DOCUMENT RESUME

ED 138 341		PS 009 202
AUTHOR	Zlatin, Marsha A.; Horii, Yoshiyuki	
TITLE	Language Acquisition: Some Acoustic and Interactive Aspects of Infancy. Final Report.	
SPONS AGENCY	National Inst. of Education (DHEW), Washington, D.C. Office of Research Grants.	
BUREAU NO	3-4014	
PUB DATE	[76]	
GRANT	NE-G-00-3-0077	
NOTE	98p.	
EDRS PRICE	MF-$0.83 HC-$4.67 Plus Postage.	
DESCRIPTORS	Child Language; *Early Childhood Education; Infant Behavior; *Infants; *Language Development; *Longitudinal Studies; *Parent Child Relationship; Parent Role; Perception; Phonetic Analysis; Preschool Children; *Psychoacoustics; Research Methodology	
IDENTIFIERS	*First Born	

ABSTRACT

This longitudinal study examines the early stages of language acquisition in four first-born infants from birth to two years. Selected aspects of vocal-verbal behavior exhibited by the children and their parents were examined. Home and laboratory recordings, diaries, interviews, and developmental observation were principal data sources. Substudies concentrating on the first 24 weeks of life included analyses of (1) fundamental frequency characteristics of nondistress vocalizations; (2) the evolution of prototype conversations; and (3) the perceptual and acoustic attributes of infant vocalization. The children displayed a rich and varied sound repertoire which seems to parallel changing aspects of evolving sensory-motor behaviors. Parent child-directed language appears to have different functions depending on such factors as the child's developmental level and the parents' perception of abilities and preferences. Preliminary findings indicate that in-depth examination of small numbers of children in a variety of interactive and non-social settings (including the home) needs to begin within the first month of life so that a large body of data, available for repeated scrutiny, can be generated. (Author/MS)

FINAL REPORT

PROJECT NO. 3-4014
GRANT NO. NE-G-00-3-0077

LANGUAGE ACQUISITION: SOME ACOUSTIC AND INTERACTIVE ASPECTS OF INFANCY

MARSHA A. ZLATIN, Principal Investigator

YOSHIYUKI HORII, Co-Investigator

Purdue University
West Lafayette, Indiana 47907

The research reported herein was performed pursuant to a grant with the National Institute of Education, U. S. Department of Health, Education and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official National Institute of Education position of policy.

U. S. DEPARTMENT OF

HEALTH, EDUCATION AND WELFARE

NATIONAL INSTITUTE OF EDUCATION

OFFICE OF RESEARCH GRANTS

ABSTRACT

Language Acquisition: Some Acoustic and Interactive Aspects of Infancy

Early stages of language acquisition for four first-born infants were studied in a longitudinal paradigm from birth to two years. Methodological and contentive goals included examination of selected aspects of vocal-verbal behavior exhibited by the children and their parents. Home and laboratory recordings, diaries, interview, and developmental observation were principal data sources. Substudies concentrating on the first twenty-four weeks of life included analyses of (1) fundamental frequency characteristics of nondistress vocalizations, (2) the evolution of prototype conversations, (3) perceptual and acoustic attributes of infant vocalization. The children displayed a rich and varied sound repertoire which seems to parallel changing aspects of evolving sensory-motor behaviors. Parent child-directed language appears to have different functions depending on such factors as the child's developmental level and the parents' perception of abilities and preferences. In response to when, where, and how to begin the study of language acquisition, preliminary findings indicate that in-depth examination of small numbers of children in a variety of interactive and nonsocial milieus needs to begin at the beginning generating detailed records that are available for repeated scrutiny. (Current status --continuing)

TABLE OF CONTENTS

Page

I. INTRODUCTION

Young children, studied from the earliest phases of development provide a cogent testing ground for hypotheses related to individual and environmental determinants of language acquisition. Historically, interest in the ontogenesis of language has involved examination of the sensory-motor period encompassing approximately the first 18 to 24 months of life (Piaget, 1952). During this time in which the child is being integrated into a social world, he is an active, creative and unique individual who becomes involved in reciprocal interactions with others and subsequent mutual regulation. Ultimately, language becomes the most effective and efficient vehicle for the child's social communication (Levi-Strauss, 1966) and his own self-regulation (Luria, 1961).

In considering the problem of where, when, and how to begin the study of language acquisition, it was concluded that sound production has the critical criterial attribute of continuity; that is, sound production features can be traced from their point of origin at birth through the developmental period. An early and still useful method of observing phonological development consisted of diaries provided primarily by linguists (Leopold, 1939-1949, 1961; Velten, 1943; Lewis, 1951, 1959) which contained anecdotal records. With the exception of Nakazima (1962, 1966, 1970, 1972), Oller, et al., (1974), Stampe (1972) and Delack (1975), theoretical models of the evolution of the phonological system which include 'prelinguistic' vocal behavior have remained without empirical support.

Jakobson (1968/1941), Shavachkin (1973/1948), and Nakazima (1972) represent a discontinuity position; they proposed that there is a clear differentiation between nonlinguistic and linguistic sound production. The discontinuity has been expressed as prephonemic/prosodic versus phonemic stages, involuntary versus voluntary, lack of constraints associated with the absence of "rules" versus "rule-governed" occurrences, etc. The continuity stance has been advocated by McCarthy (1952), Murai (1963), and more recently, by Oller, et al. (1974) and Delack (1975). The position assumed for the present investigation is that there are both continuous and discontinuous features or patterns evident as a child progresses from vocalization to verbalization. These patterns might best be revealed through systematic observation and detailed analysis of phonetic variations and their associated function and context.

Large scale cross-sectional and longitudinal normative investigations including many children allowed for specification of the milestones for acquisition of various specific measurable skills (Gesell et al., 1940; Templin, 1957; Bayley, 1969; Irwin, 1947a, 1947b, 1947c, 1947d, 1948). These contributed significant and necessary normative information. At present, we see an increasing tendency to return to studies involving small numbers of children designed to explore and describe the details of change in vocal-verbal behavior which allow for a process interpretation (Nakazima, 1962, 1966, 1970, 1972; Oller, et al., 1974; Delack, 1975; Peters, 1975). The present investigation was designed on the basis of an approach to define the genesis of individual differences, to describe qualitative and quantitative differences between stages, and to examine interaction variables which exert direct and indirect influences on children as they proceed from producing linguistically nonmeaningful utterances to their establishment of language use in interpersonal communication. We have a complex, time-consuming, and expensive task in specifying the continuous and discontinuous features of the processes and behaviors under scrutiny.

Four fundamental interdependent questions are involved in our study of infant behavior: (1) What factors motivate or impel the infant to vocalize? (2) What are the features of infant vocalization and how do they change over time? (3) What are the factors that determine the features of infant vocalization? and (4) What are the functions of vocalization in relation to the child's evolving cognitive, social, emotional and linguistic development? In order to begin to answer these questions, the objectives of the current investigation were: (1) to develop a protocol for study and analysis of longitudinal data; (2) to evolve a description of some acoustic and perceptual attributes of infant vocal behavior and of language directed to these infants during the first two years of life; and (3) to describe some aspects of parent-child interaction which foster awareness of the communicative process. The following sections of this report contain an outline of the preliminary protocol developed and the general methodology used in data collection and reduction. Background information, methodology, and results of seven preliminary substudies which have been completed will be detailed in separate sections followed by major conclusions.

II. PRELIMINARY PROTOCOL FOR LONGITUDINAL STUDY

The protocol developed involves three major research areas including the infant, the parents as representing the child's principal linguistic input, and parent-child interaction. This partitioning is intended for methodological organization of the investigation of four couples (and their first-born children who are being studied as family units).

A. Infant

1. Fundamental frequency characteristics: 0 to 2 years
   a. Objective: To trace the evolution of contrastive intonation
   b. Methodology
      (1) Descriptive statistical analysis of fundamental frequency characteristics corresponding to stages of language acquisition from its inception during the preverbal period for four infants with the following specifications:
         (a) Age of the infant
         (b) Recording conditions
            (i) Locale: home, laboratory
            (ii) Social conditions: infant alone, parent present, adult other than parent present, other
            (iii) Stage of development
      (2) Analysis of contour configurations
   c. Research completed: Descriptive statistical analysis of fundamental frequency characteristics for four infants during the first 24 weeks of life (See Section III A)

2. Syllabification and segmentation
   a. Objectives
      (1) To examine the choice of the phonetic syllable as a viable unit for description of infant vocal behavior
      (2) To specify the characteristics of syllable types in relation to the segmentation properties for infant vocal behavior
      (3) To evolve a description of the evolution of the phonological system in relation to syllable types, segmental variations, contrastive features and distributional rules
      (4) To evolve a descriptive model of the infant's behavior as he progresses from vocal to verbal utterances
   b. Methodology
      (1) Perceptual analysis: judgments of syllabicity and peaks of prominence made by individuals who have received training in listening to infant vocal behavior; randomly selected non-distress utterances sampled throughout the

period of study (0 to 2 years); acoustic analysis: spectral displays of nondistress utterances subjected to scrutiny for duration, prominent resonance structure and amplitude peaks; specification of the correspondence between perceptual and acoustic data

(2) Perceptual analysis: specification of major segmental features through a specially-adapted form of segmental transcription used by trained judges; acoustic analysis: spectral display of utterances used to specify resonance structure, occlusive features, and duration; specification of the correspondence between perceptual and acoustic data

c. Research completed

(1) Perceptual analysis of infant vocalization during the first 24 weeks for four children (see Section III B)

(2) Specification of the correspondence between the acoustic features for a sample of utterances from one infant during the first 24 weeks of life and the perceptual features for those vocalizations in relation to syllabification, peaks of prominence, and segmental transcription (see Section III C)

(3) Perceptual analysis of infant cry and noncry utterances for one infant from 3 weeks through 3 months of age (see Section III D)

d. Development of descriptive model: specification of the first 24 weeks in relation to primitive syllabification and phonetic exploratory behavior (see Section III E)

B. Parent child-directed language

1. Objective: To specify the characteristics of the linguistic environment for four children from birth to 2 years

a. Specification of syntactic structure for child-directed language

b. Specification of acoustic-phonetic attributes of selected aspects of child-directed language

c. Specification of functions of child-directed language

d. Specification of content of child-directed language

e. Comparison of child-directed language exhibited by fathers and mothers

f. Examination of the effects of varying experimental conditions on parents' child-directed language

g. Examination of the effects exerted by individual infants on the structure, function and content of their parents' child-directed language

2. Methodology
   a. Naturalistic observation and recording of parent child-directed language in home and laboratory conditions
   b. Structural analysis of parent child-directed language from written transcript
   c. Fundamental frequency analysis of selected samples of parents' child-directed language derived from acoustic analysis
   d. Segmental phonetic features and timing characteristics of parent child-directed language derived from spectral display
   e. Development of a taxonomy for description of the functions and content of parent child-directed language through observation of parent-child interaction in home and laboratory conditions
   f. Analysis of the effects of individual children on the structure, function and content of their parents' child-directed language through specification of the child's age and stage in relation to language, motor, cognitive, and social development. These factors will be used as independent variables.
3. Research completed
   a. A preliminary analysis of mothers' question forms directed to their infants during the first 16 weeks of life (see Section IV A)
   b. Structure, function and content of parent child-directed language in two experimental conditions: a comparison within and among couples (see Section IV B).

C. The evolution of conversation

1. Purpose: To describe the progression of parent-child conversation from its inception in prototype form through verbal dialogue
2. Methodology
   a. Specification of the timing features of parent-child conversations through analysis of pause time for interactive utterances
   b. Imitation
      (1) Analysis of acoustic, phonetic, and when applicable, linguistic features of parent-initiated imitative cycles (parent-child as the minimum components of a cycle)
      (2) Analysis of acoustic, phonetic, and when applicable, linguistic features of child-initiated imitative cycles (child-parent as minimum components of a cycle)
      (3) Analysis of the structure and content of verbal conversational interchange
      (4) Analysis of parent-child verbal discourse or dialogue

3. Research completed
   a. Pause time features of prototype conversations for one infant from 5 to 10 weeks of age (see Section V, A).

III. METHODS OF PROCEDURE

A. Subject Selection

Solicitation for first born infants was made through recommendations from a local obstetrician, advertisements in community newspapers, and personal acquaintance. A total of 24 couples were contacted. Nine couples met the preliminary criteria which included normal medical and psychological histories, normal hearing sensitivity and language function, English as their native language, willingness to participate in the investigation, and the condition that the mother was to be the primary caretaker. An initial interview was held with these couples during which the nature of the study was explained and details of the parents' responsibilities presented. Incentives for participation included periodic developmental evaluations, procurement of a record of the infant's development; and a master audio tape recording containing samples of the infant's utterances throughout the first two years. Following the initial prenatal interview, the couples were advised to allow some time to elapse before making a decision regarding participation. Once their decision was confirmed, the couples were seen for an additional interview to secure background information, their attitudes toward and experience with children, their expectations about newborn infants and the developmental process, and preferences in relation to sex of the infant and child-rearing practices.

The final subject selection followed the birth of the infant. Although the orientation of the investigation was that of tracing and interrelating individual patterns of behavior, reported sex differences in the child development literature (Lewis, 1971; Moss, 1967; McCall, 1972; Zelazo, 1972; Kagan, 1969; Templin, 1957; Delack, 1975) warranted inclusion of two males and two females. These four children displayed normal pre-, para-, and postnatal histories and normal hearing sensitivity. They were born within two weeks of the mother's due date and weighed between 5 lbs. and 9 lbs, 6 oz. The birth dates were September 19, 1973, October 2, 1974, December 2, 1973 and May 21, 1974.

The parents were a highly educated group. At the initiation of the study, one father had completed his doctoral work, two fathers and one mother were doctoral students, one mother was in the final stages of completing a masters degree, one was completing a bachelors degree, and one mother had two years of training in hopsital X-ray technology. Although the original criteria specified that the mother would not be working during the period of study and would thus assume the role of major caretaker, financial constraints necessitated that one mother begin working when her daughter was 10 months old. Due to the time already invested, this child was continued in the study. Through the next 14 months, she had a series of babysitters for periods ranging from a half- to a full day through which she had more continuous contact with peers than the other three children.

Following the birth of the child, recording procedures were instituted. Changes in parent and infant behavior are associated with a variety of sources internal and external to the individuals including situation or context (Nelson, 1973; Korner, 1972, 1974; Lewis, 1972), the presence or absence of observers (Wolff, 1963; Lytton, 1971, 1974), and state (Lewis, 1972, Wolff, 1963, 1965; Brackbill, 1973; Blauvelt and McKenna, 1961) to name a few. Confidence in the validity (representation of an adequate sample) and reliability of the data results from comprehensive and careful observations secured in a variety of conditions. The sources of data for the investigation included almost daily home recordings, a diary kept by the parents, weekly 24-hour logs reporting the infant's schedule of activities, and audio and video recordings made at the infant laboratory every two weeks.

B. Data Base

1. Parent Interview

Although the principal investigator and the parents have had a running dialogue throughout the conduct of this investigation, formal periodic interviews with both the mother and father were scheduled in addition to those which preceeded the initiation of recording procedures. These were held at the end of twelve months and twenty-four months of study for three of the four couples. The fourth infant has not yet reached his second birthday. The primary purpose of these interviews was to secure the parents' impression of the child's general status at that time, their view of his/her development in relation to language, cognition, social, motor and emotional growth, their views regarding the conduct of the study in relation to recording procedures, scheduling, maintaining the diary, etc., and their expectations for the next period of development.

2. Home Conditions

a. Audio recording: The parents were provided with a Sony portable cassette recorder (Model TC 110A), two microphones and a supply of tapes which were replenished every two weeks. Cleaning, operating and recording instructions were reviewed at periodic intervals. Recording samples included early awaking and pre-sleep periods, feeding, bathing, dressing, leave taking, and play alone as well as with each parent.

Prior to, during or subsequent to a recording, the parents supplied the date, time, location, activity, and position of the infant in addition to prerecording activity (e.g. "has just been fed"). The parents seem to have easily acquired the ability to automatically and naturally provide the above information which, from report, became fairly routine after a brief interval of practice. The parents have also been encouraged to make comments on the tape recordings regarding their own observations of the child which were subsequently transcribed in the infant's developmental log book.

As in past research, the problems encountered in the home recordings involve background noise, microphone distance, and microphone noises stemming from the infants' kicking, handling or eating the object which early became a target that was going to be gotten in the face of any adversity. Considerable data, however, appropriate and adequate for analysis have been derived from these tapes. The home recordings were subsequently reduced by the principal investigator according to criteria which eliminated long periods of silence (e.g. after the infant had gone to sleep) and portions with very poor signal-to-noise ratios. These tapes were then transcribed, coded by number, and retained as Master Home Tapes.

b. <u>Diary and log</u>: The parents were provided with a dated log book in which they placed almost daily notation regarding developmental information involving vocalization, language, motor skills, affective behavior (e.g. smile, reaction to strangers), food preferences and eating habits, illnesses, sleep behavior, trips, visitors, etc. The log was designed to reduce memory constraints and has provided valuable details regarding developmental change which might have slipped into obscurity. In addition, generally once a week, the parents filled out a check list for a 24-hour period providing information as to the time the child spent sleeping, awake, activities when awake (feeding, change diaper, play), people present and whether the infant was at home or out.

3. Laboratory Conditions

The infant laboratory has provided a conducive atmosphere for naturalistic observation of infants and their parents. It includes a two-way 4' x 6' observation window and a patch panel with connections for individual Sony Electret microphones (ECM 50) worn by the parent and by the child. Video and audio recording instrumentation (Teac 1230 recorder, Sony mixer MX300, Sony Video Cameras AVC-3200 and 3500, Sony Special Effects Generator SEG-1, Sony Video-corder AV 3600) were located outside the laboratory proper. Subjects have been recorded at two-week intervals throughout the period of study. The conditions included the infant alone periodically and dyadic and triadic interactions with the mother, father or both parents present.

A set of toys and furnishings appropriate for the child's developmental level have been provided. For example, initially, a portacrib was present with toys for a young infant such as squeeze objects, stuffed animals, etc.; whereas later, objects such as telephones, a table and chair, a toy stove, a play crib, tea set, and puzzles were in the room. Following each session, the infant's weight, length and head circumference measurements were taken as well as two Polaroid pictures, one of which was given to the parents.

In addition to the audio and video data derived directly from the laboratory, other aspects of the context and supplementary information were provided by the principal investigator. A running live commentary of conditions including infant state, location of principals, gaze behavior, classification of some types of utterances, observable articulatory behavior, etc. was recorded on a second channel of the audio tape. Both channels were subsequently transcribed, numerically coded, and checked for reliability with the video recording to insure correct timing of the commentary. A sample is provided in Figure 1.

Figure 1. Sample transcription from laboratory session

(J. 12/3/73; 8:6 (8 weeks, 6 days); 1:00 p.m.; 22 1/4 inches; 12 lbs. 4 oz.; awakened at 12:15 p.m. and fed; D indicated a directed vocalization, U-an undirected vocalization and Undetermined vocalizations are unmarked).
(continuation)

	Session (Channel A)	Commentary (Channel B)
37. J_____:	vocalization (D)	Active alert state looking at mother; J supine in portacrib
38. Mother:	.1 (cluck)	
	.2 Stick your tongue out?	
	.3 (cluck, cluck, cluck)	
	.4 Oh, J_____, look.	Mother sticks out her tongue
	.5 (cluck)	
	.6 Looky	
	.7 (cluck	
39. J_____:	vocalization (D)	soft; active alert state
40. Mother:	.1 Will ya do that?	
	.2 (cluck, cluck)	
	.3 Get your old tongue workin.	Mother touches J_____'s tongue and he protrudes to her finger reflexively
	.4 Where is your tongue?	
	.5 Where is your tongue?	
	.6 It's in there, isn't it?	
	.7 I see it.	
41. J_____:	vocalization (U)	J_____'s left fist to mouth
Mother:	.1 Oh, what's that?	
	.2 A finger? (Laughs)	Mother touches J_____'s fingers
	.3 You smile awfully big.	
	.4 Ya smile awfully big.	
	.5 How come you have such a big mouth?	
	.6 Such a little baby.	

As shown in Table 1, a preliminary coding system was developed to classify utterances produced by the parent and by the infant.

Table 1. Preliminary classification of infant and parent utterances for recordings made in the infant laboratory

A. Infant
   1. Spontaneous
      a. Directed
      b. Undirected
      c. Undetermined
   2. Imitative
      a. Self-imitation
      b. Reciprocal imitative
         (1) No alteration: prosodic and/or phonetic feature similarity
         (2) Phonetic alteration: including segmental features, suprasegmental features, reduction and/or expansion
         (3) Lexical and syntactic alteration

B. Parent (mother or father)
   1. Spontaneous
   2. Reciprocal imitative
      a. No alteration (prosodic-phonetic similarity)
      b. Alteration
         (1) Phonetic and/or syntactic expansion
         (2) Phonetic and/or syntactic reduction
   3. Self-imitation (self-repetition)
      a. No alteration
      b. Lexical alteration
      c. Syntactic alteration
      d. Phonetic alteration
      e. Combination

C. Reciprocal nonimitative (two part)
   1. Parent-initiated (Parent/child)
   2. Child-initiated (Child/parent)

D. Interactive
   1. Parent initiated (Parent/Child/Parent)
   2. Child initiated (Child/Parent/Child)

The infant's utterances were first classified as Spontaneous or Imitative. Within the former class, the utterance was further described as Directed if the child was in visual contact with the parent. Gaze behavior is felt to be an important sign of attachment (Bell, 1974; Stern, 1974b; Korner, 1974) and orienting (Rheingold, 1961; Sokolov, 1963) which provides information to the parent regarding the infant's preferences and capacities (Blauvelt and McKenna, 1961). When the infant's vocalization was not accompanied by visual contact with the parent, it was classified as an Undirected response; however, if the child was gazing at an object or location in the room, this was usually specified. An utterance was classified as Undetermined if the direction of gaze could not be observed. Due to the level of activity in the laboratory during recording sessions, it was decided that further classification of utterances could better be accomplished at a later time. The classification system is still being revised concurrent with the design of specific substudies within the major investigation.

4. Developmental Evaluations:

a. Audiometric Testing: Audiological examinations were conducted periodically within the Department of Audiology and Speech Sciences under the supervision of Dr. Carl Binnie. The principal form of examination initially involved observation of the children's responses to free field presentation of pure tones, speech and noise at varying levels (HL;ANSI).

b. Psychological Testing: The Bayley Scales of Infant Development (Bayley, 1969) were administered to the infants at 8, 16 and 24 months of age by a developmental psychologist. The Mental Scale was administered formally accompanied by informal observation of motor development. The Stanford-Binet Test of Intelligence (Terman and Merrill, 1960) was administered to two of the children who exceeded the ceiling for the Baylay at their 24-month examination. Results of testing were made available to the principal investigator and to the parents.

C. Data Reduction

1. Home Audio Recordings

Based on conservative average estimates, each family produced approximately 4½ hours of recording every two weeks resulting in 936 hours of home tapes for the four families over the two years. The fourth child has not yet reached his second birthday. To date, a total of 324 hours of home recordings have been reduced and numerically coded by the principal investigator and fully transcribed. This total includes reduction for one child through the first year (117 hours), reduction for one child through 44 weeks of age (99 hours), and reduction for two children through 24 weeks of age (108 hours).

2. Home and Laboratory Recordings - Developmental Master Tapes

To examine changes in the features of infant vocalization, Master Developmental Recordings for the first 24 weeks of life have been prepared for each infant from a combination of Home Master Recordings as specified in the previous section and laboratory recordings. The infant's utterances were isolated from context for these tapes and the following information accompanied every utterance: (1) source - home or laboratory; (2) original numerical code number; (3) date of recording; (4) age of the child in weeks and days; (5) whether the infant was alone or with people; if another person present, this was indicated; (6) preliminary description of the features of the vocalization or transcription; and (7) additional special comments. These sequential tapes have been used in some of the studies to be reported in subsequent sections of this report.

IV. RESEARCH STATUS: STUDY OF THE INFANT

A. Study I: Fundamental frequency characteristics of infant nondistress vocalization during the first twenty-four weeks (Zlatin, M.A. and Horii, Y.)

1. Introduction

In spoken language, variations in fundamental frequency (F_o), the acoustic correlate of vocal fold vibration, serve a linguistic contrastive function. Although numerous individuals have indicated that intonation is one of the first aspects of the infant's vocal behavior which shows phonetic drift, i. e., language-specific features (Lewis, 1951; Lieberman, 1967; Menyuk and Bernholtz, 1969; Nakazima, 1962), empirical support is meager. In addition, the literature is fraught with confusion, as different investigators employing the same terminology, mix levels of description. Lehiste (1970) exemplifies the linguist's use of the terms tone and intonation to indicate contrastive function of F_o at the word level and at the sentence level respectively. Tonkova-Yampol'skaya (1969/1973) speaks of the "intonational pattern of cry" and the "intonation of discomfort (p. 31). Both should be considered in relation to fundamental frequency contour and emotional expression, a realm of paralinguistic features (Crystal, 1975) for the adult and nonlinguistic features for the preverbal child. Description of the evolution of this prosodic feature necessitates examination of F_o characteristics displayed by infants throughout the major period of phonological development.

Variations in fundamental frequency are a reflection of complex interactions among neurological, anatomical-physiological, linguistic, and paralinguistic factors (Lehiste, 1970; Bollinger, 1964; Ohman, 1967; Crystal, 1975). From the standpoint of the infant, we need to consider increasing cortical control over vocal output (Delack, 1975; Tonkova -Yampol'skaya, 1969) during the developmental period which eventually results in his ability to match heard pitch variations, to formulate and test hypotheses regarding linguistically-contrastive contours, but much earlier, to reproduce vocal patterns which intrigue him. For example, prior to six months, infants appear to explore the extent of the pitch range their vocal folds are capable of producing. They exhibit concentrated periods of high-pitch squeals and low growling sounds (Zlatin, 1975).

The anatomical and physiological factors which influence speaking fundamental frequency are most extensive. They include size and shape of the phonatory apparatus, tension of the vocal folds, subglottic pressure, lingual articulatory gestures, and coupling of the larynx to the vocal tract (Lehiste, 1970). During the first year of life, there are major alterations of both the structures and structural relationships in the human vocal tract. As the larynx descends away from the nasopharynx (Lieberman, 1975; Hast, 1970), changes in consistency and shape as well as rapid growth in size are manifest (Kirchner, 1970; Wind, 1970). Vocal fold length almost doubles (3 mm at birth to 5.5 mm at one year). Concomittantly, there is differential enlargement of the pharyngeal area and increasing muscular stability (Bosma, Truby and Lind, 1965). Respiratory rates decrease throughout the first year with increasing thoracic participation and organization of movement in conjunction with phonatory activity (Langlois, Wilder and Baken, 1975).

One of the earliest descriptions of F_o characteristics for infants was provided by Fairbanks (1942). He examined hunger cries exhibited by one child during the first four months of life and found a progressive increase in mean F_o from an initial frequency of 373 Hz to 585 Hz. With the advent of the sound spectrograph, Lynip (1951) conducted a study of the acoustic features associated with vocalizations displayed by one infant from birth through 56 weeks. He made periodic reference to fundamental frequency characteristics.

Sheppard and Lane (1968) analyzed prosodic features exhibited by two infants from birth to five months of age. No real fluctuations of F_o within samples during this period was shown. Vocal behavior was sampled at specified times during the day when the infants were in a "good recording environment" (p. 98). During the neonatal period, the infants were periodically placed in private rooms in the hospital, and at home, samples were collected when the infant was in a plexiglas crib. From the description, these two children were always recorded alone. In addition, various types of vocal behavior including cry or distress sounds and noncry vocalization were collapsed for purposes of analysis. Although the authors do not specifically state that this procedure was used, their interpretation of the high fundamental frequencies displayed by the infants indicated that this was the case. Other studies have rather consistently revealed higher F_o characteristics in association with cry (Lenneberg, Rebelsky and Nichols, 1965; Liles, et al., 1974; Prescott, 1975; Swope, et al., 1975).

To date, the most extensive analysis of fundamental frequency characteristics was conducted by Delack (1975; Delack and Fowlow, 1975) who examined over 11,000 noncry utterances exhibited by 19 infants during the first year of life. A range of nondistress vocalizations was sampled in varying conditions. From spectrographic analysis, the findings indicated that the children showed a relatively stable mean value around 355 Hz during this period with a progressive increase of within-utterance range. Results additionally showed a sex difference in that females exhibited a higher mean F_o than males, although overlap was indicated for mean values when variability was taken into account (Delack, personal communication). This surprising finding was also shown recently in a study of cry behavior during the first 8 weeks of life (Swope, et al, 1975).

In contrast with the very early investigation conducted by Fairbanks (1942), Swope, et al. found that F_o decreased over the first two months.

Within the context of this longitudinal investigation of phonological development, the purpose of the present study was to examine the fundamental frequency characteristics of nondistress vocalizations exhibited by four infants during the first 24 weeks of life.

2. Method

The Developmental Master Tape recordings for each of the four infants were subjected to audio scrutiny.* From the sample of 1753 utterances derived from the first 24 weeks of observation, 787 nondistress, nonvegetative vocalizations were selected for acoustic analysis. Utterances were rejected when the signal-to-noise ratio was unacceptable, when another person vocalized simultaneously, and when duration was less than 200 msec. For each utterance, the infant's age in weeks, source of recording (home or laboratory), and situational context were coded.

The signals were quantized through an analog-to-digital converter with 14-bit accuracy and stored on magnetic tape. Waveform data, sampled at a rate of 10,000 times/second, was used to obtain period-by-period F_o melody plots (Figure 2). In addition to duration which was hand-calculated, the following descriptive statistics for each utterance were computed: (1) frequency range in Hz, (2) mean F_o in Hz, (3) standard deviation in Hz, (4) standard deviation in semitones, (5) median F_o in Hz, (6) mode in Hz, (7) C_5 - value in Hz of the 5th percentile, (8) C_{95} - value in Hz of 95th percentile, and (9) range between C_5 and C_{95} in semitones.

Each melody plot was subsequently checked for possible octave errors with 45-cycle narrow-band spectrographic displays (Voiceprint, 700 Series). An error rate of approximately 12% was associated with four factors. These included utterances where the infant's F_o exceeded the specified range, requiring redigitization of the signal, instances where the infant exhibited abrupt shifts in fundamental frequency generally within less than 100 msec, instances where two fundamental modes of vibration were evidenced, and utterances associated with the presence of subharmonics. Correction procedures were instituted and new descriptive statistics derived.

3. Results

The analysis of mean F_o for pooled data collapsed into four-week intervals indicated that the infants displayed little variation in fundamental frequency. The descriptive statistics

*Refer to Section III for subject selection, data collection, and data reduction procedures.

Figure 2. F_o contour (melody plot): Infant J., 3 weeks 2 days, undirected vocalization; inflected egressive vocalic type; Master Home Tape I, #10, infant alone in crib.

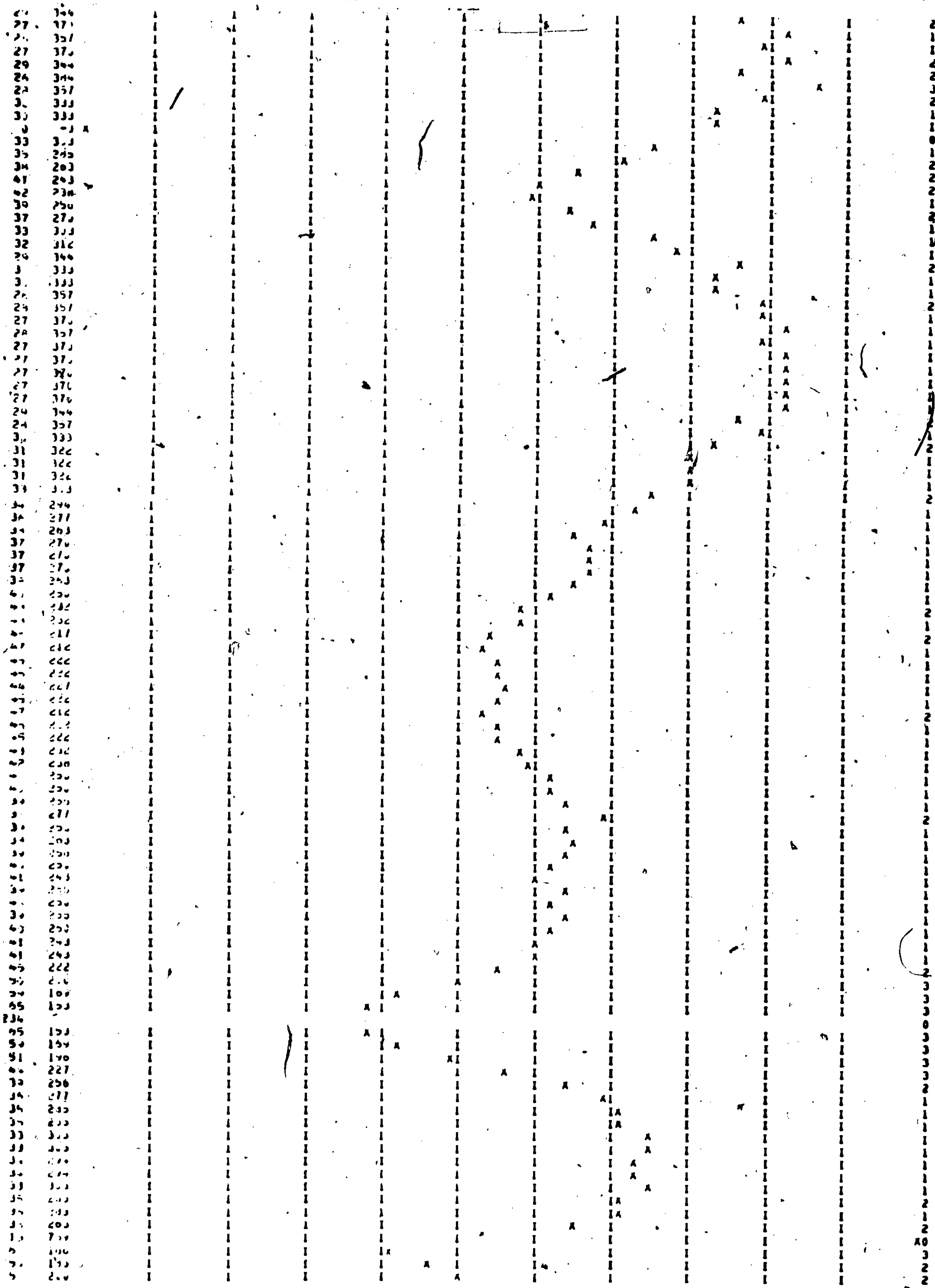


Figure 2.

for the means, plotted in Figure 3, are presented in Table 2. The mean for the period of study was 335 with a range from 317

Table 2. Measures of central tendency and variability for fundamental frequency characteristics of four infants from one to twenty-four weeks.

Interval (weeks)	Mean F_o		Median F_o		Mode F_o		s.d. Hz		s.d. Semitones	
	$\bar{X}$	s.d.	$\bar{X}$	s.d.	$\bar{X}$	s.d.	$\bar{X}$	s.d.	$\bar{X}$	s.d.
I (1-4)	317	38.2	319	38.2	329	48.0	38.8	15.2	2.24	0.95
II (5-8)	338	40.8	338	39.9	344	43.3	27.7	13.5	1.40	0.66
III (9-12)	338	40.1	337	40.9	346	43.6	31.2	15.2	1.63	0.79
IV (13-16)	339	41.7	341	41.6	346	44.8	30.4	15.5	1.57	0.71
V (17-20)	337	43.3	339	43.8	349	50.4	33.3	14.5	1.74	0.75
VI (21-24)	342	51.5	341	53.8	356	62.5	37.8	18.0	1.94	0.84

to 342 Hz. Because of the variability evidenced, it was desirable to examine whether the mean F_o values were a valid reflection of F_o characteristics. As shown in Table 3, high correlations were

Table 3. Intercorrelation matrix for measures of F_o characteristics displayed by four infants during the first twenty-four weeks of life.

	Dur.	Low F_o	High F_o	Mean	Median	Mode	C_5	C_{95}	s.d. Hz	Range (smt)	s.d. smt.
Dur.		-.33	-.01	.04	-.03	.12	-.12	.18	.30	.32	.29
Low F_o			-.24	.64	.62	.41	.90	.44	-.59	-.82	-.83
High F_o				.51	.52	.54	.28	.57	.54	.14	.21
Mean					.99	.94	.86	.93	-.04	-.24	-.34
Median						.94	.83	.91	-.02	-.22	-.31
Mode							.68	.92	.19	.01	-.08
C_5								.68	-.50	-.69	-.76
C_{95}									.24	.06	-.05
s.d. Hz										.88	.92
Range (smt)											.97

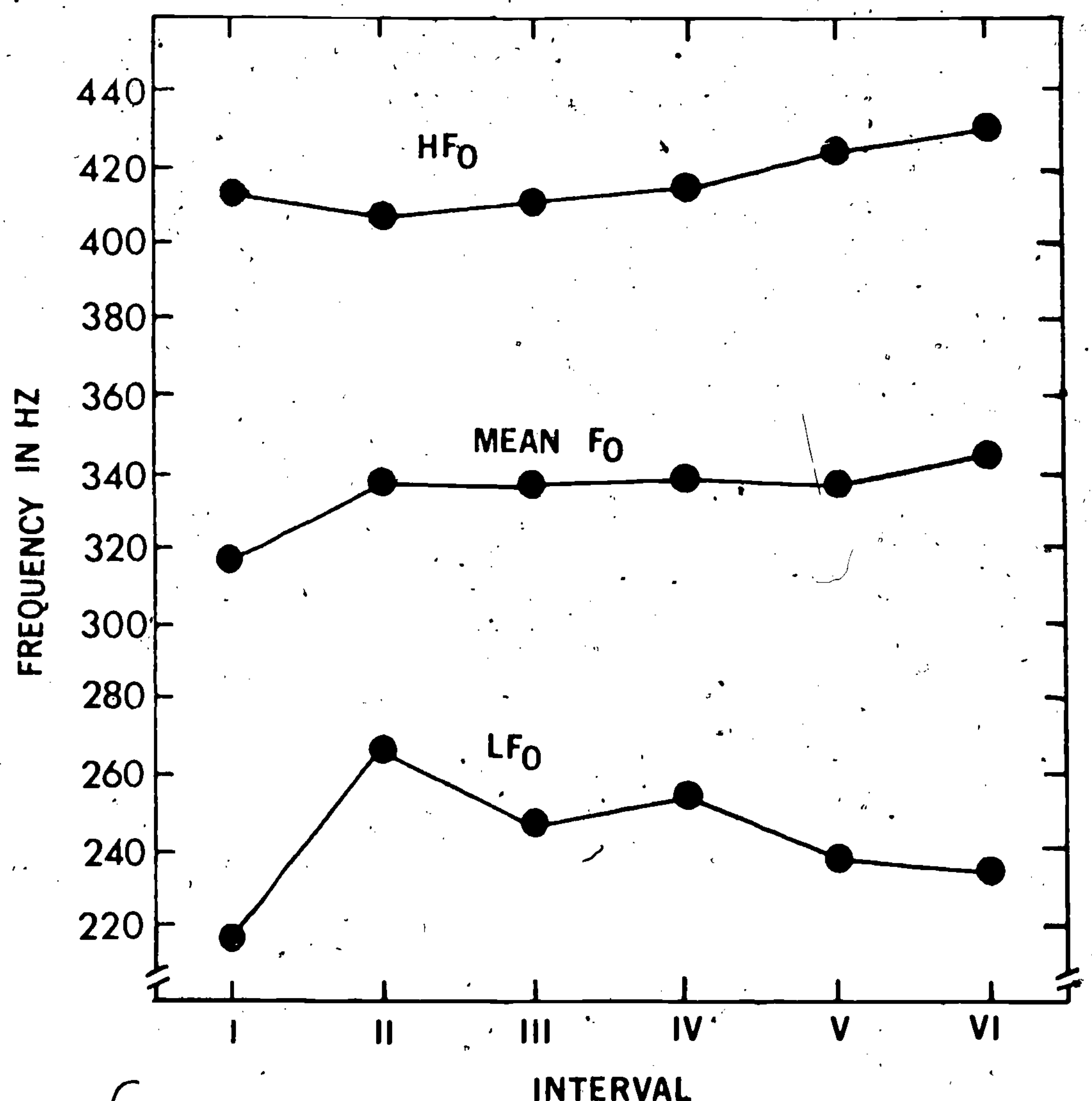


Figure 3.

Mean F_o, mean highest F_o (HF_o) and mean lowest F_o (LF_o) for four infants over the first 24 weeks. Each interval corresponds to a four-week period, thus Interval I = 1-4 weeks, II=5-8 weeks, etc.

achieved between measures of central tendency. For all four infants, mean and median values were quite consistent with each other. Modal values tended to be slightly higher.

Although there was little alteration in mean F_o, developmental changes were noted in duration and within-utterance range and variability. These two measures show parallel patterns through the first 24 weeks as depicted in Figure 4. Descriptive statistics for the range measures are presented in Table 4. High positive correlations were found between range and variability. Correlations for infants were .95, .93, .97, and .79. Furthermore, each of the four children showed a decrease of within-utterance range and variability from Interval I to II. Individual variation, which will be discussed, typified intervals II, IV, and V with all four children evidencing a rise in both parameters between 21 and 24 weeks (from Interval V to VI). Although the correlations were not as high for duration, there were positive relationships.

Table 4. Fundamental frequency range characteristics for four infants at 4-week intervals. Variables include lowest within-utterance fundamental frequency (LF_o), highest within-utterance fundamental frequency (HF_o), frequency of the 5th percentile (C_5), frequency of the 95th percentile (C_{95}), and range in semitones between C_5 and C_{95} (R_{C5-C95}).

Interval (weeks)	LF_o $\bar{X}$	s.d.	HF_o $\bar{X}$	s.d.	C_5 $\bar{X}$	s.d.	C_{95} $\bar{X}$	s.d.	R_{C5-C95} (smt.) $\bar{X}$	s.d.
I (1-4)	217	62.2	412	75.9	251	49.0	372	54.0	6.89	3.15
II (5-8)	268	50.0	408	69.8	294	40.5	381	58.5	4.34	2.15
III (9-12)	247	52.7	410	63.3	285	43.6	382	53.7	5.07	2.58
IV (13-16)	252	48.4	413	72.9	286	41.4	283	56.7	4.94	2.34
V (17-20)	239	49.7	423	76.2	281	44.5	383	55.8	5.33	2.45

Further analysis of the variables related to within-utterance range revealed a high positive correlation (r=.68) between C_5 and C_{95}. This indicated that, not only did the children vary with respect to the range itself as shown in the previous analysis, but also, they tended to move the total range simultaneously for any given utterance up and down the frequency domain.

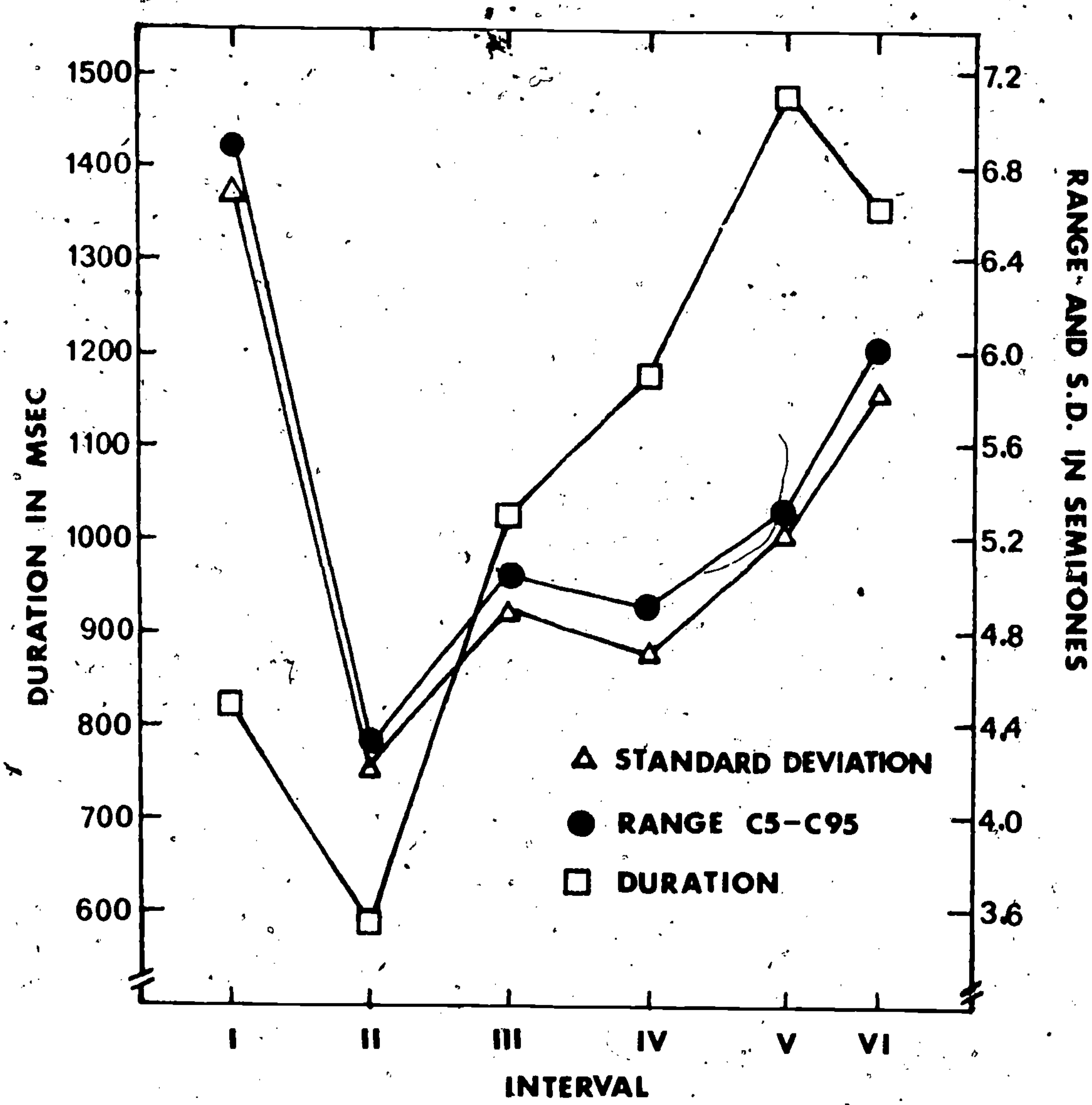


Figure 4.

Mean F_0 range in semitones, mean standard deviation in semitones, and mean duration in milliseconds for vocal fundamental frequency characteristics displayed by four infants during the first 24 weeks of life. Each interval corresponds to four-week periods. The standard deviations have been multiplied by a factor of 3.

Although the correlations between C5 and C95 were positive for all four infants, those evidenced by the two females were higher (r_{C5-C95}= .78 and .50) than those for the two males (r_{C5-C95}=.34 and .12).

Pooled data reported thus far tends to mask the variations in fundamental frequency for individual infants over the period studied. Mean F_O characteristics for each infant are displayed in Figure 5. The observed patterns and weekly changes are included in the following section.

J (Table 5): Sampling of utterances for J began at three weeks at which time his mean F_O was 315 Hz (s.d. 20.1). At 4 weeks, he evidenced a sharp rise to 385 Hz followed by a drop through 9 weeks to 305 Hz. Two subsequent peaks occurred at 13 and 23 weeks with a mean F_O of 380 and 385 respectively. With the exception of these two intervals, F_O varied about J's overall mean of 341 Hz (s.d. 21.74) for the sampling period. The lowest mean F_O at 20 weeks of 314 Hz was associated with a high preponderance of low-pitched growl-like sounds of longer duration than most utterances sampled. These dominated his vocalizations during that period. J's within-utterance range closely paralleled his mean F_O data with few exceptions. That is, range showed a pattern of dropping from 4 to 6 weeks from 6.65 semitones to 2.86 followed by a progressive increase to 7 semitones at weeks 12 and 13. J's within-utterance range decreased to 5 semitones which was maintained through 18 weeks. The period between 18 and 24 weeks showed an increase in range to a high of 10.71 semitones at 22 weeks of age. Results of the correlation analysis indicated that as the upper limits increased, J expanded his range (r_{HF_O}-R_{smt}=.78) thereby increasing the variability (r_{HF_O}- s.d.$_{smt}$=.64).

M (Table 6): Sampling of fundamental frequency for M, beginning at 4 weeks, showed a rise in mean F_O from an initial value of 351 Hz (s.d. 50.6) to a peak at 9 weeks (397 Hz, s.d. 39.0). Range dropped from a mean of 5.63 semitones to around 4 semitones during this period. M's mean F_O and range followed similar patterns showing little change between 9 and 19 weeks. Average F_O values were between 333 and 367 Hz. From 19 to 21 weeks, M's mean F_O showed a drop to 316 Hz followed by a sharp rise to 415 Hz (s.d. 62.1) as M began to experiment with high-pitched squeals of greater average duration than other utterances. The absence of samples at 24 weeks reflected a predominance of low-pitched growling sounds which were generally aperiodic. These were associated with considerable turbulance or noise in the signal prohibiting analysis. Throughout the period sampled, F_O ranged from a low of 250 to a high of 467 Hz with a mean of 358 (s.d. 23.33).

A (Table 7): A's mean overall fundamental frequency for the entire period tended to be somewhat higher than that of the other three children. Her range extended from 210 to 588 Hz with a mean of 373 (s.d. 30.93). Sampling began during the first week at which time A showed a mean F_O of 338 Hz. A subsequent rise to

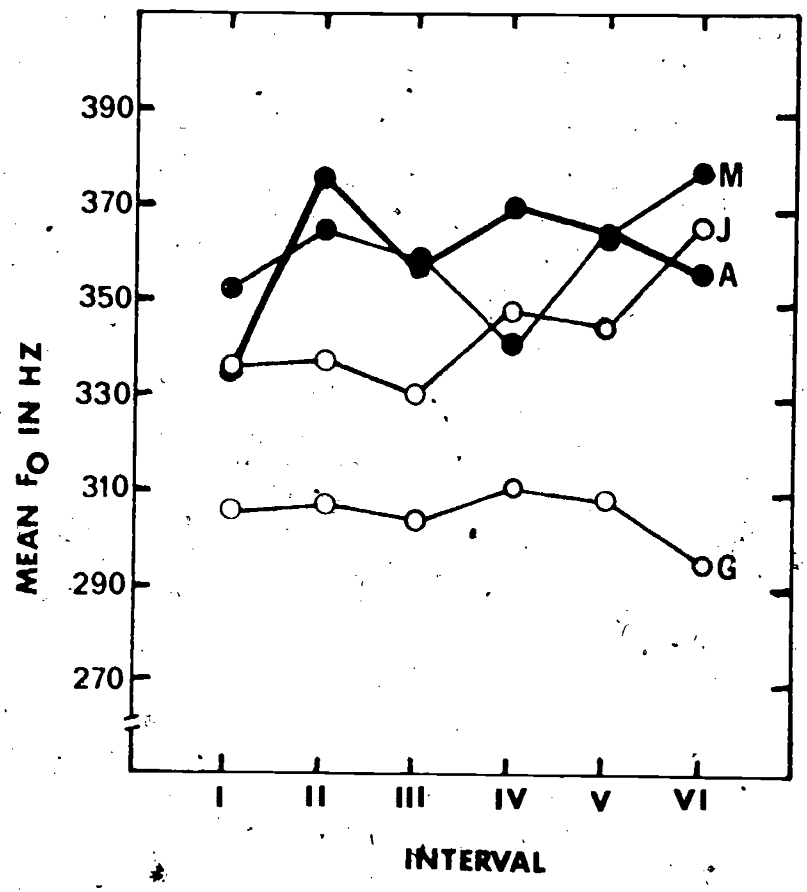


Figure 5.

Mean voice fundamental frequency values for four infants over the first 24 weeks of life.

Table 5. Fundamental frequency characteristics for J (male) over the first 24 weeks of life.

Interval (weeks)	Low F_0		High F_0		Mean F_0		C_5		C_{95}		Range (smt)	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
I (1-4)	232	76.7	445	89.1	335	33.6	268	44.9	386	32.4	6.38	2.71
II (5-8)	255	29.3	410	51.6	338	27.2	286	26.2	374	31.7	4.53	1.35
III (9-12)	213	43.3	409	67.3	330	41.3	267	44.5	379	56.7	6.04	2.71
IV (13-16)	246	61.4	421	70.5	348	46.8	285	45.7	395	68.6	5.76	2.28
V (17-20)	230	53.6	436	68.6	344	40.6	277	49.7	394	49.0	6.28	2.61
VI (21-24)	224	47.8	468	68.3	366	49.2	276	53.1	435	68.7	7.85	3.76

Table 6. Fundamental frequency characteristics for M (female) over the first 24 weeks of life.

Interval (weeks)	Low F_0 Mean	Low F_0 s.d.	High F_0 Mean	High F_0 s.d.	Mean F_0 Mean	Mean F_0 s.d.	C_5 Mean	C_5 s.d.	C_{95} Mean	C_{95} s.d.	Range (smt) Mean	Range (smt) s.d.
I (1-4)	270	44.8	458	60.2	351	50.6	295	44.3	411	62.7	5.63	1.38
II (5-8)	301	47.2	432	60.3	365	35.9	317	36.8	411	52.9	4.40	2.05
III (9-12)	294	37.0	440	58.0	359	26.4	316	23.1	407	51.0	4.23	2.46
IV (13-16)	272	21.6	412	71.2	340	28.8	303	26.6	377	41.1	3.70	1.42
V (17-20)	278	40.5	444	71.0	363	45.2	309	47.5	416	61.6	5.01	2.80
VI (21-24)	270	35.9	448	75.2	378	63.7	304	34.6	430	73.8	5.81	2.19

Table 7. Fundamental frequency characteristics for A (female) over the first 24 weeks of life.

Interval (weeks)	Low F_0		High F_0		Mean F_0		C_5		C_{95}		Range (smt)	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.
I (1-4)	294	0.0	454	0.0	338	0.0	294	0.0	433	0.0	6.60	0.0
II (5-8)	301	54.3	452	58.4	376	30.6	338	29.1	424	56.3	3.81	2.08
III (9-12)	276	45.6	425	57.2	357	36.1	309	31.0	397	48.6	4.26	2.08
IV (13-16)	266	54.2	456	63.3	370	33.2	307	43.8	420	46.4	5.44	2.78
V (17-20)	245	58.9	465	68.8	366	35.1	306	43.0	416	35.2	4.97	1.78
VI (21-24)	255	41.1	442	57.6	356	34.2	300	40.3	410	47.2	5.44	2.23

375 Hz through 5 weeks of age was maintained through the 7th week, followed by a decrease to 341 Hz at 10 weeks. Within-utterance range showed a decrease from an initial value of 6.60 semitones at Week 1 to 3.36 at Week 6 followed by a rising trend through 15 weeks at which time the value was 6.51 semitones. A's F_o characteristics varied about her mean value with peaks at 16 and 20 weeks 397 and 402 Hz. The latter was associated with a higher proportion of high-pitched squeals which dominated her vocalizations as shown for M previously. The following week, A 'played' in a lower portion of her frequency range resulting in a mean F_o of 341 Hz (s.d. 32.6). The final two weeks of sampling showed that A's vocalizations were typified by values closer to her overall mean. These were 366 and 372 Hz respectively. Within-utterance range varied between 4.9 and 5.7 semitones between 18 and 24 weeks. From the individual correlation analyses, A showed the strongest relationship between duration and range C_5 and C_{95} in semitones ($r_{dur-Range}$=.69). Longer utterances were also associated with greater variability ($r_{dur - s.d._{Hz}}$=.77).

G (Table 8): The youngest child in the study evidenced a consistently lower mean F_o in comparison to the other infants throughout the first 24 weeks. Fundamental frequency ranged from 185 to 469 Hz with a mean of 307 (s.d. 15.03). At Week 1, G's mean F_o was 315 Hz (s.d. 12.1). For fourteen of the 24 weeks, G's mean F_o was less than 305 Hz dropping to the lowest values at 21 and 23 weeks respectively. The highest mean value obtained was at 4 weeks (335 Hz, s.d. 21.0). F's within-utterance range tended to follow that of the other three children through 18 weeks with the exception of his widest range evidenced at 3 weeks (8.14 semitones, s.d. 3.66) followed by a decrease through Week 8 (2.69 semitones, s.d. 1.38). Range increased with peaks of 6 semitones at 11 and 12 weeks. Wider within-utterance range for G was also associated with greater variability (Range-s.d.$_{Hz}$=.59). Although G's mean fundamental frequency data was lower than that evidenced by the other children, he did not differ from them in relation to physical measures including weight, length and head circumference. The features which did differentiate ~~G from the~~ other children included a higher proportion of nasals in his vocalizations and less physical activity.

4. Discussion

The results of this study of vocal fundamental frequency profiles of four infants during the first 24 weeks of life indicate little developmental change in mean F_o during this period when data are pooled. The overall mean F_o was 335 Hz, about 20 Hz lower than that of the infants studied by Delack (1975). The results of both investigations, however, may be even more similar as the measurements in the Delack study were made from spectrographic harmonic displays; this technique is associated with a range of measurement error in the realm of about 40 Hz. In the

Table 8. Fundamental frequency characteristics for G (male) over the first 24 weeks of life.

Interval (weeks)	Low F_0		High F_0		Mean F_0		C_5		C_{95}		Range (smt)	
	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d	Mean	s.d.	Mean	s.d.
I (1-4)	201	54.3	395	71.5	307	30.8	237	44.2	360	49.8	7.23	3.44
II (5-8)	243	38.5	374	69.3	308	27.2	267	25.9	349	51.1	4.49	2.47
III (9-12)	226	31.4	359	33.0	304	19.8	252	32.2	342	29.6	5.27	2.51
IV (13-16)	234	31.6	373	58.2	310	28.1	263	27.8	348	42.2	4.69	1.93
V (17-20)	231	34.9	386	74.5	309	29.9	267	24.3	347	44.6	4.41	1.73
VI (21-24)	211	39.5	378	72.4	294	27.3	245	30.4	336	35.8	5.40	2.20

present study, individual variation in each of the measures was obscured when averaged as mean data; in addition, we acknowledge the limitation that the number of children included in this analysis was small.

Duration of utterances did show a developmental pattern tending to parallel within-utterance range and variability. There was a decrease in these measures from Interval I (1-4 weeks) to Interval II (5-8 weeks) followed by a progressive gradual increase through 20 weeks. The conclusions regarding the first and last intervals, however, must be regarded as tentative as relatively fewer utterances were available for analysis which may have resulted in greater excursions from the mean. With respect to duration and range, we would agree with Delack (1975) that these two time frames are at least partially independent. Increasing duration of utterances reflects alterations of both physiological variables such as respiration (Langlois, et al., 1975), as well as features of infant vocalization. The importance of regarding the characteristics of infant vocal behavior within a somewhat different frame of reference from that of the adult speaker or even a young child who has reached a stage of producing linguistically meaningful utterances is highlighted by the apparent independence of these variables. Although there appears to be no evidence to support the notion that variations in F_0 are associated with length of linguistic utterances, with the possible exception of stress (Lehiste, 1970), the children in the present investigation did show such a positive relationship.

Differences in the findings among studies of infant fundamental frequency characteristics are related to two major variables. These are sampling and measurement techniques employed. With respect to sampling, it is now evident that longitudinal paradigms are preferred over cross-sectional designs to examine the nature of change (Gilbert, 1970). Representativeness of sampling is a constant concern as vocal behavior displayed by the infant potentially varies with the social situation he is in, that is, whether he is alone or with others, with environmental variables such as sound, light, temperature, swaddling, etc. (Wolf, 1963; Brackbill, 1973; Korner, 1972, 1974), with his state and activity level, and with stage of development.

A number of investigators have found variations in infant vocal behavior depending on social context (Weisberg, 1963; Rheingold, 1963). The findings of two studies (Delack, 1975; Nakazima, 1972) are consistent in that infants showed the highest frequency of vocalizations produced when alone between 6 and 7 months of age. From our own preliminary observations, the infants participating in the present longitudinal investigation also appeared to produce differential vocal behavior depending on the social context. This was particularly apparent for one child who tended to utter a higher proportion of undifferentiated sounds during long periods of play alone in his crib at 3 months.

Upon hearing his mother's voice as she came down the hall toward his room, he emitted a series of vocalizations that would have been classified as predominantly syllabic in nature (Zlatin, 1975).

Variations in fundamental frequency characteristics displayed by infants may reflect not only specific localized changes in intratracheal pressure and muscle tone (Hast, 1966), but also more generalized alterations in muscular tension and activity levels. If F_o is associated with muscular tension of the whole body in the adult (Bollinger, 1964), we would expect potentially greater interdependence in the very young child. The resultant F_o fluctuations may be associated with different infant states as the vocal folds respond synergistically to alterations in body tension and activity levels. Infant state is not regarded as a continuum, but as reflecting qualitatively different conditions and different internal organization (Wolff, 1963). Wolff (1972) describes 5 states from regular deep sleep through crying or distress. Failure to differentiate among the types of vocalization emitted by the infant in different states results in inflated F_o values particularly when cry and noncry utterances are collapsed as in the study conducted by Sheppard and Lane (1968). Variations among cry studies may reflect different surrounding stimulus conditions. Samples of cry have been secured when the infant was judged to be hungry (Fairbanks, 1942) when his foot had been flicked or snapped with a rubber band (Karelitz and Fisichelli, 1962), when his hair had been pulled (Ringel and Kluppel, 1964) or when he was physically restrained (Swope, et al., 1975), etc. Although Murai (1961) indicated that noncry vocalizations are less state and situation bound than cry, this has yet to be empirically validated.

Fundamental frequency has been shown to be higher when an organism is excited (Bollinger, 1964). Excitement may not only be a physiological and emotional state (Bollinger, 1964), but also, for the infant, may reflect underlying cognitive operations. Kagan (1969) postulated that infant vocalizations are often a manifestation of excitement which are generated by the child as he processes moderately discrepant stimuli. Results of research conducted by Zelazo, Kagan and Hartmann (1975), furthermore, revealed that females appear to be more predisposed than males to express excitement through vocal behavior. These combined speculations and findings may contribute to our interpretation of a tendency for females in both the present study and that of Delack (1975) to evidence higher F_o characteristics. Failure to find sex differences for older children with respect to F_o may reflect greater independence of laryngeal musculature (Weinberg and Zlatin, 1970). Comparison of the two males appears to clarify and offer preliminary confirmation of the hypothesized relationship between F_o and state or activity levels. J was judged to be the more active of the two males and his fundamental frequency characteristics were more like those of the females than were G's. The latter male, as previously indicated, was the least active infant of the four, and appeared to process information predominantly through the visual modality throughout the first year. Quieting to the presentation of stimuli was most frequent for this infant. The varying behavioral profiles and consequent individual differences among infants needs to be considered when examining any aspect of developmental behavior (Crystal, 1973).

Although length of utterance, duration of respiratory cycles and type of utterance have been considered in relation to fundamental frequency variations (Sheppard and Lane, 1968; Stark, Rose and McLagen, 1975), no attention has been given to articulatory features associated with changes in quality and patterns of vocalization which vary with the infant's stage of development during the first year. In the present study, high F_o peaks after the first interval (the first four weeks) were often associated with concentrated periods of high-pitched squealing. For some infants, weeks characterized by relatively low F_o were associated with exploration of the contrasting end of the frequency domain, i.e. low-pitched growls. Variations in the number and types of segments within utterances may also contribute to F_o fluctuations. For example, Ladefoged (1967) indicated that F_o is lowered when resistance of the vocal tract impedance is increased. Nasals, which are classified as approximants and are associated with greater constriction of the supraglottal tract than vowels were more dominant in the vocalizations of the two males, particularly G. Although not yet subjected to direct scrutiny, it appears that supraglottal articulatory activity may potentially constitute an additional source of variation with respect to studies of infant fundamental frequency characteristics.

The second major source of variation in infant studies of fundamental frequency involve measurement techniques or procedures employed to extract F_o as well as adaptations which need to be made to handle the ideosyncratic features which characterize infant vocalization. The two major means of measuring F_o include time domain and frequency domain analyses. In the latter procedure, the fundamental frequency is determined from spectral displays of harmonic structure which tend to be more subject to measurement error. The technique employed in the present investigation involved computer extraction of F_o by means of a peak-picking program yielding a period-by-period analysis. The program, originally designed to analyze adult conversation, had little difficulty handling continuously periodic signals. Instances where utterances were less than 200 msec in duration, at times, presented problems. Most short utterances were characterized by some aperiodicity of the signal and abrupt shifts of F_o. The program tries to make use of 'past F_o history' within an utterance. By the time F_o level to be tracked was estimated, the utterance had terminated.

Although Stark, Rose and McLagen (1975) felt that abrupt shifts in F_o were primarily reflective of sudden changes in vocal fold tension, the high prevalence of glottal stops in infant vocalization, supraglottal constriction activity, and sudden changes in subglottic pressure may also play a role. Lehiste

(1970) for example, found that glottal stops tended to suddenly arrest rising F_o. Another somewhat ideosyncratic feature of infant vocalization is the presence of dysphonation (Truby and Lind, 1965) which has been attributed to two fundamental modes of vibration. One usually corresponds to the infants' typical fundamental whereas the second is associated with a significantly lower periodicity. The phenomenon is clearly revealed through spectrographic analysis. When first seen by these investigators, the broadly spaced vertical striations present in the spectrograms were thought to be glottal fry which has been observed in utterances produced by these children. Bosma (1972) has described multiple potential phonatory sites for the infant including the vocal folds, the aryepiglottic folds and even the ventricular folds. Pharyngeal constriction is another potential source. An imperceptible drop in amplitude is often concurrent with the presence of dysphonation.

Lehiste (1970) has noted that subharmonics appear in the presence of glottal fry in adult speakers. Dysphonation and fry in the infant vocalizations did not appear to be associated with their presence. The source of the subharmonics for infant vocalizations is currently unknown. When encountered by the computer program, an octave error was noted. The program 'looks' for the smallest difference in harmonic relations and calculates F_o. The presence of subharmonics resulted in frequency estimations which were actually one-half of the true value. In some instances, particularly for the two females, the F_o range extended beyond the upper limits set by the program. When this occurred, those utterances were, at that time, eliminated from the analysis. Therefore, the mean F_o values for A and M may be slight underestimations. Longer utterance duration was displayed by these four infants than those indicated in other studies (Delack, 1975; Murai, 1961). The difference appears to be related to variations in measurement criteria employed. We followed the principle of measuring duration from continuous vocal samples, most of which involved a single egressive flow or breath group (Lieberman, 1967). In some instances, multiple breath groups were measured, potentially inflating the duration estimates. In addition, these infants produced multiple syllabic utterances with pauses which did not reflect an alteration of the air stream direction, but a closure of the tract, most often at the glottis.

In conclusion, the fundamental frequency characteristics of infants appear to be related to a number of variables which potentially interact in a complex manner. High F_o in the infant seems to reflect not only structural properties of the larynx but also physiological and aerodynamic alterations associated with varying states. This hypothesis needs validation through direct empirical observation. If the hypothesis is confirmed, we will be compelled to pursue the question involving identification of that period in the course of development when state and vocalization become more independent.

B. Study II: Perceptual analysis of infant vocalization during the first 24 weeks (Zlatin, M.A.)

1. Introduction

In an attempt to answer the question raised earlier in relation to the features of infant vocalization and how they change over time, investigators are faced with two methodological problems. The first involves securing extensive samples of infant vocal behavior in varying conditions at different age levels. The second problem involves descriptive criteria employed.

In this study of evolving productive features, the basic unit of analysis selected was the phonetic syllable (Davidsen-Nielsen, 1974). This unit is operationally defined as a relative peak of sonorance characterized variably by a rise in fundamental frequency, amplitude and duration. Spectrographically, the phonetic syllable is characterized by a well-defined spectrum in the form of buzz-excited relatively quasi-static formants. A perceptual study was conducted to evaluate the choice of the syllable as a descriptive unit for infant vocal behavior.

2. Method

One hundred phonational episodes excluding cry, discomfort, and vegetative sounds were randomly selected from the Master Developmental Tapes for each of the four infants. Six judges, who had varying degrees of experience in listening to very young children ranging from extensive to minimal, were trained to listen in an 'infant mode' to reduce the biases imposed by past phonological experience. With training, a number of investigators have found more accurate and consistent judgments of auditory features (Wasz-Hockert, et al., 1964; Stark, Rose and Benson, 1974; Stark, Rose and McLagen, 1975). Consistent with the training procedures, in the perceptual task, judges identified the syllabicity of the utterance (Syllabic, Nonsyllabic or Combined) and the number of sonorant peaks perceived, if any, for 447 randomized productions. The judges also received training in an adapted form of segmental transcription (Table 9). This involved differentiation between vocalic types and constrictives.

Within the latter class, the subtypes were glottal stops, glottal aspirates and supraglottal constrictives. Variations in the latter category included glides and nasals. Further training was done for phonatory, articulatory, and resonatory qualities which tend to be somewhat ideosyncratic to infant utterances. These included dysphonation, hyperphonation (Truby and Lind, 1956), glottal fry, nasalization and saliva friction noise. Relative durational judgments were also made.

Table 9. Adapted segmental transcription notation for recording infant vocalizations.

Notation	Phonetic Features
NS	nonsyllabic
V	vocalic
ʔ	glottal stop
h	glottal aspirate
C	supraglottal constrictive
G	supraglottal-glide
N	nasal
Ṇ	syllabic nasal
~	additive nasal resonance as Ṽ
	dysphonation
	glottal fry or harsh quality
	hyperphonation
	saliva constrictive; diacritic placed above segmental variant(s)
.	brief duration
:	prolonged

In counterbalanced order, judges transcribed the tape recordings freefield presented at a peak level of 80 dB SPL (C-scale) via a tape loop repeater system (TEAC A1200-U recorders, AP5 speaker, Dyna-SCA 80 amplifier). In addition to interjudge reliability for syllabicity, number of sonorant peaks and transcription, intrajudge reliability was also computed for these variables. For intrajudge reliability, 10 randomly-selected utterances for each infant were transcribed posttest.

3. Results

Syllabification: As shown in Table 10 results of the analysis for judgments of syllabicity revealed a high percentage of agreement and disagreement among the six listeners. The sources of agreement and disagreement appeared to be rather evenly distributed among the four infants indicating that one child was not more difficult to judge than another.

Table 10. Syllabification: Percentage of agreement among six trained judges for 447 utterances produced by four infants during the first twenty-four weeks of life.

Number of Judges Agreeing	Total Agreement	Agreement for Individual Infants			
		M	J	A	G
6	66	60	73	61	65
5	20	25	11	20	22
4	12	09	13	14	11
3	.04	06	03	05	02

Most disagreements were associated with syllabic utterances being judged as nonsyllabic (42%) or as combined (40%). The primary sources of disagreement included utterances with an extremely high fundamental frequency, with durations of less than 200 msec, and prolonged utterances with a duration of the vocalic portion greater than one second. At times the infants initiated and/or terminated utterances with a voiced or partially voiced (breathy) inspiration. Some listeners attended to these portions of the utterance while other listeners disregarded this feature and attended only to the egressive phase of the vocalization. This condition was not anticipated prior to the conduct of the study, but will be considered in future perceptual work. The listener with the most prior exposure to infant vocalization accounted for the fewest disagreements (2.5%), whereas the two most naive listeners accounted for 52.5% of the disagreements in syllabification. These results indicated the need for more extensive and detailed training.

Sonorant Peaks: As shown in Table 11, reliability for judgments of the number of perceived sonorant peaks was poorer than that for syllabification. Nine long troublesome utterances, discarded from the analysis because of extensive disagreement, were characterized by extreme fluctuations of fundamental frequency.

Table 11. Peaks of Sonorance: Percentage of agreement among six trained judges for 447 utterances produced by four infants during the first twenty-four weeks of life.

Number of Judges Agreeing	Total Agreement	Agreement for Individual Infants M	J	A	G
6	41	36	51	41	38
5	27	30	22	24	31
4	18	26	16	12	17
3	12		06	21	12

Thus, high F_0 confounds judgments of syllabicity and number of sonorant peaks. Changes in manner, source, fundamental frequency, amplitude and sonority appeared to contribute, in a complex manner, to perception of prominence. There seems to be a relationship between the designation of syllabicity in the present investigation and a speculation offered by Menyuk (1971) in her review of infant vocalization. In addition to the variables mentioned above, Menyuk indicated that changes in respiratory control, initiatory and offset phenomena, as well as articulatory alterations, contribute to the perception of infant utterances becoming more "adult-like". Study of some of these interactions is currently in progress.

Intrajudge reliability for syllabification was also better than that for number of perceived peaks of prominence (Table 12). Detailed analysis of the segmental transcription showed that alteration of syllable structure accounted for 15% of the disagreements. This included instances where a listener added or deleted an entire syllable (11%), changed a previously identified syllable to nonsyllabic (2%), or changed a nonsyllabic to a syllabic (2%). Other sources of disagreements in transcription included alteration of constrictives (20%), alteration of nasals (11%), and addition, deletion or alteration of glottal stops and aspirates (54%).

Table 12. Intrajudge reliability: Percent of agreement for 43 infant utterances on syllabicity and number of perceived peaks of sonorance.

	Total	Individual Listeners 1	2	3	4	5	6
Syllabicity	94.2	100	93	95	91	91	95
Peaks	83.8	95	86	70	91	77	84

Results of this study indicated that the syllable is a viable perceptual unit for analysis of infant utterances. Judgments of peaks of prominence appear to be somewhat less reliable than those made for syllabicity. Furthermore, when listeners receive extensive specialized exposure to infant vocalization, a respectable degree of inter- and intrajudge reliability can be achieved. Specific features of infant vocalization which present difficulty in this type of perceptual task include high and/or fluctuating fundamental frequency and extended duration of vocalic patterns.

C. Study III: Correspondence between perceptual judgments and acoustic attributes for selected infant vocal behaviors during the first 24 weeks -- a preliminary study (Zlatin, M.A.)

1. Introduction: Evolving an acceptable valid descriptive system has constituted a major methodological problem in studies of infant vocalization. A system which includes analysis of both perceptual and acoustic attributes appears to be the most satisfactory (Crystal, 1975). A first approximation to a useful descriptive system involves, then, a choice of features or characteristics of the signal which have perceptual reliability and acoustic support. The perceptual reliability of some aspects of infant utterances including the syllable, peaks of prominence and specified articulatory features was demonstrated in the previous study (Study II in this report). An alternative but complementary feature system was used by Stark, Rose and McLagen (1975). The purpose of the present study was to examine the relationship between perceptual features and acoustic attributes for utterances produced by four infants during the first 24 weeks of life.

2. Method: For each of the four infants participating in this longitudinal investigation, a sequential Developmental Master Tape recording was prepared sampling utterances over the first 24 weeks of life (See Section II, C, 2). Three sound spectrograms were made for every utterance consisting of a wide-band (450 cycle) display with amplitude contour, a wide-band scale expanded display through 4000 Hz, and a narrow-band (45 cycle) display. For a total of 1753 utterances, 5359 spectrograms were available for the analysis.

Of the 1753 utterances, 447 vocalizations which had been semi-randomly selected for the perceptual study (See Study II) were separated and of these, preliminary acoustic analysis has been completed for 44 utterances. The analysis involved specification of total duration, duration of phonated and nonphonated portions, duration of specific features, designation of amplitude peaks, measurement of central formant frequencies, specification of intonation contour, and designation of spectral features such as noise, occlusives, etc.

From these spectrograms, the acoustic Base Structure for each vocalization was determined which was subsequently compared with the results of the perceptual judgments made by the six trained listeners (Study II).

3. Results: Excellent agreement between the perceptual and acoustic data was achieved for 41 of the 44 utterances judged as syllabic. These were characterized by one or more vocalic segments with well-defined resonance structures. Of the three remaining utterances, one revealed two nasal segments characterized by an impoverished noisy harmonic spectrum with low-frequency emphasis. This was identified by one listener as a prolonged nasal and by the other as vocalic. Four of the six judges agreed that the second utterance was nonsyllabic. It was characterized by a voiceless onset (41 msec), short duration (177 msec), a noisy harmonic spectrum, and a rapid simultaneous fall of resonances one, two and three. For the third phonational episode, two listeners indicated that the whole utterance was nonsyllabic and the others indicated that the utterance consisted of both syllabic and nonsyllabic components. The acoustic analysis revealed three nonsyllable portions with durations of less than 100 msec each characterized by the absence of prominent resonance structure and a CV (constrictive-vocalic) portion with a duration of 242 msec.

Analysis of the correspondence between the number of perceptually-identified peaks and the number of acoustic peaks revealed 83% agreement for one peak, 83% agreement for two peaks, 72% agreement for three peaks, and 48% for four. Longer utterances seemed to elicit less agreement; however. this interpretation must be made cautiously. For two utterances, one physical peak corresponded to two clearly identifiable perceptual peaks. Both utterances were vocalic-glide-vocalic sequences as confirmed from spectral display. The failure for amplitude to fall during the glide element is not known; perhaps the glide portion was not sufficiently constricted to offer DC back pressure on the glottis or increased AC impedance. In another instance, a tap from an unknown articulatory source accounted for two physical peaks where only one was perceived. In four instances, separate physical peaks perceived as one, were accounted for by the presence of dysphonation. This phenomenon has also been observed by Stark, Rose and McLagen (1975), who attributed the intensity fluctuations to the presence of pharyngeal friction.

Comparison of the segmental transcription with the base structure derived from spectral displays revealed rather consistent patterns of onset, offset, and within-utterance segments, as well as vocal quality, as shown in the correlation matrices (Tables 13, 14 and Table 15). For onset or initiatory behavior, glottal stops were identified acoustically in 30/44 utterances, but were correctly perceived only 30% of the time. These were heard more often (53%) as smooth vocalic onsets. A counter tendency was noted for offset behavior. Acoustically, vocalic offsets were perceived more than half the time as a glottal stop, especially when the terminal vocalic was of very short duration.

Table 13. Co-relation matrix specifying the correspondence between acoustic and perceptual data for onset of 44 utterances produced by one infant during the first 24 weeks of life.

	Perceptual Responses							
Acoustic	ʔ	h	C	G	N	NS	V	
ʔ	54	12	2	4		4	95	1
h	1		1	1			5	
C	2		68	1	1		2	
G			1	6	1	1	3	
N					5		1	
NS						6		
V	3			2	1		18	

Table 14. Co-relation matrix specifying the correspondence between acoustic and perceptual data for offset of 44 utterances produced by one infant during the first 24 weeks of life.

	Perceptual Responses						
	ʔ	h	C	G	N	NS	V
ʔ	15	1					9
h	10	8	1				
C	3	1	2				
G							
N	1				3		2
NS	2		1			9	
V	84	14	3		1	2	91

Embedded glottal stops were readily identified. Listeners furthermore agreed with the acoustic spectrum 95% of the time for vocalic elements and 75% of the time for embedded supraglottal constrictives. The principal confusions for supraglottal constructives involved glottal stops and glides.

Table 15. Co:relation matrix specifying the correspondence between acoustic and perceptual data for embedded segments of 44 utterances produced by one infant during the first 24 weeks of life.

			Perceptual Responses						
	ʔ	h	C	G	N	NS	V	[illegible]	omit
ʔ	18								1
h									
C	20		155	30					1
G	4		4	50	1	1	3		4
N				2	19		8		6
NS						4	2		
V					15	2	454		8
[illegible]	5							1	
Addit	7						11		

Acoustically, agreement for glides was also 75% with confusions principally involving glottal stops, constrictives and vocalics. Glides presented difficulty elsewhere in the analysis for individual listeners. Shifting vocalic quality was, at times, transcribed as having an intermediate glide. At other times, the presence of a glide in the spectral display was missed by listeners who transcribed a prolonged vocalic or two vocalics with omissions of the glide element. Nasals also provided a source of difficulty as the co:relation was 54%. Nasals were most often transcribed as vocalics (23%) or as a nasalized vocalic element.

The analysis of phonatory quality revealed that the listeners identified the presence of dysphonation 69% of the time when indicated in the acoustic display. Corresponding to the description by Truby and Lind (1965), dysphonation was characterized by a noisy harmonic spectrum and by widely-spaced vertical striations more often in conjunction with closely-spaced striations, indicating two fundamental modes of vibration. The presence of saliva constriction noise was also identified correctly 52% of the time and confused principally with dysphonation (16%).

It appears that the major sources of disagreement in this preliminary comparison of acoustic and perceptual data involve glottal stops and aspirates particularly in relation to onset and offset behavior. Other classes of sounds which present problems, as so frequently noted in the literature, include glides and nasals. The results of this portion of the investigation, however, indicate that these classes of sounds can and should be included in the description of infant vocalization, but that they warrant further study.

In relation to preparation of stimuli for perceptual studies of this nature, the presence of voiced or partially voiced breathy inspirations either preceding and/or following an utterance seems to present a special problem which must be dealt with during training sessions. This behavior appears to be more frequently associated with utterances produced by the infant in the first three months of life, although further analysis is needed to make this statement conclusively. If this observation is confirmed, we might cautiously speculate that the presence of the behavior could reflect poor coordination between the phonatory source mechanism and supraglottal articulatory activity. Its reduction, disappearance or alteration in quality could be considered to be a mark of increasing control over the systems. From inspection of this data, it appears that the infant in the early months frequently increases respiratory rate prior to the initiation of phonation, a pattern which is notably different from rest breathing. This behavior, which has also been observed by Carol Wilder (personal communication), may represent the building of air pressure and flow rates that are necessary to initiate phonation.

Results of the perceptual study indicated the viability of employing the phonetic syllable as a unit of analysis in this investigation. Acoustic data combined with perceptual judgments of syllabification, peaks of sonorance, and transcription made by individuals who have been trained to listen in an infant mode has yielded valuable information regarding the nature of infant vocal behavior.

D. Study IV: Classification of early infant cry and noncry vocalization (Zlatin, M.A., Hixson, P. K. and Coggins, C. R.)

1. Introduction

As one of the infant's earliest behaviors, crying has evoked considerable interest both as a possible index of the child's physical condition (Feingold, 1972; Karelitz, 1963; Karelitz and Fisichelli, 1962; Ostwald, 1972) and as a precursor of later language development (Murai, 1960, 1963; Wolff, 1969; Stark, Rose and Benson, 1974). Cry behavior has been variably defined as a response to distress (Nakazima, 1962; Truby and Lind, 1965) or as a physiological utterance produced in uncomfortable situations (Murai, 1960). Noncry behavior has been defined in similar, though antithetical, terms as a vocalization produced in a comfort state (Lewis, 1951).

Spectrographic analysis does not appear to provide any obvious features for differentiating cry from noncry vocalization (Wolff, 1973) leading one to conclude that there may be a similarity of acoustic and perceptual characteristics. However, duration of the utterance and preceding contextual events appear to be significant in making the distinction (Prechtl, et al, 1969; Formby, 1967; Valanne, et al., 1967).

A descriptive classification of cry has been developed by Truby and Lind (1965). They defined three primary types including phonation, dysphonation and hyperphonation. For phonation, the sound source consists of quasi-periodic vocal fold vibration and the laryngeal, pharyngeal, nasal and oral cavities serve as principal resonators. Spectrographically, this cry is characterized by an abrupt onset with a rapid rise in harmonic contour and intensity and by a fundamental frequency around 450 Hz. Dysphonation represents effortful performance with extreme constriction of the supraglottal airway. The cry is perceptually "harsh" sounding associated with a random noise-like energy dispersion evident in the spectral displays. At times, two source tones appear to be operating simultaneously, one with a low fundamental frequency around 130 Hz and the other around 500 Hz. Hyperphonation is perceived as a high-pitched vocalization or laryngeal whistle. Truby and Lind (1965) attributed this quality to an extreme contraction and subsequent foreshortening of the vocal folds or to damping of the fundamental tone. Spectrographically, hyperphonation is characterized by extreme shifts of the fundamental frequency from around 400 Hz to frequencies as high as 1400 to 4000 Hz.

This preliminary investigation was designed with a twofold purpose. First, it was necessary to determine whether the cry types of phonation, dysphonation and hyperphonation as described by Truby and Lind (1965) for cry behavior could be utilized as perceptual and acoustic features in specifying the phonatory quality of noncry vocalizations. The second question involved determination of the extent to which listeners who had no knowledge of the situational context or the infant's state of arousal could discriminate between cry and noncry vocalizations on the basis of an isolated auditory signal which was controlled for duration.

2. Method

Ninety-five cry and noncry vocalizations were selected from Home Master Recordings (see Section III, C, 1) of one infant between 3 weeks and 3 months of age. Of the 75 noncry vocalizations, twenty-five were specified as phonations, twenty-five as dysphonations, and twenty-five as hyperphonations on the basis of perceptual judgment and instrumental acoustic analysis corresponding to the definitions of Truby and Lind (1965). The cry vocalizations were also distributed according to type. Three instances of each utterance were randomized on listening tapes with a 10-second interstimulus interval.

Five adult listeners served as judges in this preliminary investigation. Prior to the listening task, the judges received training in recognition of the three primary phonatory types through a specially-prepared recording which incorporated examples from the recording which accompanies the Lind monograph (1965) and samples derived from the Master Home Tapes. Listeners performed to criterion on the training tapes prior to making judgments from the test tapes proper. Training and test stimuli were presented on an Ampex AG350 Recorder through Grason-Stadler D30 earphones. Each listener was provided with a keyed specially-prepared response form to make the following judgments: (1) cry or noncry, (2) primary phonatory type including phonation, dysphonation or hyperphonation, and (3) secondary phonatory type if the listener perceived more than one type within a single utterance.

3. Results

From the combined analysis of all vocalizations, the judges displayed correct classification of the utterance in relation to phonatory type 90.6% of the time. As a group, the listeners were slightly better judges of phonatory type for cry in comparison to noncry utterances. The percentage of correct primary judgments of cry ranged from 100% to 76.7% with a mean of 88%. The listener with the most prior experience in listening to infant vocalization achieved 100% correct judgment for cry vocalization types. When secondary correct judgments were included for the cry utterances, most listeners improved in their ability to classify vocalizations. With secondary judgments, the percentage of correct responses ranged from 76% to 100% with a mean of 92%. The percentage of correct judgments for noncry utterances ranged from 78.7% to 89.8% with a mean of 84.2%. When secondary judgments were included in the calculations, the mean percentage of correct judgments increased to 90.6%.

Examination of the three phonatory types revealed that the listeners correctly identified basic phonation 95.4% of the time. The overall percentages of correct identification for dysphonation and hyperphonation were 85.8% and 84.4% respectively. The listeners were more accurate in their judgments of dysphonation in noncry utterances (91.2%) than in cry (80.4%); however, the reverse was shown for hyperphonation in that this phonatory quality was judged correctly 86.2% of the time for cry and 82.6% for noncry. The results of these analyses indicated that listeners were able to reliably judge phonatory type at both cry and noncry utterances. There appears to be a continuity of these features for varying types of vocal behaviors displayed by infants during the first 3 months of life. High internal consistency within listeners was also demonstrated in that the percentages of the total number of utterances for which individual judges attributed the same phonatory quality to all three instances of the stimuli were 87.3%, 70.5%, 70.5%, 75.8% and 70.5%. As in the previous analysis involving comparison of judgments among the listeners, the individuals were also more internally consistent in their judgments of cry than noncry types. For the former, the percentage of utterances judged in the same manner for each of the three presentations of a given stimulus ranged from 65% to 100% with a mean of 80.0% and for the latter, scores ranged from 66.7% to 84.0% with a mean of 73.6%.

The second question posed in this preliminary study involved the extent to which listeners could differentiate between cry and noncry utterances from isolated auditory signals. Consistent with the findings of previous researchers (Prechtl, et al., 1969; Formby, 1967; Valanne, et al., 1967), the listeners identified cry correctly only 32% of the time and noncry 81% of the time. Since the duration of cry appears considerably longer than noncry vocalizations during the first three months of life, duration was controlled so that phonatory quality could be examined as the principal determining factor for making the distinction. As shown in the previous analysis, there appears to be consistency of the phonatory types for cry and noncry utterances. Therefore the results of the second analysis were not surprising. It seems then, that duration, and knowledge of the contextual events prior to and during an utterance and observation of infant state constitute the principal differentiating factors for distress and nondistress vocalization.

E. Preliminary Descriptive Model of Infant Vocalization During the First 24 Weeks: Primitive Syllabification and Phonetic Exploratory Behavior

1. Primitive Syllabification in Infancy

The preliminary results of the present investigation indicate that over the course of the first 24 weeks of life, the infant's vocalizations are characterized by an increasing frequency of syllabic utterances and a relative decrease in the frequency of nonsyllabic productions. There appears to be a small number of base structures which typify primitive syllabification during this period which are presented in Table 16. Early initiatory behavior is most often characterized by primitive laryngeal articulations (Lindqvist, 1972) in the form of

Table 16. Preliminary base structures for infant syllabification in the first 24 weeks.

One-Syllable	Two-Syllable	Elaborated
ʔV	VCV	ʔVCVCV
hV	VGV	ʔVGVʔV
CV	ʔVCV	ʔVGV V
GV	ʔVGV	ʔVʔVCV
V	ʔVʔV	ʔGVGVNCV
ʔVʔ	VCCV	ʔVNCNCN
	hVCV	ʔVNCVCh
	hVGV	ʔVʔ:ʔVCVCV
	ʔV*Vʔ	VGVCV
	NCV	

ʔ	glottal stop	G	glide
V	vocalic	N	nasal
C	supraglottal constrictive	*	dysphonation
h	glottal aspirate	:	prolonged

glottal stops and aspirates and less frequently occurring supraglottal constrictives and glides. Supraglottal constrictives and vocalic onsets increase through this period which is also marked by the emergence of syllabic nasal initiations most often released to a homorganic supraglottal constrictive. Vocalics, glottal aspirates, and glottal stops are typical offset behaviors. Infants at this very early stage show a 'preference' for open syllables which continues throughout the first and into the second year as shown by Oller (1973). The sounds intervening between two vocalic elements include glottal stops, supraglottal constrictives, and glides. A typical open-constrictive-open pattern [agʊ] and variations on this theme were observed in vocalization displayed by all four of the infants (Zlatin, 1974).

Among the four children, there was considerable regularity in the appearance and quality of two-syllable utterances and syllable elaboration. The most primitive form of glottal stop-vocalic-glottal stop-vocalic in nondistress utterances appeared around 3 weeks followed by the appearance of other two-syllable utterances between 6 and 8 weeks. Increasing occurrences of syllable elaboration were noted between 11 and 14 weeks. Throughout this period, primitive one and two-syllable vocalizations continued. Concurrent with the beginning of exploratory behavior between 17 and 21 weeks, a decline in elaborated syllable productions was noted.

2. Exploration of the Vocal Tract

To date, descriptions of exploratory behavior in relation to characteristics of infant vocalization have been vague. We have observed periods of concentrated specific repetitive vocal activities which persist for different lengths of time for each child and which show extreme fluctuations or variations within one or more parameters of phonetic behavior. The onset of vocal tract exploration appeared to correspond to the third stage of the sensory-motor period as described by Piaget (1952). A hallmark of this stage is the coordination of grasp and vision. The ages for the presence of this behavior and corresponding phonetic parameters are shown in Table 17. The specific categories of phonetic exploratory behavior include: (1) airstream direction, (2) pitch, (3) loudness, and (4) supgraglottal activity.

Three of the infants showed a period of concentrated ingressive vocalization. J provided the most outstanding example of the fortuitous discovery. Very short ingressives, primarily associated with onset and offset phenomena, were present in his early vocal behavior. One morning, J produced a loud ingressive followed by a "startle" and sudden quieting. Subsequently; a variety of ingressives continued to dominate his phonetic output for about a month. Only G failed to show exploration of ingressive flow of air during the first 6 months. He did show a brief period of play with ingressive sounds around 7½ months which lasted for less than a day. This was interpreted as indicating that 'practice' of a behavior and subsequent internalization takes a shorter period of time at later stages of development and that infants display different behaviors commensurate with their own needs and interests. The saliva or 'bubble' play and labial-lingual trills are only two examples of a larger variety of supraglottal exploratory utterances. It is our impression that duration is also explored as a phonetic parameter.

It is tempting to speculate about the latent factors which motivate the infant to explore his sound-producing system. We may consider the following: (1) The infant is a stimulus-seeking organism (Ryan, 1974; Peters, 1971; Stern, 1974a, 1974b) with a 'preference' for the auditory modality (McCall, 1974) resulting

Table 17. Exploration of the vocal tract by four first-born infants. The table presents the child's age in weeks.

	Coordination of Grasp-Vision	Direction: Airstream		Pitch		Loudness	Supraglottal Activity	
		Ingressive	Nasal Egressive	Squeal	Growl	Shout	Saliva Trill:	Lab.-ling.
M	17-18	21-22	19	23-	24	20-23	19-22	23
			13-15			15		
A	15	18	18	20-23	21	22	23	18
			21					
J	12-13	20-24	22	19	17	17	18	--
					20			
G	14-16	**	14-24	20	18	17-18	17	18-20
						21		

** 7½ mos.

in self-produced sound input; his selectivity brings him into contact with certain parts of the environment or aspects of vocal production, rather than others at different times (Dember and Earl, 1957); (2) The infant's self-regulatory ability is in the process of evolving so that he is increasingly able to bring about repetition of a desired effect or effects which intrigue him (Hutt and Hutt, 1970); (3) An incentive for some aspects of the infant's exploratory behavior is his search for novelty and subsequent continuation of behaviors which were fortuitously discovered (Piaget, 1952) such as that described for J. earlier in relation to ingressives. Once discovered, there is a continuation of the behavior because stimulation begets the desire for more stimulation. The continuation of the search for novelty and infants' preferential attention to more complex stimuli (McCall, 1971) may contribute to the syllable elaboration described earlier and to the variations of within-class phonetic parameters.

Hutt (1967) indicated that exploratory manipulative behavior declines with increasing stimulus familiarity. The specific decline in exploration and manipulation of phonetic parameters around 6 months of age may be related to Lieberman's (1975) description of the timing of physical structural development as well as to the child's cognitive growth. That is, the infant's vocal tract is undergoing rapid changes in structural relationships during this period. Therefore, it may be necessary for him, when he is able, to act on the vocal tract deriving 'knowledge' from his action. Once structural relationships are relatively stable, his actions become internalized operations. During the first 6 months, the child may be constructing the rudiments of a sensory-motor scheme through reproductive assimilation which can be called upon later in coordination with language.

3. Origins of Intelligence and Language

Some years ago, Vygotsky (1934/1962) posited that language and thought evolved from two separate genetic roots. Although his model has been widely cited, we have lacked rigorous experimental data to attest to its validity. The derived correspondence between stages within the sensory-motor period and the vocal behaviors displayed by the infants in the present study is shown in Figure 6. During the first stage the infant evidences reflexive vocalization, a common term in the language literature, consisting of cry, discomfort sounds, vegetative sounds (e.g. coughs, grunts, hiccoughs, etc. as described by Stark, Rose and Benson, 1974), and primitive one-syllable utterances. Concurrent with Stage II, the infant shows increasing syllabification in the form of two-syllable utterances. A schema for vocalization is emerging and undergoing some differentiation as illustrated by primitive syllable elaboration. The infant also shows some tendency to produce reduplicated syllables. Primitive syllable elaboration continues until the early part of Stage III, followed by a reduction in this behavior and emergence of exploratory phonetic behavior.

Figure 6. Origins of Intelligence and Language.

Stage I	The use of reflexes	Reflexive vocalization: cry, vegetative, & discomfort sounds
Stage II	The first acquired adaptations and the primary circular reaction	Early syllabification: one- and two-syllable prototypes and primitive reduplication Primitive syllable elaboration
Stage III	The secondary circular reactions and the procedures destined to make interesting sights last	Reduction of syllable elaboration Exploratory phonetic behavior Parameters: airstream direction pitch loudness supraglottal activity Reduction of exploratory phonetic behavior
(Piaget, 1952)		

The descriptive model which evolved from detailed observation of four infants during the first 24 weeks of life is yet incomplete. Further work is currently in progress that will provide more detailed specification of the nature of vocalization produced during this period. Once the data is reduced and analyzed from the remaining 18 months of investigation, this proposed early edition will not only be subjected to further scrutiny, but will be completed.

V. RESEARCH STATUS: PARENTS' CHILD-DIRECTED LANGUAGE

A. Study I: An Analysis of Mothers' Question Forms Directed to Infants During the First 16 Weeks of Life (Zlatin, M. A. and Shisler, W.)

1. Introduction

Parent-child interaction is a dynamic multipurpose condition where both participants have social, emotional and linguistic roles (Crystal, 1975). Until recently, the language environment of the infant has been described within the framework of the features of adult communication. Friedlander (1968) and McNeill (1970) both suggested that the child must contend with the "entire adult corpus". He learns, then, to decode and organize linguistic information which is often embedded "amidst pandemonium and chaos." This early description disregarded the fact that some aspects of the environment, be they linguistic or nonlinguistic, are more salient for the child than others and become instrumental in effecting variations in his behavior (Lewis and Freedle, 1972; Stern, 1974a).

In the last five years, we have seen a dramatic increase in studies of mothers' child-directed language. Results of work conducted by Broen (1972), Snow (1972), Phillips (1973), Dale (1974), and Glanzer and Dodd (1975), among others, have shown systematic differences in mean length of utterance, vocabulary, and syntactic, prosodic and acoustic features between child-directed and adult-directed utterances.

Variations in parents' linguistic behavior reflect interactions among such variables as individual style (Phillips, 1973; Nelson, 1973), the parents' changing perception of the child's comprehension and production abilities (Shere and Kastenbaum, 1966), and direct responses from the infant (Bernal, 1972; Sedlakova, 1964). Results of a structural analysis of child-directed language during the first two months preliminary to the present study indicated that question forms accounted for 50-65% of the corpi followed by declaratives (30%) and a low frequency of imperative forms. The latter was dominated by the lexical items, "see" and "look". In addition, the mothers, at times, appeared to fulfill both roles of dialogue. From a total of 776 question, 91 (12%) were answered by the mother herself.

The purpose of the present study was to obtain a detailed structural description of the types of questions mothers direct to their infants during the first 16 weeks of life in home and laboratory conditions. We were also interested in analyzing the patterns of repetition within the corpi, the frequency of mothers answering their own questions, and the frequency of infant vocalization following question form presentation.

Table 18. Categories for question forms and examples of mothers' child-directed language during the first 16 weeks of life.

Wh-Questions

Formal:
1. What do ya see?
2. What are ya lookin at?
3. What ya doin down there?
4. Who's over there?
5. Where is your blanket?

Deleted:
1. Huh? (meaning what did you say?)

Formal + Tag
1. What'sa troubles?...Hmm?
2. What happened to all those smiles we had yesterday?...Hmm?
3. Where do all those great big eyes come from?...Huh?
4. What you doin down there?...Huh?
5. Who's over there?...Huh?

Interrogative Reversals

Formal:
1. Are you getting sleepy?
2. Aren't ya gonna be good today?
3. Is that Marsha there?
4. Is that what you want?
5. Would you repeat that please?

Deleted:
1. You gonna walk? (= Are you gonna walk?)
2. Ya gonna make a speech?
3. Having a bad time?
4. Watching his one?
5. Gonna turn over?

Formal + Tag
1. Will you wake up and smile a little bit? ...Huh?
2. Can ya stick your tongue out?...Huh?
3. Is that better?...Hmm?
4. Would you like everything clean on?...Huh?
5. Is that your problem? ...Huh?

Deleted + Tag
1. Ya gonna go to sleep on Marsha again?...Hmm?
2. Well, you gonna do some tricks?...Hmm?
3. You ready to go bye-bye? Huh?
4. You gonna take a nap? ...Hmm?
5. You gonna talk some more?...Huh?

Do Support Questions

Formal:
1. Do you hear that?
2. Do you see anybody in there?
3. Did you call?
4. Do you see that, Mandy?
5. Don't you wish you never had to wear clothes?

Deleted:
1. See Marsha's head? (Do you see Marsha's head?)
2. You want him?
3. Ya know that?
4. Ya want your hair combed?
5. Wanna sit up a minute?

Formal + Tag
1. Do ya wanna hold this?...Hmm?
2. Now do you think Marsha wants to hear that?...Hmm?
3. Do you know where it came from?...Hmm?
4. Don't cha want to go to sleep?...Hmm?
5. Do you think you can fit both those hands into your mouth?...Hmm?

Deleted + Tag
1. You see anybody in there?...Huh?
2. You see anything you like there?...Huh?
3. Wanna go to the lumber yard?...Huh?
4. Anything to say today?...Hmm?
5. You agree?...Huh?

Supra-segmental Questions
1. You're not talking?
2. They did?
3. No smiles at all today?
4. Nothing better to do?
5. Nothing more?

Formal Tag Questions
1. You're not going to go to sleep, are ya?
2. You just forgot a couple of syllables, didn't ya?
3. Well you're learning how to reach for things, aren't cha?
4. You've been keeping to yourself, haven't ya?
5. You want to have a nice clean bed later, don't you?

Multiple Tag Questions
1. You're not going to go to sleep, are ya? Huh?
2. Can you get up on your knees, Huh? Huh?
3. Can you tell me more, Hmm? Heh?
4. Where did you get those? Hmm? Hmm?
5. Can I have a laugh this morning? Huh? Huh?

2. Method

Question forms were derived from transcriptions of Home and Laboratory recordings (See Sections III, B, 2, a and III, B, 3 of this report) for mothers of first-born infants between the ages of 4 and 16 weeks. This time span was separated into three periods including 4 to 7 weeks (A1), 8 to 11 weeks (A2) and 12 to 16 weeks (A3).

Five major structural categories were wh-questions, interrogative reversals, do-support questions, questions marked by suprasegmental intonation contour only, and tag questions. Within each of these categories, subtypes included (1) formal - the surface form of the question met the requisites for structural completeness; (2) deleted - utterances where one or more constituents were omitted from the surface form; and (3) formal plus informal tag - question forms followed by utterances such as, "huh" or "hmmm". Other modifications or combinations of these classifications and examples of each are provided in Table

Child-directed language is characterized by a high rate of repetition (Broen, 1972). The results of our own preliminary work indicated that mothers of infants during the first 2 months of life showed a repetition rate of 28% for questions (221/776) in various forms. In the present study, a question was classified as a repetition if it contained the same or similar meaning as the one preceding it. As shown in Table 19, the subcategories of repetiton included (1) exact, (2) deletion, (3) addition, (4) paraphrase, and (5) syntactic adjustment.

A repetition was classified as exact if no syntactic or lexical alterations were made. When a repetition was characterized by a loss or addition of information carried in the initial utterance, it was classified respectively as a deletion or addition. Syntactic adjustment involved transformation of internal constituents without alteration of the question form. A repetition which contained the same information as the preceding question, but was stated in a different manner, was considered to be a paraphrase. The frequency of question forms, repetitions, answered questions, and the number of times infant vocalization followed presentation of a question form was tabulated for each mother in home and laboratory samples. A total of 1700 questions were analyzed including 1026 from the first mother and 674 from the second

3. Results

As shown in Table 20, wh-question forms showed the highest frequency of occurrence followed by interrogative reversal, do-support, tag and suprasegmental question forms. Little difference was shown in the comparison of the frequency of these question forms between home and laboratory conditions with the exception of do-support questions which occurred more

Table 19. Categories of repetition question forms and examples from child-directed language during the first 16 weeks of life for two mothers.

Repetitions		
Exact:	1.	Are you getting sleepy? Are you getting sleepy?
	2.	What are ya lookin at? What are ya lookin at?
	3.	What do you say? What do you say?
	4.	What you doin down there? What you doin down there?
	5.	Is that the best you can do? Is that the best you can do?
Deletion:	1.	Ya gonna go to sleep on Marsha again?...Huh? To sleep?
	2.	Will you wake up and smile a little bit? Wake up and smile a little bit?
	3.	Is she gonna go for a little ride today? Is she gonna go for a ride?
	4.	Ya want your hair combed? Want your hair combed?
	5.	What do you say this morning? What do you say?
Additions:	1.	What happened to all those smiles we had yesterday? What happened to all those smiles and talkin we had yesterday?
	2.	Gonna take it? Gonna take the bottle?
	3.	Are ya saying hi? Are ya saying hi or I?
	4.	You lookin at the light? Are you lookin at the light?
	5.	Anything interesting? Do you see anything interesting this morning?
Paraphrases:	1.	What do you see over there? What are you lookin at?
	2.	Who's that? Who's over here?
	3.	This is something like yours, isn't it? Is this something like your?
	4.	Your're not talking? Aren't you talking today?
	5.	Does ________ want to go for a little ride? Is she going for a ride today?
Syntactic Adjustments:	1.	What is that? Well, what was it?
	2.	Dance for her? Dance for us?
	3.	What are those, _____?...Huh? What are these, _____?...Huh?
	4.	Shall we change your bottom? Shall we change it?
	5.	What are you struggling about? What are you struggling for?

Table 20. Frequency of occurrence of five major types of question forms presented to two infants during the first 16 weeks of life in home and laboratory conditions.

Question	Frequency of occurrence			
	Laboratory	Home	Total	% of Total
Wh-question	384	354	738	43
Interrogative Reversal	178	243	421	25
Do-support	193	158	351	21
Tag	63	99	162	9
Suprasegmental	10	18	28	2

frequently in the laboratory condition and interrogative reversals were considerably more frequent in the home.

Further analysis showed that the mother most often presented the children with complete syntactic forms of questions. Complete (formal) forms accounted for 69% (1202) of the questions followed by deletion of initial constituents (14%), the addition of an informal tag (13%), deletion plus informal tag 92%), and multiple tags (2%). These findings were consistent within each of the major question types examined.

Results of the analysis of frequency of occurrence of each of the question types over the age range from 4 to 16 weeks indicated that for four of the five categories an increase was shown from A1 (4-7 weeks) to A2 (8-11 weeks) followed by a decrease in the third period A3 (12-16 weeks). These categories included wh-questions, interrogative reversals, do-support and tag questions. Only the category of suprasegmentals showed a consistent decrease over this period. The noted increase between 8 and 11 weeks may be related to the infants' expanding behavioral repertoire. Vocalizations increased in over all frequency as did social responsiveness shown in behaviors such as smiling and prototype conversations.

From the total of 1700 questions, 382 (22%) were repeated by the mothers in some manner. Exact repetition of a previous utterance accounted for 41%, followed by paraphrase (29%), addition (14%), deletion (13%), and syntactic adjustment (3%). Consistent with the increase in frequency of question types during the second period, a higher rate of self-repetition was also shown during this period followed by a slight decrease (Table 21). Exact repetitions and paraphrase showed the most dramatic rise from A1 to A2.

Table 21. Rate of self-repetition of question forms in child-directed language during the first 16 weeks of life. A1 represents the period from 4 to 7 weeks, A2 from 8 to 11 weeks, and A3 from 12 to 16 weeks.

Repetition Type	A1	A2	A3	Total	% of Total
Exact	31	69	58	158	41
Deletion	14	19	16	49	13
Addition	11	16	27	54	14
Paraphrase	20	54	35	109	29
Syntactic Adjustment	2	6	4	12	3

The repetition rates at home and in the laboratory were quite similar. The frequency was 52% (197) for the home condition and 48% (185) for the laboratory. Examination of the repetition subtypes indicated that there was consistency with the overall analysis for three of the five categories including exact repetition, deletion and paraphrase. Although the frequency of occurrence was low, parents doubled the number of additions in the home condition (36 for home compared with 18 in the laboratory) and produced a greater number of syntactic adjustments in the laboratory.

From the corpus of 1700 questions, 159 (9.4%) were answered by the mother herself. Analysis across the three age periods indicated a rate of 26% (42) for A1, 50% (79) for A2, and 24% (38) for A3. Again, the frequency of the mothers answering their own questions was similar in laboratory and home condition. The former showed a rate of 48% (76) and the latter 52% (83).

As indicated in the methods section, M1 showed a higher overall number of questions in comparison to M2, exhibited a higher frequency of questions in the laboratory (53% than at home (47%), showed less frequent repetition of utterances than M2, and answered her own questions about 10% of the time. The second mother (M2) exhibited fewer questions in the laboratory (43%) than at home (57%), showed a higher self-repetition rate than M1, and showed a comparable rate of answering her own questions (3%). For the first mother, 15% of all questions analyzed were repeated in some manner, while the second infant was exposed to a repetition rate of 34%. While the proportion of total number of questions answered by the mother was similar for the two women, the absolute frequency of occurrence was nearly double (105) for M1 in comparison to M2 (54). It appears, then, that the second child was exposed to fewer questions, fewer answered questions and greater redundancy. Observation of the frequency of vocalization following questions presented by the mother showed a lower overall rate for the infant of M2 (22%). From a total of 182 (11%) vocalizations, the first infant produced 131 (72%) and the second 51 (28%). A comparison across the three age periods indicated a vocalization rate following questions of 15% (28) for A1, 52% (94) for A2, and 33% (60) for A3. Corresponding to the principal investigator's subjective impression, the infants were more vocal in the home (57%) than in the laboratory (43%).

4. Conclusion:

In summary, questions presented to children by 2 mothers during the first 16 weeks of life are most often syntactically complete, are characterized by a higher percentage of wh-types in comparison to other forms, are repeated about 22% of the time most often exactly, and are answered by the mother herself about 9% of the time. A comparison of the three periods within the first 16 weeks indicated that the time between 8 and 11 weeks, when the infant is displaying increased vocalization and an expanding behavioral repertoire is associated with more frequent questions presented by the mother, more frequent repetition of questions and a higher rate of the mothers answering their own questions. Although the total number of questions directed to these two children was similar in home and laboratory conditions, as was the rate of self-repetition and answering, there were differences in the frequency of specific subtypes of question forms and the amount of information provided by the mothers through their questions. Based on a low frequency of occurrence, the mothers more frequently added information to self-repeated questions in the home condition. Stylistic differences were shown in that the mother of the more vocal infant produced a greater number of questions, more often answered her own questions, and repeated herself less often. The results of this study should be considered to be preliminary at this time because of the small number of individuals involved and the limited sampling period. Nevertheless, this data contains valuable descriptive information in relation to the linguistic environment of the young infant which will be further analyzed in a longitudinal paradigm.

B. Study II. Structure, Function and Content of Parents' Child-Directed Language: A Comparison Within and Among Couples (Zlatin, M. A. and Phelps, H. L.)

1. Introduction:

The background information in relation to the characteristics of and factors related to child-directed language displayed by parents during the first two years of their children's lives has been provided in the introduction to the previous study (Section IV, A). Although there is a growing literature describing the features of mothers' child-directed language, there are comparatively fewer involving fathers (Rebelsky and Hanks, 1971; Giattino and Hogan, 1975). In addition, to our knowledge, there has been no study to date which has simultaneously examined both a child's language acquisition and his immediate linguistic environment; that is, both the child and the parents studied as a family unit over the first two years.

The purposes of the present descriptive study were to attempt to code and quantify three large aspects of oral language interchange between children and their parents -- structure, function and content. Although linguistic structure has been examined in some detail, it was necessary to evolve a preliminary taxonomy for function and content. In addition, this study addressed itself to three major questions: (1) What effect does altering the experimental conditions have on parent language? (2) Are there differences in child-directed language between mothers and fathers in relation to structure, function and content? (3) What are the potential effects of the child's language on his/her parents' linguistic behavior?

2. Method:

Subjects

At the time of study, three of the four infants were at Stage I (Brown, 1973) in their language development and the fourth child was at a preverbal stage. J, age 1;21.6 (one year, 21 weeks, 6 days), showed primarily single-word utterances with two-wordcombinations emerging (e.g. "get down"), self-repetition of undirected single words with variations in intonation representing phonological play, extensive facial expressions, and was highly imitative. He engaged in manipulative and functional play. A, age 1;14.3, exhibited an extensive single-word vocabulary, infrequent 2- and 3-word utterances, phonological play in the form of rhythmic syllabification, and appeared to be quite 'conversational' in that she both answered questions and gave directions. M, age 1;25.3, exhibited primarily jargon, single words, infrequent 2-word combinations, and engaged in some phonological play. G, age 0;42.0, was at the preverbal stage. He exhibited some reduplicated syllables, vocalizations characterized by a variety of syllable types, and extensive nasals. He was at the stage of scooting behavior and was beginning to crawl. Play was characterized by manipulation and mouthing of objects and extensive visual scanning.

Procedures

Each parent was seen for two half-hour interactive sessions on successive days in the infant laboratory, a naturalistic playroom with a 4' by 6' one-way mirror. On the first day, the parent interacted with the infant for a half hour of free play. On the second day, the parent/child interaction was under similar conditions, but the parent was given a series of instructions which related to a specific set of activities that the child was to be engaged in. The activities included feeding the child pudding, showing him a book, presenting a set of selected stimulus cards, playing with body parts, and playing with toys provided. The toys and furnishings in the room were identical under both conditions.

The sessions were recorded on audio and video tape. A live corresponding narrative was made on the second channel of the audio recorder. All instrumentation (Sony Video Cameras AVC-3200 and 3500, Sony Special Effects Generator SEG-1, Sony Video-corder AV-3600, TEAC 1230 recorder) was outside of the playroom with the exception of individual microphones (Sony Electret ECM-50) worn by the parent and by the child.

A total of 1600 utterances was analyzed which included 100 from 4 mothers and 4 fathers in free play and directed play conditions. Structure was analyzed from written transcripts, while function and content were determined from a combination of the transcripts and video tape recordings. Mean length of utterance was calculated by computer (ESSAY Program developed by Alden Mo and associates).

The categories for structure, function and content are presented in Table 22. Under structure, incomplete sentences greater than one word were designated as constructions (e.g. "and another one"). The second category under function was a general one which included labeling, locating, demonstrating (e.g. "This is how it goes."), and attributing. The category of self-talk was developed from our preliminary observations that some of the parents' utterances, although possibly directed toward the child, appeared to reflect externalized thought processes. These were found most often to be characterized by greater length and by more 'exotic' vocabulary items. Some examples are listed on the following page:

Table 22. Structure, function and content categories for parents' child-directed language.

Structure	Function	Content
Single words	Questions	Inanimate objects
Constructions	Labeling +	Motor
Declarative Statements	Positive Reinforcement	Social
Imperatives	Self-talk	Sensory
Questions	Affective Mood	Affective
	Onomatopoetic +	
	Games and Rhymes	
	Denial	
	Attention-getting Nondirectives	
	Reports	
	Modeling Social Behavior	

I think Mother Goose has her stories mixed up.
You're in rare form today.
You're rambunctious today.
What are you investigating?
I've got a deal you can't refuse.
I'm gonna enroll you in mechanical engineering.
You're not really paying attention to me, are you?

Other utterances which were classified as self-talk included a subcategory where parents appeared to be talking for the child superimposing an externalized thought process. Examples include:

Say, I don't know what those things are, Mom.
Say, big deal.
I'll just get it myself, Dad.
No kisses for Mom? Is that what you say?

Under function, conveying affective mood on the parent included utterances such as, "oh!", "wow!", "aw", "ouch", and "Oh my goodness." The next category included onomatopoetic sounds and instances when the parents ascribed sounds to inanimate objects such as, "brrr" for motors, "meow, beep-beep, boom, bzzz, ring-ring" (for the telephone), and "That bear says I wanna be your friend." The next function category involved statements denying the truth value of lexical forms or statements and denial of the correctness of a phonological form (e.g. "No, that's a pluto." "That's not mommy's knee.") The last three categories were attention-getting nondirectives such as calling the child's name, reports involving statements which dealt with objects, events, and/or people displaced in time or space from the immediate situation, and modeling social behavior such as talking on the telephone.

The categories for content included: (1) inanimate objects, (2) motor, e.g. "Sit down. Clap"; (3) social, e.g. "good girl", games and rhymes; (4) sensory, e.g. "look", "What do you see?"; and (5) affective, e.g. "Are you tired?" "You think you're so cute." "What's the matter?" If an utterance was associated with more than one content category, multiple frequencies were tabulated. For example, the direction, "Look at the book." would receive a point for the sensory category and a point for the inanimate object category.

3. Results and Discussion

Experimental Conditions

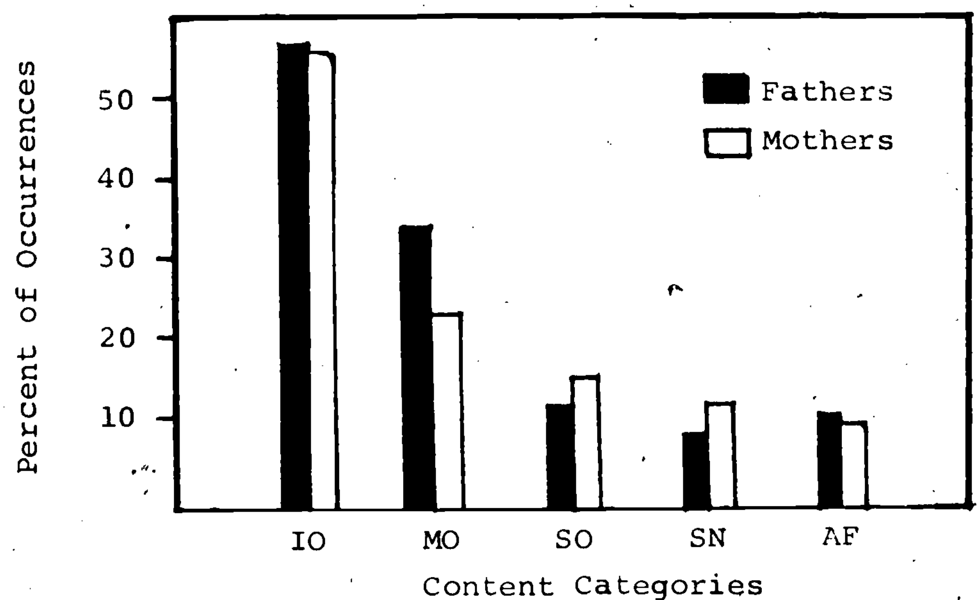
The effect of imposing structure by giving the parents direction or specific activities to engage in during a play situation made more of a difference for fathers than for mothers. Analysis of the total number of utterances for the entire session revealed similar rates of verbalization between the two conditions for the mothers and specific analysis indicated similarity in the number of questions, rate of imitating the child's utterances, and expressed positive reinforcement. One mother verbalized her awareness of the imposed directions. Following a display of resistance, she stated, "Guess I shouldn't force ya to do things. Shouldn't force ya."

Fathers were more verbal in the directed play condition and demonstrated more than a threefold increase in the number of times they solicited the infant's attention with single words. The observation that fathers appeared to pay less direct attention to the child during the directed play period was reflected in longer mean length of utterance, fewer directions, and fewer social remarks. All parents showed a higher rate of self-talk in the second condition which possibly reflected their concern with the imposed directions and they less often corrected the child's utterances. The analysis revealed a somewhat surprising result in that all parents showed considerably more direction in the freeplay condition. This was difficult to interpret, but may reflect the parents' attempt to impose structure in naturalistic conditions and perhaps use other tactics when given specific activities to do; that is, they would sometimes pretend that they wanted to read a book to attract the child's attention.

Comparison of Mothers and Fathers

Mothers and fathers were quite similar in their use of single words, questions, and reference to inanimate objects and the child's affective behavior (Figure 7). In comparison to the fathers, mothers, as a group, made more frequent reference to the social situation, evidenced a greater number of utterances which pertained to sensory function, engaged in considerably more child games, rhymes and songs, imitated the child's utterances more frequently, gave more expressed positive reinforcement, and more often used words conveying their own affective mood. Mothers also displayed a greater variety of ways of attracting their children's attention. They engaged in more self-talk than fathers possibly because more contact with the infant conditions a higher frequency of externalization of their own thoughts. The mothers' teaching strategies were reflected in a greater variety in content of their child-directed language. Even though the MLU for mothers was slightly higher than for fathers (Mean MLU for Mothers = 3.54; Mean MLU for Fathers = 3.45), the former displayed a higher frequency of single words and constructions indicating that they more often reduce their language input to the child to effect learning or a response.

Figure 7. Comparison of mothers' and fathers' child-directed language for percent of utterances in five major content categories. The categories include Inanimate Objects (IO), Motor (MO), Social (SO), Sensory (SN), and Affective (AF).



From the analysis of content (Figure 7), we saw that fathers made more frequent reference to motor behaviors possibly because this is their most typical kind of interaction with their children. Fathers additionally appeared to be more directing than mothers in their attempts to control the infant's activities with fewer available strategies. The description of the fathers may leave a misimpression. It is necessary to consider that the reductions in various behaviors described may be related to less familiarity with the experimental situation as well as to variations in style of interaction as the fathers came into the laboratory considerably less often than the mothers. Future studies will compare the parents' linguistic style from home tape recordings in addition to those solicited in the laboratory to reduce the potential bias imposed. In addition, we also need to consider cultural effects in determining the differential roles played by the mothers and fathers which affect their interaction behavior and the extent to which various behaviors will be displayed in public.

The greatest within-couple consistency was shown in the frequency of questions for both structure and function as well as in the analysis of content. The latter finding indicated that individual infants had one of the most striking effects on this aspect of their parents' linguistic behavior.

Child Stage/Parent Language Correspondence

Historically, the effects of parent-child interaction have been viewed in a unidirectional manner. We are all familiar with statements such as, "The parents condition the child to . . . ." In 1972, Lewis and Rosenblum edited a book entitled, THE EFFECT OF THE INFANT ON ITS CAREGIVER. The papers included clearly demonstrate the changes in thinking in recent years. There is a reciprocal, bidirectional relationship between the parent and child where both partners exercise mutual regulating influences on each other. The findings of the present descriptive study indicate that linguistic and nonlinguistic factors, as well as developmental level of the child, influence the structure, function, and content of parent-language.

Parents of the most 'referential' (Nelson, 1973) child in the study who additonally showed more advanced linguistic development at the time of study, asked a greater number of questions than other couples and more often appeared to expect a response. They showed the fewest instances of self-talk, and gave their child the fewest directions. Parents of the child who exhibited a significant amount of jargon, asked the least number of questions, showed the highest frequency of onomatopoetic sounds and attribution of sound producing capabilities to inanimate objects, and showed the second highest number of directions following the parents of the preverbal child. The parents of the youngest child in the study exhibited more single words with a notably higher frequency of single-word directives, a greater number of affective content remarks concerning the infant such as, "How do you fell?" and "Are you tired?" They also showed more frequenct exclamatory words conveying their own affective mood or state of surprise such as, "wow" and "oh boy". These utterances were highly inflected and possibly served as attention-attracting devices. These parents additionally showed the least frequent social content and modeling remarks.

Analysis of the total number of utterances for both experimental conditions indicated that the more advanced the child was in linguistic development, the more verbal the parents. These results appeared to correspond with findings from the investigation of questions presented by mothers during the first 16 weeks of life. That is the mother of the more vocal infant produced a greater number of questions. These statements do not imply a unidirectional causal relationship. That is, 'the more verbal the parents, the more vocal the child' could just as easily be interpreted as 'the more vocal the child, the more verbal the parents.'

The analysis of both child-directed language and self-talk indicated that the affective state or 'mood' of the child and the infant's primary style of interacting with his world of people and objects influenced the content of his parents' language. One child in the study had evidenced somewhat advanced motor development and had been quite active. His parents showed a markedly higher percentage of utterances involving movement in comparison to other couples. In contrast, the youngest child's motor development had been slower and his dominant mode of interacting with his world has consistently been more visual. His parents evidenced a higher proportion of sensory-related remarks particularly involving the visual modality. The influence of the child's cognitive development was also felt to be reflected in the low number of reports or mention of objects, events or people displaced in time or space from the immediate situation. The parents' reports most often involved disapppearance of an object or the other parent, a rather temporally-immediate event.

Structure

As shown in Table 23, the analysis of mean length of utterance by word count shows a trend indicating a positive relationship between the child's language development and his/her parents' MLU; however, it was felt that the three older children were too homogeneous to reveal substantial differences. Although the results of the analysis comparing fathers and mothers indicated that the latter showed slightly longer MLU, it can now be seen that this was true only for the parents of the youngest child. In all other couples, mean length of utterance was greater for the fathers than for the mothers.

Table 23. Mean Length of utterance by word count for parents' child-directed language in freeplay and directed play conditions.

Child	Parent	Freeplay	Directed Play	Individual Total	Couple Total
M	Father	3.58	3.78	3.68	
	Mother	3.26	3.96	3.60	3.64
J	Father	4.00	3.67	3.84	
	Mother	3.37	4.03	3.70	3.77
A	Father	3.27	3.57	3.41	
	Mother	3.03	3.56	3.29	3.35
G	Father	2.72	3.06	2.91	
	Mother	3.46	3.74	3.61	3.25

The structural analysis revealed that questions occurred most frequently, followed by single words, declarative statements, imperatives, and constructions (Table 24). Although questions occurred most frequently, they functioned in a variety

Table 24. Structural analysis of parent child-directed language.

Structure	Total Number of Occurrences	Percent of Total
Question	547	28
Single words	413	21
Declarative Statements	406	20
Imperatives	326	16
Constructions	300	15

of ways -- to describe attributes (e.g. "Isn't that cute?"), to give directions (e.g. "Why don't you throw the ball?"), to describe motor activities which the child was already engaging in (e.g. "Are you climbing?"), and in self-talk. Most often, the parents did not appear to expect a response from the child with the exception of the parents of the child most advanced in linguistic and conversational behavior. Lack of expectation of a response seems to result in a high rate of questioning, using informal tags (e.g. huh? hmm?), self-repeating, and a high frequency of parents answering their own questions.

The structural analysis further revealed a number of utterances which were functionally pre- or postposed, but were structurally discrete. The purpose of many of these utterances appeared to be to build additional redundancy into the linguistic signal. Informal tags occurred both before and after utterances (e.g. "Are ya happy? hmm?" and "Hmm? Shoes?"). Other examples of redundancy include:

Imitation followed by a postposed confirmation remark

"Car. That's right."
"Rockrock. Yes."

Preposed confirmation followed by imitation or expansion

"Yeah. There's the peas."
"Umhmm. Bear."
"Yes. That's a lid."

Function

The analysis of function indicated that questions retained their position of the most frequent type of utterance in these experimental conditions (Table 25). These were

Table 25. Functional analysis of Parent child-directed language.

Function	Total Number of Occurrences	Percent of Total
Questions	533	32
Labeling +	405	24
Directions	397	24
Positive Reinforcement	96	6
Self-talk	73	4
Affective mood	54	3
Games and rhymes	39	2
Onomatopoetic +	27	1.6
Model Social Behavior	21	1
Denial	18	1
Attent.-Get. Nondirec.	18	1
Report	6	0.4

followed by labeling, attribution, demonstration, and directions. The remaining categories show a disproportionate drop in frequency in comparison to the three major classes.

As in previous studies of child-directed language (Brown and Bellugi, 1964), a high rate of selective parent imitation of infant utterances was observed. Imitation served a variety of functions which could be interpreted as language-teaching devices. Some of these included confirmation of a lexical item, questioning a lexical item or requesting clarification, maintaining vocal-verbal contact with the child, and modeling behavior for role interchange as a speaker and listener. A high frequency of the word "no" in parent child-directed language also serves various functions such as denial of the truth value of a child's utterance and directing (no=stop). From these observations, we concur with Crystal (1975) in that function of utterances cannot be derived from lexical items and/or structure alone. The nonverbal context, paralinguistic, and prosodic features must be known; and even then, a degree of subjectivity persists in the interpretation of intent.

4. Conclusion:

The results of this descriptive study, we feel, demonstrate the value of examining family units including mother, father, and child. Analyses of structure, function, and content showed variations for different experimental conditions, variations between mothers and fathers, and variations which appeared to be related to individual children. Parents bring considerable communicative experience to the interactive situation with internalized models of dialogue. We make the assumption that they are linguistically-adaptive depending on the effectiveness of their communication with a listener, that they have a variety of strategies available to communicate intent, affect, and meaning, and that their adjustments affect the language development of their children.

VI. RESEARCH STATUS: THE EVOLUTION OF CONVERSATION

A. Study I: Parent-infant interactive utterances: an examination of silent pause intervals (Zlatin, M. A. and Whitman, I. A.)

1. Introduction:

During the early months of life, infants and their mothers have been observed to engage in interactional behavior that has the quality of conversational interchange (Bateson, 1971; Hunt, 1972; Lewis and Freedle, 1972). Although some degree of vocal contagion (Piaget, 1952) may be present, these 'prototype' conversations appear to constitute a type of social interchange from which language structure and function may be derived (Bruner, 1975). That is, they may serve to assist the infant in his development of communicative awareness by establishing the auditory-vocal circuit as a viable means of information exchange. These early exchanges may be initiated by either the mother or the infant and are characterized by one or more sequences of three events -- initiator vocalizes, vocal response from the coparticipant, vocal response from the initiator (Lewis and Freedle, 1972; Tulkin and Kagan, 1972). It is evident that both participants are engaged in mutual regulation of each others behavior (Moss, 1965).

The purpose of this preliminary study was to examine the duration, range and variability of pause intervals which characterize prototype conversations from their emergence for one infant.

2. Method:

The infant selected for study was one of four children who displayed the earliest emergence of interactive prototype conversations. Video and audio tape recordings of the first four laboratory sessions for this infant were observed and scrutinized for the presence of this behavior. (See Section III, B, 3 of this report for detailed description of recording procedures in the laboratory.) Both the mother and the father were individually involved in these sessions with their daughter.

An interactive prototype conversation was defined as one in which:

1) the minimum number of components is three and the initiator may be either the parent or the infant, i.e. mother/infant/mother or infant/mother/infant;

2) the maximum pause time between vocal behavior exhibited by each participant does not exceed 15 seconds, within a sequence;

3) the participants maintain the same basic body position and/or motor behavior;

4) the maximum number of complete related ideas vocalized by the parent does not exceed 5 prior to the infant's onset of vocalization;

5) the general topic of conversation exhibited by the adult participant remains essentially the same throughout a given sequence; and

6) eye contact between the participants is sustained throughout the interaction.

The dates of the sessions, age of the infant and number of conversational interchanges between the infant and her parents is presented in Table 26.

Table 26. The emergence of prototype conversations for one infant for four laboratory sessions.

Date of Recording	Age of Infant (weeks;days)	Number of Interactive Sequences
1/11/74	5;5	0
1/16/74	6;3	2
2/ 8/74	9;5	18
2/22/74	10;2	24

A coding system was devised to designate the number of components in an interaction. An interaction consisting of the minimum of three components was coded as M; a number preceding M indicated the total number of minimum components in the sequence. Thus 2M denoted an interaction containing two minimum components or 6 units; 3M signified three minimum components or 9 units in the interaction, etc. Additional components to the minimum were indicated by a plus. Therefore, a code of M + 1 was equivalent to an interaction containing the minimum of three components plus one additional unit, and M + 2 represented the minimum components plus two additional units, etc. The example that follows has been included to illustrate the typical coding used in an interactive sequence, the nature and content of a typical interaction, and the pause time being measured. This interactive sequence contains two minimum components plus one additional unit and six pauses. In accordance with the aforementioned coding system, the proper code for this particular sequence is 2M + 1.

	M:	Hi A_____!
		(Pause)
	I:	Vocalization
		(Pause)
M ______	M:	Hi pretty girl.
		What ya doing?
		Huh?
		(Pause)
M + 1 _____	I:	Vocalization
		(Pause)
M + 2 ______	M:	A_____'s a pretty girl.
		You're a pretty girl.
		(Pause)
2M _____	I:	Vocalization
		(Pause)
2M + 1 _____	M:	You're a pretty girl!
		Yes!
		You're a pretty girl!

Interactive pause time was computed from amplitude tracings (Nagra III, NP 65-6000 recorder; Beckman RS Dynograph). Multiple tracings of selected sequences were made for estimation of reliability and in instances where there was uncertainty regarding the initiation and/or termination of utterances. At times, the parent and infant vocalized simultaneously within an interactive sequence. There were no instances of overlap in the first two sessions. In session 3, 12 of 18 interactive sequences had some degree of overlapping utterances and in Session 4, 14 of 24 sequences were associated with this behavior. For statistical purposes, instances of overlap were stipulated as <u>0</u> and were not averaged into the total computation of the number of components in an interaction.

3. <u>Results and Discussion</u>:

A total of 44 interactive sequences were identified for the four sessions. The length of these sequences varied from those containing 3 components (M) to those containing as many as 36 components (12M+1). Interactive sequences that exceeded 6 units were observed in this infant by 6 weeks 3 days. This onset is considerably earlier than has been noted by other investigators. Lewis and Freedle (1972) indicated that shorter interactive sequences were observed in their infants at 12 weeks of age.

The means and standard deviations for interactive pause time tabulated for sessions 3 and 4 are shown in Table 27.

Table 27. Mean and standard deviation of pause intervals for parent child (P-C) and child-parent (C-P) interactive sequences.

Pause Condition	Session	Total Number of Pauses/Session	Mean Length (seconds)	Standard Deviation
P-C	3	71	.97	.92
C-P	3	71	1.16	.81
P-C	4	97	.90	1.05
C-P	4	97	.91	.97

From this limited sample for one infant, the mean pause time was very short and the variability was considerable. Pearson-Product-Moment correlations between pause length occurring after a parent's vocalization and after an infant's vocalization were derived to determine whether pause length varied as a function of the speaker preceding the silent interval. No relationship was found for Session 3 and the results of the analysis for Session 4 indicated a very low positive correlation. These results were interpreted as indicating that, for these individuals, a pause duration following the parent's vocalization in an interactive sequence was not related to the pause time following the infant's vocalization. Results of an analysis of variance for pause length between Sessions 3 and 4 also failed to yield statistically significant differences. It was felt that the findings from both analyses reflect the extremely limited sample size and large amount of variability. Further study following the continued development of prototype conversations between this infant and her parents as well as for the other three children under study is anticipated. The other children also evidenced the emergence of interactive sequences between 7 and 8 weeks of age.

VII. CONCLUSIONS

To summarize the current status of this investigation and derive conclusions, we return to the questions posed in the introduction involving when, where, and how to begin the study of language acquisition. To these will also be added the remaining wh-forms -- what to study and why study this behavior.

Our preliminary results indicate that an examination of the evolution of language as a form of communicative behavior which is closely aligned with cognition, most cogently should begin at the beginning; that is, within the first month of life. From the infant's initial reflexive sound repertoire emerges basic syllable-like structures which share features with earlier forms of vocalization (Stark, Rose and McLagen, 1975), thus demonstrating a continuous unfolding process rather than one initially characterized by discontinuity. These basic structures seem to be successively elaborated followed by a period of discontinuation when the child shifts his focus to direct exploration of vocal tract (phonetic) parameters such as direction of the air stream, pitch, loudness, and various articulatory gestures. The need to begin at the beginning also reflects our growing appreciation of change effected in the child's linguistic and nonlinguistic environment. Through an early initiation of study, we may not only trace the features which are salient for a particular infant at different stages of development, but also we may trace the evolution of communicative style between parent and child.

With respect to the question of where to conduct the study, our preliminary findings confirmed the necessity of examining the infant in a variety of social interactive and nonsocial conditions. Even within the first six months, these children displayed differential vocal behavior when they were alone and when they were involved with people. We also observed different vocal behaviors, at times, in the infant laboratory compared with the corresponding behavioral repertoire in the home samples. To generate a comprehensive data base, therefore, it appears to be necessary to gather consistent samples of the child's behavior in multiple settings including the home where some of recordings may be characterized by less than ideal quality, as well as in naturalistic laboratory conditions. In the latter, greater quality control can be gained.

Given that we examine the infant from the first month of life in a variety of settings, when he is alone, and when he is interacting with primary caretakers, how do we proceed to collect, reduce, integrate, and analyze the data in a manageable manner? The value of studying a small number of children in depth over time within their family units, i.e. including mothers and fathers, was confirmed. Although this procedure prohibits a single investigator from generalizing to large populations, the richness of the data seems well worth this initial sacrifice. Generalizations will, in time, evolve from comparisons among many such studies using this methodology, one which seems to have gained increased favor among investigators of language acquisition in the United States and increased respect from some sections of the research community. Our research efforts are attempting to find out not only what children learn, but also how they learn -- how behavior evolves.

As indicated earlier, diary studies conducted primarily by linguists (Leopold, 1939-1949; Velten, 1943; Lewis, 1951) provided us with some valuable information regarding the nature of change in linguistic behavior; however, the data were not available for repeated scrutiny. This need has dictated the use of audio and video recording for more permanent storage. We have also found that it is necessary to secure almost daily samples of the infant's behavior, as there are some aspects of apparent import which may be present in the repertoire for very brief periods and rapidly become assimilated. Other valuable sources of data include developmental logs where the parents maintain records of various facets of the child's behavior as they emerge, periodic interviews, and results of formal testing procedures which yield information regarding the child's auditory sensitivity, cognitive, motor, social and emotional development. At present, data collection has been completed for three children and the first six months of data has been reduced to accessible form for all four. The process has been both tedious and time consuming; however, we find ourselves in agreement with Hutt and Hutt(1970) who indicated that, "Regrettably, if we are to find out how people actually behave. . ., there seems to be no substitute for detailed and painstaking observation." (p. 9)

In response to the question of <u>what</u> to study, a protocol was developed to examine selected aspects of behavior exhibited by the children and their parents which were most salient for a longitudinal paradigm; this is, aspects of behavior which had the critical criterial attribute of continuity from inception through the early phases of the child's linguistic development. Seven preliminary substudies which focused on the first twenty-four weeks of the child's life were conducted, including at least one in each of the three major content areas -- the child, the parents, and parent-child interaction. The decisions regarding <u>what</u> to study were dictated by the specific long-term goals of the investigation. With a primary emphasis on the child's phonological development, fundamental frequency (F_o) was selected so that contrastive intonation eventually could be examined. Consistent with the findings of Delack (1975), mean vocal fundamental frequency characteristics over the first twenty-four weeks showed little change, but within-utterance range and variability do increase. Averaging procedures were found to mask the individual variations in F_o which appeared to be associated with state of the infant, physical activity levels, and characteristics of the child's evolving vocal repertoire.

The second aspect of infant vocalization selected was the phonetic syllable (Davidsen-Nielsen, 1974) which constitutes the basic unit of speech production. Since it is relatively well-agreed that criteria for features derived from adult models of speech production could not be forced on the infant (Crystal, 1975), it was necessary to evolve a system which could be tested through perceptual and acoustic analysis. Results indicated that the phonetic syllable and the features derived were viable. Listeners who had received necessary special listening training in an 'infant mode' could reliably identify syllabicity, peaks of prominence and segmental variations. Perceptual responses showed an acceptable correlation with the acoustic instrumental analysis for a selected sample. Although differing from the features developed by Stark, Rose and McLagen (1975), the two systems seem to be compatible. It should be realized, however, that despite the work done by Nakazima (1962, 1966, 1970, 1972), Murai (1961, 1963), and Stark, among others, investigators of infant vocalization are still in their own infancy with respect to descriptive feature systems. Although children's utterances have more typically been considered apart from the situational context in which they occur, it does not seem to be advisable to continue this practice. From the analysis of phonatory characteristics associated with cry and noncry types, as well as from our preliminary observations regarding intonation in the second year of life, the situational context seems to be an important factor in description and interpretation of a child's productions. One aspect of the situational context involves parent child-directed language.

We chose to begin this portion of the study by examining question forms presented to two of the children by their mothers during the first sixteen weeks of life. This form has been reported to account for a large percentage of child-directed language in other investigations (Broen, 1972; Snow, 1972; Phillips, 1973). Observation of questions, furthermore, constituted a source for revealing change as the children became more able to fulfill their communicative roles linguistically in conversational interaction. A wide variety of question types was presented to the children during the first period of their development. These were often repeated in various forms including exact repetition, reduced, expanded, paraphrased or otherwise altered versions. The mothers, at times, answered their own questions thereby fulfilling both communicative roles. The frequency of questions increased as the children became more vocal. A second study revealed that questions with respect to both structure and function (i.e. inquiry) occurred more frequently than any other category in the child-directed language number of factors including situational context in which the dyadic and triadic interactions occurred, the child's developmental stage as reflected by his behavioral and linguistic repertoire, the parents' perception of the child's abilities, the parents' own needs for establishing contact through the auditory-vocal channel, the parents' internalized model of discourse behavior, their communicative styles, and the specific preferences exhibited by their infant. Although we have only sampled parent child-directed language during two periods of development, within-couple and within-family styles have emerged to provide us with a perspective that could not otherwise have been gained.

The final content area for which the least direct analysis has been completed involved particular facets of parent-child behavior as they engaged in direct interaction. It was found that prototype conversations (Hunt, 1972; Lewis and Freedle, 1972) appeared within the first two months of life for each of the four children. One objective of this study is to trace the evolution of communicative style between parents and their children from its inception through the period when the infant, as previously indicated, first begins to fulfill his communicative role as a linguistic partner. The development of communicative awareness on the child's part and the ground-work for opening and establishing the auditory-vocal channel as a means of communication for information exchange seems to be laid in the earliest period of the child's life.

The last question raised in our list is <u>why</u> study language acquisition. We have found investigators from diverse disciplines interested in the problem and each is impelled by seemingly different underlying motivations. A linguist, for example, may examine or consider acquisition to advance the status of a theory of language as well as to potentially reveal language universals common to children from diverse communities and differential language-specific features. An anthropologist may share the latter interest with the linguist, but adds the dimension of viewing language as a transmitter of culture. A psychologist may view language in relation to socialization, cognition and emotional development. Educators view language as being essential for academic achievement. The present study was, in part, initially motivated by the principal investigator's concern with identification and treatment of children who were suspected of evidencing developmental disability; however, this study has been conducted with an appreciation of each of the views enumerated above.

In conclusion, the present study is relatively unique to the field of language acquisition in that behavior of the children and their parents was sampled in both ecological and manipulative environments providing a large data base which is now available for repeated scrutiny. From this data, objective measures were developed to describe the features of the infant's emerging sound system. We have just begun to relate these features to other unfolding aspects of the child's behavior in the context of his immediate linguistic and nonlinguistic environment. This, we hope, will allow for potentially stronger interpretative power than when a child's behavior and the characteristics of his environment are examined in relative isolation. We are compelled to consider language acquisition from the viewpoint of an interactive process in which the child and his parents, while independent, are the principals in a reciprocal mutually-regulating relationship. The evolution of a theory of language and the development of a model of infant behavior with adequate descriptive specification will call for devoted efforts by many individuals. It has often been said that one of the most difficult assignments that can be offered to man is that of contemplating and conceptualizing his own nature. This seems to be at the heart of the task we have set for ourselves in examining the evolution of language specifically by initiating study in the earliest period of infancy.

REFERENCES

Bateson, M. C. (1971) Speech communication. Quarterly Progress Report, No. 100, M.I.T. Research Laboratory of Electronics, Cambridge, Mass., pp. 169-176.

Bayley, Nancy (1969) Manual for the Bayley Scales of Infant Development. New York: The Psychological Corporation.

Bell, R. (1974) "Contributions of Human Infants to Care Giving and Social Interaction." In M. Lewis and L. A. Rosenblum (Eds.). The Effect of the Infant on Its Caregiver. New York: John Wiley, pp. 1-20.

Bernal, J. (1972) Crying during the first 10 days of life and maternal responses. Devel. Med. Child Neurol., 14, 362-362.

Blauvelt, H. and McKenna, J. (1961) Mother-neonate interaction: capacity of the human newborn for orientation. In B. M. Foss (Ed.). Determinants of Infant Behavior. New York: John Wiley, pp. 3-35.

Bolinger, D. L. (1964) "Intonation as a Universal," Proceedings of the 9th International Congress of Linguistis, Cambridge, Mass., 1962 (The Hague: Mouton and Co., pp. 833-848).

Bosma, J. F. (1972) "Form and Function in the Infant's Mouth and Pharynx." In J. F. Bosma (Ed.) Third Symposium on Oral Sensation and Perception, Springfield: Charles C. Thomas, pp. 3-29.

Bosma, J. F., Truby, H. M.. and Lind, J. (1965) "Cry Motions of the Newborn Infant." In Lind, J. (Ed.) Newborn Infant Cry, Uppsala: Almquist & Wiksells Boktryckeri Ab., pp. 61-92.

Brackbill, J. (1973) Continuous stimulation reduces arousal level: stability of effect over time. Child Dev., 44:43-46.

Broen, P. A. (1972) The verbal environment of the language-learning child. Monograph No. 17, American Speech and Hearing Association.

Brown, R. (1973) A First Language: The Early Stages. Cambridge: Harvard University Press.

Brown, R. and Bellugi, U. (1964) Three Processes in the Child's Acquisition of Syntax. Harvard Educational Review 34:133-151.

Bruner, J. S. (1973) Organization of early skilled action. Child Development, 44:1-11.

Bruner, J. S. (1975) The ontogenesis of speech acts. J. Child Language, 2:1-19.

Crystal, D. (1973) Non-segmental phonology in language acquisition: a review of the issues. Lingua, 32:1-45.

Crystal, D. (1975) The English Tone of Voice. London: Edward Arnold.

Dale, P. S. (1974) Hesitations in maternal speech. Lang. and Speech, 17:174-181.

Davidsen-Nielsen, N. (1974) Syllabification in English words with medial sp, st, sk. J. Phonetics 2:15-45.

Delack, J. B. (1975) Prosodic features of infant speech: the first year of life. Paper presented at the Eighth International Congress of Phonetic Sciences, Leeds, England.

Delack, J. B. and Fowlow, P. J. (1975) The ontogenesis of differential vocalization: development of prosodic contrastivity during the first year of life. Paper presented at the Third International Child Language Symposium, London, England.

Dember, W. N. and Earl, R. W. (1957) Analysis of exploratory, manipulatory and curiosity behaviors. Psychol. Rev., 64:91-96.

Escalona, S. K. (1968) The Roots of Individuality. Chicago: Aldine.

Fairbanks, G. (1942) An acoustical study of pitch of infant hunger wails. Child Development, 13:227-232.

Feingold, M. (1972) Baby Cries -- the Differential Diagnosis. New York: Medcom, Inc.

Formby, D. (1967) Maternal recognition of infant's cry. Devel. Med. Child Neurol., 9:293-298.

Friedlander, B. Z. (1968) The effect of speaker identity, voice inflection, vocabulary, and message redundancy on infants' selection of vocal reinforcement. J. Exper. Child Psych., 6:443-459.

Friedlander, B. Z. (1971) Listening, language and the auditory environment. In Hellmuth, J. (Ed.) Exceptional Infant, Vol. 2, Studies in Abnormalities. New York: Brunner/Mazel. pp. 248-275.

Gessell, A., et al. ([illegible]) The First Five Years of Life: The Preschool Years. [illegible]: Harper & Row, Publishers.

Giattino, J. and Hogan, [illegible] ([illegible]) Analysis of a father's speech to his language-learning child. J. Speech Hear. Dis. 40:524-537.

Gilbert, J. H. (1970) Formant concentration positions in the speech of children at two levels of linguistic development. J. Acoust. Soc. Amer., 48:14[illegible]4-1406.

Glanzer, P. D. and [illegible] ([illegible]) Developmental changes in language spoken [illegible]. Paper presented at the Biennial Meeting of the [illegible] for Research in Child Development, Denver, Colorado.

Hast, M. H. (1966) [illegible]ological mechanism of phonation: tension of the vocal fold [illegible]. Acta Oto-Laryng. 62:309-318.

Hast, M. H. (1970) The developmental anatomy of the larynx. Oto-laryng. Clinics [illegible] [illegible]:413-438.

Hunt, J. M. (1972) C[illegible] and motivational development under diverse rearing [illegible]. Paper presented at the American Psychological Ass[illegible]ion Convention, Honolulu.

Hutt, C. (1967) [illegible] effects on response decrement and stimulus satiation in [illegible]. Brit. J. Psychol. 58:365-373.

Hutt, S. J. and Hutt, [illegible] (1970) Direct Observation and Measurement of Behavior. [illegible]: Charles C. Thomas.

Irwin, O. C. (1947a) [illegible] speech: consonant sounds according to place of articulation. J. Speech Dis. 12:397-401.

Irwin, O. C. (1947b) Infant speech: consonant sounds according to manner of articulation. J. Speech Dis. 12:402-404.

Irwin, O. C. ([illegible]) [illegible]elopment of speech during infancy: Curve of phonemic frequencies. J. Exper. Psych. 37:187-192(a).

Irwin, O. C. (194[illegible]) Infant speech: The problem of variability. J. Speech Dis. [illegible]-176.

Irwin, O. C. (194[illegible]) Infant speech: speech sound development of sibling and only infants. J. Exper. Psych. 38:600-602.

Jakobson, R. (1941/196[illegible]) Child Language, Aphasia and Phonological Universals. The Hague: Mouton. English translation of Kindersprache, Aphasie und Allgemeine Lautgesetze. Uppsala: Almquist and Wiksell.

Kagan, J. (1969) On the meaning of behavior: illustrations from the infant. Child Dev. 40:1121-1134.

Karelitz, S (1963) Infant vocalizations: J. Indian Ped. Soc. 2:1-3.

Karelitz, S. and Fisichelli, V. R. (1962) The cry thresholds of normal infants and those with brain damage. J. of Pediat. 61:679-685.

Kirchner, J. A. (1970) Pressman and Kelemen's Physiology of the Larynx. Rochester, Minn.: American Academy of Ophthamology and Otolaryngology.

Korner, A. (1972) State as a variable, as obstacle, and as mediator of stimulation in infant research. Merill-Palmer Quarterly, 18(2):76-94.

Korner, A. F. (1974) "The Effect of the Infant's State, Level of Arousal, Sex and Ontogenetic Stage on the Caregiver". In M. Lewis and L. A. Rosenblum (Eds.) The Effect of the Infant on Its Caregiver. New York: John Wiley, pp. 105-122.

Ladefoged, P. (1967) Three Areas of Experimental Phonetics. London: Oxford University Press.

Langlois, A., Wilder, C., and Baken, R. J. (1974) Pre-speech respiratory patterns in the infant. Paper presented at the Annual Meeting of the American Speech and Hearing Association, Washington, D. C.

Lehiste, I. (1970) Suprasegmentals. Cambridge: M.I.T. Press.

Lenneberg, E. H., Rebelsky, F. G., and Nichols, I. A. (1965) The vocalization of infants born to deaf and hearing parents. Human Development 8:23-37.

Leopold, W. (1939-1949) Speech Development of a Bilingual Child. Evanston: Northwestern University Press, 4 volumes.

Leopold, W. (1961) Patterning in children's language learning. In Saporta, S. (Ed.) Psycholinguistics: A Book of Readings. New York: Holt, Rinehart and Winston.

Levi-Strauss, C. (1966) The Savage Mind. Chicago: University of Chicago Press.

Lewis, M. M. (1951) Infant Speech: A Study of the Beginnings of Language. 2nd edition, New York: Humanities Press.

Lewis, M. M. (1936/1959) How Children Learn to Speak. New York: Basic Books.

Lewis, M. M. (1972) State as an infant-environment interaction: an analysis of mother-infant interaction as a function of sex. Merrill-Palmer Quarterly, 18:95-121.

Lewis, M. and Freedle, R. (1972) Mother-infant dyad: the cradle of meaning. Paper presented at Symposium on Language and Thought: Communication and Affect, Erindale College, University of Toronto, March, 1972.

Lewis, M. and Rosenblum, L. A. (Eds.) (1972) The Effect of the Infant on Its Caregiver. New York: John Wiley.

Lieberman, P. (1967) Intonation, Perception and Language. Cambridge: M.I.T. Press.

Lieberman, P. (1975) On the Origins of Language. New York: Macmillan.

Liles, R. I., Hoops, H. R., Strauss, M., McClung, J. and Ostrea, E. (1974) A comparative acoustic and perceptual analysis of early crying behavior of congenitally drug-addicted and non-addicted infants. Paper presented at the Annual Meeting of the American Speech and Hearing Association, Las Vegas, Nevada.

Lind, J. (Ed.) (1965) Newborn Infant Cry. Uppsala: Almquist and Wiksells Boktryckeri AB.

Lindquist, J. (1972) A description of laryngeal articulation in speech. Speech Transmissions Laboratory Quarterly Progress and Status Report, 2-3:1-9.

Luria, A. R. (1961) The Role of Speech in the Regulation of Normal and Abnormal Behavior. New York: Liveright.

Lynip, A. (1951) The use of magnetic devices in collection and analysis of the preverbal utterances of an infant. Genetic Psychological Monographs, 44, 221-262.

Lytton, H. (1971) Observation studies of parent-child interaction: a methodological review. Child Development, 42(3): 651-684.

Lytton, H. (1974) Comparative yield of three data sources in the study of parent-child interaction. Merrill-Palmer Quarterly, 20, 53-64.

McCall, R. B. (1971) "Attention in the Infant: Avenue to the Study of Cognitive Development." In Walcher, D. N. and Peters, D. L. (Eds.) The Development of Self-Regulatory Mechanisms, pp. 107-137. New York: Academic Press.

McCall, R. (1972) Smiling and vocalization in the infant as indices of perceptual cognitive processes. Merrill-Palmer Quarterly, 18(4): 342-347.

McCall, R. B. (1974) Exploratory Manipulation and Play in the Human Infant. Monog. of Soc. Res. Child Dev., 39.

McCarthy, D. (1952) Organismic interpretations of infant vocalizations. Child Development, 23, 4:273-280.

McNeill, D. (1970) The Acquisition of Language. New York: Harper and Row.

Menyuk, P. (1971) The Acquisition and Development of Language. Englewood Cliffs, N. J.: Prentice-Hall.

Menyuk, P. and Bernholtz, N. (1969) Prosodic features and children's language production. Research Laboratory of Electronics Quarterly Progress Reports, No. 93.

Moss, H. A. (1965) Methodological issues in studying mother-infant interaction. Amer. J. Orthopsychiat., 35:428-486.

Moss, H. A. (1967) Sex, age, and state as determinants of mother-infant interaction. Merrill-Palmer Quarterly 13:19-36.

Murai, J. (1960) Speech development in infants-analysis of speech sound by sona-graph. Psychologia, 3:27-35.

Murai, J. (1961) Speech development in early infancy. Tetsugakukenkyu, 474:20-42.

Murai, J. (1963) The sounds of infants: their phonemicization and symbolization. Studia Phonologica III, 17-34.

Nakazima, S. A. (1962) A comparative study of the speech developments of Japanese and American English in childhood (1): a comparison of the developments of voices at the prelinguistic period. Studia Phonologica, II:27-46.

Nakazima, S. A. (1966) A comparative study of the speech developments of Japanese and American English in childhood (2). Studia Phonologica, IV:38-48.

Nakazima, S. (1970) A comparative study of the speech developments of Japanese and American English in childhood (3): the reorganization process of babbling articulation mechanisms. Studia Phonologica, V:20-35.

Nakazima, S. (1972) A comparative study of the speech developments of Japanese and American children (4): the beginning of the phonemicization process. Studia Phonologica, VI:1-37.

Nelson, K. (1973) Structure and strategy in learning to talk. Monographs of the Society for Research in Child Development, Vol. 38, Nos. 1-2. (published by the University of Chicago Press for the Society for Research in Child Development), February-April.

Öhman, S. E. G. (1967). Word and sentence intonation: a quantitative model. Speech Transmission Laboratory, Quarterly Progress and Status Report 2-3. Stockholm: Royal Institute of Technology, pp. 20-54.

Oller, D. K. (1973) Regularities in abnormal child phonology. J. Speech Hear. Dis., 16:36-47.

Oller, D. K., Wieman, L. A., Doyle, W. J. and Ross, C. (1974) Child Speech, Babbling and Phonological Universals. Papers and Reports on Child Language Development, Stanford University Committee on Linguistics, 008, pp. 33-41.

Ostwald, P. (1972) The sounds of infancy. Devel. Med. Child Neurol. 14:350-361.

Peters, D. L. (1971) "The Development of Self-Regulatory Mechanisms: Epilog." In Walcher, D. N. and Peters, D. L. (Eds.) The Development of Self-Regulatory Mechanisms. New York: Academic Press, pp. 231-239.

Peters, A. M. (1974) The Beginnings of Speech. Papers and Reports on Child Language Development, Stanford University Committee on Linguistics, 008, pp. 26-32.

Phillips, J. R. (1973) Syntax and vocabulary of mother's speech to young children: age and sex comparisons. Child Development, 44:182-185.

Piaget, J. The Origins of Intelligence in Children. New York: Norton (1952).

Piaget, J. and Inhelder, B. (1969) The Psychology of the Child. New York: Basic Books.

Prechtl, H. F. R., Theorell, K., Gramsbergen, A., and Lind, J. (1969) A statistical analysis of cry patterns in normal and abnormal newborn infants. Devel. Med. Child Neurol, 11:142-152.

Prescott, R. (1975) Infant cry sound; developmental features. J. Acoust. Soc. Amer., 57:1186-1191.

Rebelsky, F. and Hanks, C. (1971) Father's verbal interaction with infants in the first three months of life. Child Development, 42:63-68.

Rheingold, H. L. (1961) "The Effect of Environmental Stimulation Upon Social and Exploratory Behavior in the Human Infant." in B. M. Foss (Ed.) Determinants of Infant Behavior. London: Methuen and Co., Ltd., pp. 143-177.

Ringel, R. L. and Kluppel, D. D. (1964) Neonatal crying; a normative study. Folia Phoniat. 16:1-9.

Ryan, J. (1974) "Early language development: towards a communication analysis." In Richards, M. P. M. (Ed.) The Integration of a Child into a Social World. London: Cambridge University Press, pp. 185-213.

Sedlakova, E. (1964) Acoustic analysis of the voice in the newborn. Folia Phoniat. 16:44-58.

Sheppard, W. C. and Lane, H. L. (1968) Development of the prosodic features of infant vocalizing. J. Speech Hear. Res. 11:94-108.

Shere, E. and Kastenbaum, R. (1966) Mother-child interaction in cerebral palsy: environmental and psychosocial obstacles to cognitive development. Genetic Psychology Monographs, 73: 255-335.

Shvachkin, N. Kh. (1948/1973) The development of phonemic speech perception in early childhood. Pedagogicheskikh Nauk RSFSR, 12:101-132. In Studies of Child Language Development, C. Ferguson and D. I. Slobin (Eds.) New York: Holt, Rinehart and Winston, Inc.

Sinclair, H. (1970) The transition from sensory-motor behavior to symbolic activity. Interchange, 1:119-126.

Snow, C. E. (1972) Mother's speech to children learning language. Child Development, 43:549-565.

Sokolov, Ye N. (1963) Perception and the Conditioned Reflex. New York: Pergamon Press.

Stampe, D. (1972) A dissertation on natural phonology. Ph.D. dissertation. University of Chicago.

Stark, R. E., Rose, S. N. and Benson, P. J. (1974) Classification of infant vocalization behavior. Paper presnted at the Convention of the American Speech and Hearing Association, Las Vegas, Nevada.

Stark, R. E. Rose, S. N. and McLagen, M. (1975) Features of infant sounds: the first eight weeks. J. Child Lang. 2:205-221.

Stern, D. N. (1974a) "Mother and Infant at Play: The Dyadic Interaction Involving Facial, Vocal and Gaze Behaviors." In M. Lewis and L. A. Rosenblum (Eds.) The Effect of the Infant on Its Caregiver. New York: John Wiley, pp. 187-214.

Stern, D. N. (1974b) The goal and structure of motorh-infant play. J. Amer. Acad. Child Psychiat., 13:402-421.

Swope, S., Anderson, D. C., Berry, R. C., and Kennedy, A. J. (1975) Acoustic parameters of infant cries: a longitudinal study (in press).

Templin, M. C. (1957) Certain Language Skills in Children: Their Development and Interrelationships. Minneapolis: The University of Minnesota Press. (Child Welfare Monograph Series, No. 26.)

Terman, L. M. and Merrill, M. A. (1960) Stanford-Binet Intelligence Scale. Boston: Riverside Press.

Tonkova-Yampol'skaya, R. V. (1969/1973) Soviet Psychology 7:48-54. Appears in Ferguson, C. A. and Slobin, D. I. (Eds.) Studies of Child Language Development. New York: Holt, Rinehart and Winston.

Truby, H. M. and Lind, J. (1965) "Cry sounds of the newborn infant." In J. Lind (Ed.) Newborn Infant Cry. Uppsala: Acta Paediatrica Scandinavica Supplement 163, pp. 7-61.

Tulkin, S. R. and Kagan, J. (1972) Mother-child interaction in the first year of life. Child Development, 43:31-41.

Umeda, N. (1975) Vowel duration in American English. J. Acoust. Soc. Amer., 58:434-445.

Valanne, E. H., Vuorenkoski, V., Partanen, T. J., Lind, J., and Wasz-Höckert, O. (1967) The ability of human mothers to identify the hunger cry signals of their own new-born infants during the lying-in period. Experentia, 23:768.

Velten, H. V. (1943) The growth of phonemic and lexical patterns in infant language. Language, 19:281-292.

Vygotsky, L. S. (1934/1962) Thought and Language. Cambridge: M.I.T. Press.

Walcher, D. N. and Peters, D. L. (Eds.) (1971) The Development of Self-Regulatory Mechanisms. New York: Academic Press.

Wasz-Höckert, O., Partanen, T., Vuorenkoski, V., Valanne, E., and Michelson, K. (1964) Effect of training on ability to identify preverbal vocalizations. Devel. Med. and Child Neurol., 6:393-396.

Weinberg, B. and Zlatin, M. A. (1970) Speaking fundamental frequency characteristics of five- and six-year-old children with mongolism. J. Speech Hear. Res. 13:418-425.

Weisberg, P. (1963) Social and nonsocial conditioning of infant vocalizations. Child Development, 34:377-388.

Wind, J. (1970) On the Phylogeny and the Ontogeny of the Human Larynx. Groningen: Wolters-Noordhoff.

Wolff, P. H. (1963) "Observations of the early development of smiling." In B. Foss (Ed.) Determinants of Infant Behavior, II. London: Methuen and Co., Ltd. pp. 113-138.

Wolff, P. H. (1969) The natural history of crying and other vocalizations in early infancy. In B. Foss (Ed.) Determinants of Infant Behavior, IV, London: Methuen and Co., Ltd., pp. 81-89.

Wolff, P. H. (1965) The development of attention in young infants. Annals of the New York Academy of Sciences, 118:815-830.

Wolff, P. H. (1972) "The Interaction of State and Non-nutritive Sucking." In J. B. Bosma (Ed.) Third Symposium on Oral Sensation and Perception. Springfield, Ill.: Charles C. Thomas, pp. 293-310.

Zelazo, P. R. (1972) Smiling and vocalizing: a cognitive emphasis. Merrill-Palmer Quarterly, 18(4):349-365.

Zelazo, P. R., Kagan, J. and Hartmann, R. (1975) Excitement and boredom as determinants of vocalization in infants. J. Genet. Psychol., 126:107-117.

Zlatin, M. A. (1974) Variations on a theme: [agʊə]. Paper presented at the Annual Convention of the American Speech and Hearing Association, Las Vegas, Nevada.

Zlatin, M. A. (1975) Explorative mapping of the vocal tract and primitive syllabification in infancy: the first six months. Paper presented at the Annual Convention of the American Speech and Hearing Association, Washington, D. C.

IX. Dissemination

Zlatin, M. A. and Stephens, M. I. Why mess with infant vocalization? Purdue University Contributed Papers, Speech, Hearing and Language, No. 3, pp. 9-21 (May 1974).

Zlatin, M. A. Variations on a theme [ag$^{\gamma}$ʊ^{ə}]. Paper presented at the Annual Convention of the American Speech and Hearing Association, Las Vegas (November 1974).

Zlatin, M. A. Explorative mapping of the vocal tract and primitive syllabification in infancy: The First Six Months. Paper presented at the Convention of the American Speech and Hearing Association, Washington, D. C. (November 1975).

Zlatin, M. A. and Phelps, H. Structure, Function, and Content of Parents' Child-Directed Language: A Comparison within and among Couples. Paper presented at the Convention of the American Speech and Hearing Association, Washington, D. C. (November 1975).

Baran, J., Zlatin, M. A. and Daniloff, R. F. Do Mothers Maximize Phonetic Contrastivity: A Study of VOT. Paper presented at the Meeting of the Acoustical Society of America, Washington, D. C. (April 1976).

X. Utilization Activities

Although we are still in the process of further reduction of data and analysis, the results thus far gleaned from this investigation have been utilized for furthering research efforts, primary educational purposes, as well as for continuing education. As the principal investigator is a member of a university faculty involved in training of undergraduate and graduate students, the video tapes secured have provided a rich source for classroom observation of infants during the first two years of life and of parent-child interaction. Categorical classification systems evolved for the contentive aspects of the study have been adopted by students in evolving descriptions of infants who are developing normally as well as of infants who are suspected of evidencing developmental problems. The mission of those individuals involved in research and educational efforts directed toward early identification of developmental disability is to potentially facilitate later academic and social adjustment for individual children who are at risk for problems in both areas. The principal investigator has disseminated information gained from the study in professional meetings and through invited workshop presentations to professionals involved in education. She has also been asked to consult in the design and implementation of research in other institutions. In the United States, we are fortunate that investigators have had a long-standing interest in development and have provided us with cross-sectional normative information for large samples with respect to a number of emergent behaviors during the preschool years. It has been with these 'benchmarks' or milestones that current researchers are afforded the opportunity to study fewer children longitudinally in greater depth. The investment of both time and finances appears to be yielding fruit, as findings from diverse research groups, each of which is examining few children both within this country as well as in other linguistic communities, are providing a rich data base. From this base, universal and specific features of language acquisition should ultimately be evolved.

XI. ACKNOWLEDGMENTS

We wish to extend our appreciation to Dr. Audrey Riker for her skillful administration of developmental scales and for her insightful remarks regarding the status of the children throughout the conduct of this investigation; to Dr. Carl A. Binnie for the audiological evlauations, to Dr. Raymond G. Daniloff for his advice and direct participation in the acoustic analyses and the perception study; to Henrietta K. Franks for the many hours spent in data reduction, correction and transcription; and to Dr. M. Irene Stephens for her continuing assistance and support. We are also grateful to the staff, graduate students and faculty of the Department of Audiology and Speech Sciences for a myriad of contributions to this investigation, including facilities, equipment, materials and time involved in securing, preparing and transcribing recordings. Finally, we are indebted to four very special families who contributed their own time and energies over a long period. We can truly say that these parents and their children became our teachers.