
NAME	173 / 65 / (23)	234 / 106 / (25)	109 / 62 / (6)	X	100 / 33 / (9)	130 / 62 / (55)	80 / 0 / (1)	82 / 18 / (5)	161 / 0 / (1)
COMM (General Comment)	124 / 57 / (50)	146 / 124 / (52)	110 / 51 / (29)	150 / 104 / (78)	84 / 47 / (71)	152 / 85 / (54)	92 / 76 / (59)	54 / 38 / (62)	127 / 50 / (31)
Mean for Column	127 / 61 / (180)	185 / 129 / (161)	108 / 59 / (179)	137 / 100 / (149)	102 / 63 / (145)	139 / 75 / (187)	113 / 74 / (169)	71 / 59 / (169)	140 / 81 / (194)

Contextual Functions	Child AL All times	Child AB All times	Child RS All times	Tape T_1 (All children)	Tape T_2 (All children)	Tape T_3 (All children)	ALL DATA
RESP (Response following a question)	107 / 77 / (97)	101 / 68 / (42)	90 / 63 / (110)	97 / 68 / (51)	94 / 79 / (73)	102 / 65 / (125)	98 / 70 / (249)
RQ (Request)	134 / 68 / (102)	142 / 88 / (32)	122 / 73 / (93)	130 / 71 / (104)	127 / 90 / (50)	133 / 64 / (73)	131 / 73 / (227)
GIVE	127 / 91 / (40)	212 / 94 / (3)	165 / 73 / (5)	118 / 58 / (27)	206 / 128 / (13)	83 / 26 / (8)	136 / 91 / (48)
PRO (Protest)	190 / 173 / (14)	134 / 74 / (31)	153 / 100 / (91)	143 / 77 / (30)	138 / 116 / (53)	173 / 106 / (53)	153 / 105 / (136)
RQ INFO (Request for Information)	125 / 65 / (43)	181 / 88 / (19)	144 / 68 / (26)	119 / 47 / (9)	169 / 90 / (10)	142 / 74 / (69)	143 / 73 / (88)
COM/RQ (Command/Request)	132 / 67 / (10)	112 / 72 / (16)	101 / 71 / (21)	163 / 7 / (2)	98 / 80 / (14)	114 / 67 / (31)	111 / 70 / (47)
ATTENT (Call attention to)	267 / 141 / (19)	116 / 65 / (12)	130 / 68 / (14)	124 / 70 / (13)	272 / 152 / (17)	137 / 59 / (15)	184 / 125 / (45)
PERS (Personal Comment)	103 / 43 / (10)	118 / 86 / (59)	78 / 52 / (13)	117 / 88 / (51)	80 / 41 / (21)	140 / 71 / (10)	110 / 78 / (82)
NAME	195 / 95 / (54)	126 / 60 / (64)	93 / 34 / (7)	170 / 67 / (24)	184 / 110 / (39)	128 / 62 / (62)	154 / 84 / (125)
COMM (General Comment)	129 / 90 / (131)	127 / 88 / (203)	84 / 64 / (152)	125 / 88 / (187)	91 / 83 / (185)	135 / 71 / (114)	114 / 84 / (486)
Mean for Column	139 / 90 / (520)	127 / 82 / (481)	109 / 77 / (532)	125 / 79 / (498)	119 / 102 / (475)	129 / 74 / (560)	125 / 85 / (1530)

T_1 = Tape 1
T_2 = Tape 2
T_1 = Tape 3

Bold = range
Middle = standard deviation
(__) = N for cell

X – category not productive during this time

Appendix B.2

MEAN DURATION FOR EACH CONTEXTUAL FUNCTION

Contextual Functions	Child AL ALT_1	Child AL ALT_2	Child AL ALT_3	Child AB ABT_1	Child AB ABT_2	Child AB ABT_3	Child RS RST_1	Child RS RST_2	Child RS RST_3
RESP (Response following a question)	345 / 314 (21)	376 / 196 (34)	356 / 333 (42)	592 / 456 (13)	353 / 266 (14)	590 / 574 (15)	279 / 296 (17)	360 / 456 (25)	492 / 344 (68)
RQ (Request)	454 / 412 (46)	657 / 205 (11)	423 / 211 (45)	750 / 630 (11)	454 / 540 (12)	363 / 145 (9)	664 / 531 (47)	494 / 439 (27)	752 / 306 (19)
GIVE	464 / 575 (24)	303 / 123 (8)	273 / 123 (8)	X	440 / 124 (3)	X	721 / 374 (3)	344 / 149 (2)	X
PRO (Protest)	X	485 / 216 (2)	505 / 324 (12)	1336 / 701 (9)	1250 / 882 (17)	431 / 124 (5)	700 / 553 (21)	971 / 746 (34)	653 / 516 (36)
RQ INFO (Request for Information)	383 / 212 (9)	710 / 312 (7)	393 / 250 (27)	X	1135 / 1392 (2)	610 / 500 (17)	X	141 / 0 (1)	354 / 460 (25)
COM/RQ (Command/ Request)	X	X	514 / 246 (10)	X	427 / 274 (5)	486 / 265 (11)	227 / 103 (2)	359 / 323 (9)	663 / 530 (10)
ATTENT (Call attention to)	990 / 791 (5)	534 / 320 (14)	X	369 / 0 (1)	X	638 / 403 (11)	615 / 492 (7)	906 / 62 (3)	966 / 324 (4)
PERS (Personal Comment	931 / 709 (2)	1091 / 338 (8)	X	1157 / 887 (37)	471 / 307 (12)	546 / 325 (10)	295 / 423 (12)	195 / 0 (1)	X
NAME	787 / 368 (23)	638 / 222 (25)	451 / 299 (6)	X	610 / 336 (9)	502 / 243 (55)	801 / 0 (1)	290 / 162 (5)	536 / 0 (1)
COMM (General Comment)	807 / 441 (50)	621 / 423 (52)	487 / 223 (29)	1104 / 786 (78)	887 / 541 (71)	488 / 341 (54)	378 / 418 (59)	343 / 205 (62)	925 / 600 (31)
Mean for Column	544 / 458 (180)	576 / 348 (161)	418 / 264 (179)	1057 / 788 (149)	789 / 603 (145)	516 / 346 (187)	498 / 482 (169)	503 / 503 (169)	655 / 488 (194)

Contextual Functions	Child AL All times	Child AB All times	Child RS All times	Time T_1 (All children)	Time T_2 (All children)	Time T_3 (All children)	ALL DATA
RESP (Response following a question)	360 / 285 (97)	514 / 457 (42)	429 / 371 (110)	386 / 362 (51)	366 / 316 (73)	459 / 380 (125)	417 / 360 (249)
RQ (Request)	462 / 322 (102)	530 / 514 (32)	633 / 472 (93)	580 / 502 (104)	520 / 425 (90)	501 / 275 (73)	542 / 424 (227)
GIVE	383 / 456 (40)	440 / 124 (3)	570 / 344 (5)	492 / 557 (27)	341 / 129 (13)	273 / 123 (8)	415 / 432 (48)
PRO (Protest)	902 / 304 (14)	1148 / 808 (31)	862 / 621 (91)	806 / 663 (30)	1042 / 789 (53)	734 / 463 (53)	890 / 665 (136)
RQ INFO (Request for Information)	443 / 274 (43)	665 / 598 (19)	346 / 453 (26)	382 / 212 (9)	738 / 596 (10)	433 / 410 (69)	462 / 427 (88)
COM/RQ (Command/ Request)	514 / 246 (10)	467 / 280 (16)	491 / 445 (21)	227 / 103 (2)	383 / 297 (14)	552 / 363 (31)	488 / 347 (47)
ATTENT (Call attention to)	654 / 506 (19)	615 / 392 (12)	778 / 407 (14)	740 / 614 (13)	599 / 324 (17)	725 / 402 (15)	682 / 443 (45)
PERS (Personal Comment	1059 / 386 (10)	914 / 790 (59)	287 / 406 (13)	945 / 867 (51)	694 / 444 (21)	546 / 325 (10)	832 / 740 (82)
NAME	681 / 314 (54)	517 / 258 (64)	398 / 240 (7)	787 / 360 (24)	587 / 267 (39)	497 / 245 (62)	581 / 295 (125)
COMM (General Comment)	586 / 397 (131)	864 / 654 (203)	475 / 456 (152)	742 / 681 (187)	630 / 478 (185)	607 / 448 (114)	667 / 561 (486)
Mean for Column	511 / 372 (520)	780 / 630 (481)	557 / 496 (532)	682 / 632 (498)	609 / 503 (475)	533 / 392 (560)	605 / 518 (1533)

T_1 = Time 1   **Bold** = duration   X = Category not productive during this time

T_2 = Time 2   Middle = standard deviation

T_3 = Time 3   ( ) = N for cell

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