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ABSTRACT

The early communication network existing between a mother and her 12-week-old infant was explored. Over 50 infants of both sexes from a variety of social classes were seen in their homes, and a wide variety of maternal and infant behaviors were studied. Of special interest was the vocalization-in-communication data. The results indicate a lawful, consistent, and predictable pattern of communication and suggest that meaning is being established at the very beginning of life. (Author)

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Educational Testing Service
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Mother-Infant Dyad: The Cradle of Meaning

Michael Lewis and Roy Freedle

Abstract

The interest of this paper was to explore the early communication network that exists between a mother and her 12-week-old infant. Over 50 infants of both sexes from a variety of social classes were seen in their homes. A wide variety of maternal and infant behaviors were studied. Of special interest was the vocalization-in-communication data. The results indicate a lawful, consistent, and predictable pattern of communication and suggest that meaning is being established at the very beginning of life.

Mother-Infant Dyad: The Cradle of Meaning

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> Language is a recent acquisition. Physiologically, the localized speech center is uniquely human. Biological evidence suggests that when new organs arise, they operate through previously extant ones, modulating and moderating them rather than abolishing them. . . .Sperry. . .reports evidence suggesting that the rule is true of speech as well. Human information processing in this view may be taken as basically perceptual, with words and language operating upon the basic perceptual system (Reitman, 1965, p. 250).

To understand much of what is to follow it is necessary to experience the data base out of which much of our thinking grew. Such a data base would require that you view, as well as hear, what transpires between a mother and her very young infant. The following transcription cannot do it justice--absent are the nuances, the color, and subtlety of what makes up this dyadic relationship. Be that as it may, what follows is a sample description of the interaction of a mother with her 12-week-old infant. The interaction occurs over a 50-second period of time. The infant was awake sitting in an infant seat in the kitchen while the mother was cleaning up the breakfast dishes.

> 9:30:10
> F is sitting in her seat holding a rubber toy which is tied to the side of the chair. Mother has her back to F as she reaches for dish. F squeaks rubber toy making noise. As a "consequence" F kicks her feet and squeals with apparent delight. Mother turns toward F smiling. F looks at mother and vocalizes. Mother walks toward F smiling and vocalizing. F quiets, eyes fixed on mother. Mother touches F's face. F vocalizes and moves her hands toward mother. Mother sits in front of F and vocalizes to her. (Talking about the toy which mother now holds.) F watches mother and

listens. Mother pauses, F vocalizes. Mother touches F and vocalizes to her. F vocalizes.
9:31:00

The observer of this interaction cannot help but be struck by the communication network that the mother and her infant have established. Examination in detail of this type of interaction reveals a behavior matrix made up of both maternal and infant behaviors. Each member of this dyad is an active participant, each affects the determinants of the other's behavior. Moreover, the structure of the dyadic relationship reveals the kinds of chaining and pausing processes that one would expect to obtain from a two-way communication system (Jaffe & Feldstein, 1970). Take chaining as a first example. Here we refer to chaining as simply the number of actor changes; thus, "mother touches, infant vocalizes, mother vocalizes" consists of a three-chain structure. Observation of mother-infant interactions indicate that by 12 weeks as many as six-chain structures exist, these initiated by the infant as well as the mother. In a recent study by Lusk and Lewis (1972) it was shown that the length of these chains increases within the first year of life, although the initiator of these chains does not seem to be developmentally related. It would seem that the patterns or sequential complexity of responses that the infant can sustain in interaction with the caretaker increases as the infant matures.

Our conception of a general communication system would be one that constrains behavior and therefore gives meaning. By meaning we are referring to the differentiation or partitioning of the infant's world (be it spatial, temporal, internal or external). We shall show that this differentiation can occur by situation and general behavior, as well as more specific sequences of vocalization states.

The interaction of the infant and its mother reflects what we believe to be a rather finely tuned and potentially meaning-laden system wherein each allows the other to act. Nowhere is this more readily seen than in the vocalization interaction of these two dyadic members. If we forget that the infant at 12 weeks of age is totally without any formal language system, observation of their vocal interactions strikes one as having a "conversational" quality. Mother vocalizes, infant listens; infant vocalizes, mother listens--the chain of vocalizations varying in length. The resulting phenomenon might very well be said to resemble that of two adult language users carrying out a conversation.

Lieberman (1967) reported that infants of about three months appear to be able to respond differentially to friendly as contrasted with hostile voices. Other differentiations that infants appear capable of making are between exaggerated (baby talk) and normal intonation (Lieberman, 1967) and between inflection and noninflection (Kagan & Lewis, 1965). Other evidence (also cited by Lieberman, 1967) regarding the primitive behaviors from which language may later evolve concerns the cries of infants which Lieberman believes "provide the basis for the linguistic function of intonation in adult speech." While Lieberman argued for an innately determined basis of crying behavior, the work of Bell and Ainsworth (1971) suggested that infant crying and caretaker response are subject to learning principles. Their work revealed that, contrary to simple response learning theory, reinforcement of crying behavior in the first quarter year (responding by holding the infant, etc.) does not produce subsequently more crying at one year, but, in fact, more subsequent communicative behavior. The authors stated, and we must concur, that crying, even in the first quarter year of life, is a communicative behavior, reinforcement of which leads subsequently to other noncrying communicative behaviors. Infant crying, then, is part of the general communicative network of the infant and his world.

From a phonetic point of view others have hypothesized infant language capacities. Even at this very early age it is possible to identify regularities such as the "innate breath group" which will later be adapted to serve a linguistic function--segmentation of the speech signal into sentences (Lieberman, 1967). Moreover, the recent work of several investigators indicated that phonetic properties of the language--the consonants |b| and |p|--are differentiated at very early ages (Eimas, Siqueland, Jusczyk & Vigorito, 1971). Whether from a phonetic or semantic point of view, Lieberman's finding of speech frequency differences in infants as a function of who is talking to them is rather interesting. Infants will attempt to mimic the fundamental frequency of the person talking to them, whereas in a free-play situation, the child's fundamental frequency is different, usually higher.

The corpus of observations on infant linguistic behavior, although limited, compels us to consider that at a very early age it may be possible to detect precursors of a system which may be, or may evolve into, a more formal language system. While the details may be in some doubt, there exists from birth a communication network between the infant and his mother.[2] It is our general hypothesis that the anlagen of language is developed of and from aspects of this communication system. The major focus of this paper, therefore, will be on the communication and semantic aspects found in infant-mother interaction.

For us the function of language is to communicate. Like Levi-Strauss (1966) we believe that language is a symbolic system which cannot exist apart from social interaction. And conversely, social interaction is a symbolic system. Man alone is by nature helpless and needs others, making social commerce axiomatic. Given that the function of language is to communicate, it would appear that meaning becomes the central factor to be considered when one wishes to explore the development of language. If it is semantics[3] that needs study, the problem becomes increasingly difficult: how to talk about meaning in an organism without formal language properties. The problem is not new, and in its general form deals with the interrelationship of language, thought, and mind. If the primary way to get at meaning is through language, is it possible to study meaning in a nonverbal organism? This problem has been dealt with for deaf children (Furth, 1966) and for nonhuman primates (for example, Gardner & Gardner, 1969; Goodall, 1971). However, little attempt has been made to deal with this problem in infants prior to single word utterances.[4]

We intend to study semantics without language, for we are interested in the earliest forms and/or precursors of meaning. We hope to demonstrate that at least by three months one can already discern some regularities in vocalization behaviors which occur nonrandomly and are distributed differentially as a function of situational context. A close analysis of these regularities suggests that they reflect perceptual-cognitive structures which are, or become, the earliest forms of such semantic notions as "location of," "object or subject of," "presence versus absence of," etc.[5]

Meaning may initially rely upon the perceptual isolation and recognition of featural or relational differences in the external world, such as noticing the direction of approach versus withdrawal, who does what to whom, which is a subject-object distinction, etc. One can deduce that the organism probably perceives such differences by noting a significant shift in its behavioral patterns that occur in situations which distinguish, for example, whether the infant is or is not the object of the mother's vocalizations. Also, if behavioral patterns shift as a function of mere changes in location such that the particular location favors a different spontaneous emission of behaviors, then one might claim that this forms a necessary but perhaps not sufficient basis for the development of the semantic notion of location, or for the more specific problem of mapping function to location. Similarly, a change in behavior when a stranger approaches an infant versus withdraws from the infant can be interpreted as a potential precursor of the semantic notion of direction.

Thus, it seems more than reasonable to explore semantics in the communication network of the very young infant. After all, it would be even more implausible to maintain that the infant magically leaps to semantic conceptions only after he begins to struggle with single word utterances. No one could maintain that during the first year the infant is without knowledge (Piaget, 1952; Vygotsky, 1962). Thus, we felt it reasonable to assume that some form of semantic as well as phonetic and intonational substrates of language are developing continually from the moment of birth.

Method

To obtain data on the mother-infant interaction, it was necessary to observe each dyad over a relatively long period in a naturalistic setting. Each infant seen was three months old (± one week). The sample of infants seen was deliberately chosen in order to obtain as heterogeneous a group as possible. For this reason boys and girls of two racial groups (black and white) as well as from the entire socioeconomic spectrum (using the Hollingshead five-point scale, 1957) were included. There were infants of black professionals as well as infants of poor working class white families.

In all, over 80 dyads have been seen; however, the data analysis is laborious and the number of dyads varies as a function of the analysis.

Each infant was seen in its home. Contact with the mothers was made in a variety of ways: through the mothers' initiative, through birth announcements in the newspapers, and through church groups in lower socioeconomic areas. Two observers were trained and used in this study, one for the black community and one for the white. The observer reliability was moderately high, at least for overall frequency of infant behaviors (rho's ranged from .50's to .80's). The vocal behavior reported in this paper has a much higher reliability, typically in the .80's.

The mothers were instructed that the observer was interested in studying the infant's behavior. The observer sat next to but out of sight of the infant. It was stressed that it was the infant who was to be observed--not the mother. Moreover, the mother was to try to forget the presence of the observer and not engage her in conversation. When conversation was attempted, the observer reminded the mother that she was to ignore her. Prior to observation, the observer spent time with the mother attempting to put her at ease.

While every attempt was made to make the observation session as natural as possible, the presence of the observer was bound to have an effect. This problem has been discussed before (Lewis & Goldberg, 1969); because of the ethical consideration of observation without the mother's knowledge and approval, this was the only procedure available.

The observation data were collected using a checklist sheet. Each sheet represents 60 seconds, divided into six 10-second columns. Infant behaviors are listed in the upper portion of the sheet, while adult behaviors are in the lower portion. When a behavior not listed on the sheet occurred, the observer wrote it in. For the most part, the behavior categories are self-explanatory and include vocalization, feed, smile, extra movement, fret/cry, quiet play, and noise/nonvocalization. The "extra movement" category consisted of all gross physical movements, such as limb movement or rolling of the body. "Quiet play" consisted of the child watching a toy move, playing with his fingers; and noise/nonvocalization was similar to extra movement, except that noise accompanied the behavior (by kicking feet against the crib). It is clear that these behaviors are not totally exclusive, reflecting a further difficulty in studies of this sort. Although the behaviors have some overlap, the observers were, in general, able to differentiate between them. Maternal behaviors listed included touch, hold, vocalization, look at, smile/laugh, play, feed, change clothes, rock, vocalization to others, reading or watching TV. Mother's touch and holding categories were used to distinguish between a discrete touch versus a physical support. If during a "hold" the mother also discretely touched the child, both categories would be scored. Finally, the categories of reading/TV and vocalizing to others were used to indicate that the mother was involved in activities <u>not</u> directed toward the child.

For each 10-second interval the observer checked off the occurrence of both infant and mother behaviors, also recording when possible which behaviors preceded which.

Also recorded by minute was a general description of the physical situation that the infant-mother were engaged in at that time; for example, "infant-mother in kitchen, infant in infant seat on table."

If the infant closed his eyes for longer than 30 consecutive seconds, observation stopped. In order to obtain two full hours of eyes-open data, a minimum of two hours of observation and on some occasions as much as three or four hours were necessary. In fact, for one-third of the sample, two visits to the home were required.

Methods of Data Analysis

Various levels of interactive analysis are possible with these types of data. In several recent papers (Lewis, 1972; Lusk & Lewis, 1972) some of the more obvious were presented. In the present paper we shall deal with three methods of data analysis.

The simplest is the frequency distribution, that is, how much vocalization, quiet play, smiling, etc., the infant exhibited in the two hours of observation. Likewise the same data analysis is possible for the mother's behavior.

Simultaneous behavior within 10-second unit--the number of 10-second units for which there are both child and mother behaviors, keeping in mind the specific nature of the interaction. Since it is often difficult to determine exactly which one of the pair initiates a behavior sequence and time duration of the sequence, a more conservative approach is to restrict the analysis to a 10-second time unit, recognizing that it is an arbitrarily selected unit of time.

Directional interactive analyses. Under this analysis, four categories of interactive behavior are possible for each specific behavior. For example, consider the infant's vocalization. One question to be asked is whether the vocalization was a response to a maternal behavior or was an initiator of a maternal behavior, these being scored as two separate categories. This was accomplished by making use of the scoring of a "1" or a "2," "1" indicating initiating. Two additional categories were necessary for interactions with less clarity of direction. For example, the child vocalizes, and it was observed that the mother had been vocalizing to the infant for 30 seconds prior to and 10 seconds after the child's vocalization. Does the mother's vocalization constitute an initiation, and her vocalization subsequent to the child's a response? It is not at all clear since the infant did not vocalize immediately. In this case this type of interaction was scored separately. Finally, a fourth category was necessary for interactive behavior whose direction could not be assessed. Thus, for each infant behavior, each maternal behavior had four possible direction components. While we have illustrated this for vocalization data, it applies equally well for all behavioral categories.

There are, of course, many more measures of interaction for which individual measures may be obtained. For example, one can look at length of interaction; for another, density of response. In considering these types of data analysis, one must consider that we are discussing the possibility that each of these varies as a function of the context or situation in which they take place, as well as the idiosyncratic nature of the infant-mother interaction.

Results

Consistent with our theme, the results section will deal with three aspects of the problem of infant vocalization in order to demonstrate the nonrandom, selective and interactive quality of the infant's vocalization: (1) the general communication network, or the matrix of maternal and infant behaviors; (2) a model of sequential interaction between the infant and maternal vocalizations; and, finally, (3) an examination of the influence of situation on the infant and maternal vocalizations.

General Communication Matrix

At first consideration the vocalization matrix between two adult members of a dyad would appear to be the vocalizations of each member--a vocalization of A elicits a vocalization by B. Examination reveals, however, that this is only part of the vocalization matrix. The matrix consists of more than the words and sentences of A and B. A's sentence may elicit a frown from B which in turn elicits a new sentence by A.

Likewise, the caretaker-infant communication matrix is made up of more than the vocalizations of each member. In order to understand the function and meaning of vocalization (by either party) it will first be necessary to place these vocalizations within the communication matrix in which they appear and for which they are uttered.

The first analysis consists of the frequency of maternal and infant vocalizations which occurred within the two hours of observation. The data for over 40 infant-mother pairs reveal considerable individual differences. For example, the number of 10-second periods in which there was an infant vocalization ranged from 28 to 438! On the average, vocalizations occurred for approximately 25 per cent of the observation time. Frequency of maternal vocalization also showed individual differences ranging from 101 to 493 10-second periods. Maternal vocalization was relatively frequent during the two hours of observation--approximately 38 per cent of the time. The frequency of maternal to infant vocalizations was significantly related so that high frequency vocalization of one was associated with high frequency of the other ($r = .43$, $p < .05$). Interestingly, while sex of the infant is not reflected in the mean frequency differences, the sex of the infant does affect the maternal output. Mothers of girls vocalize significantly more to their infants than do mothers of boys (mean 291.3 versus 227.1; $t = 2.04$, $p < .05$).

Still another individual difference has to do with the socioeconomic level of the family. The families were divided into social class according to Hollingshead's scale--a scale utilizing occupation and educational level. The frequency data for the mothers failed to indicate any social class effect; however, the frequency of the infants' utterances was clearly related to class. There was almost a perfect ordering, with the lower class infant vocalizing more. While these analyses are not meant to inform us as to the relationship of the utterance to the communication network, they do indicate that there are vast and significant (concerning their social consequences) individual differences in the output of vocalization for both a mother and her 12-week-old infant.

These individual differences will be discussed again; however, it is important to consider the frequency of output data from the beginning. In order to observe the general communication matrix in which the utterances are embedded, it is necessary to consider the matrix of who does what to whom, when. In Table 1 such a matrix is constructed in which infant vocalization

Insert Table 1 about here

is related to the variety of maternal behaviors, while maternal vocalization is related to the variety of infant behaviors. The data represent the mean number of 10-second intervals in which a particular set of behaviors occurred. There could be a maximum of 720 such intervals. Look first at the infant vocalization data (top half of the table), both in terms of the infant vocalizations eliciting a maternal behavior (left half) and the infant vocalizations as a consequence of maternal behaviors (right half). In both cases the vocalization-vocalization pairing is strongest. In the case of infant initiated vocalization-mother responds, the next three strongest maternal responses are smile, look at, and touch. The three next strongest maternal elicitors of an infant vocalization are play with, look, and smile. Thus, next to maternal vocalization, maternal looking at and smiling to are the two constantly strongest responses associated with infant vocalizations.

Next, observe maternal vocalization (bottom half of the table) and those infant behaviors associated with it. Again, the vocalization-vocalization pairing is strongest. In the case of maternal initiated vocalization-infant response (left side), the infant smile is next strongest. For infant initiated behavior-maternal vocalization, infant distress (either movement or fret/cry) is the likeliest (after infant vocalization) to elicit a maternal utterance (right side). While there is a parallel between maternal response and infant vocalization, regardless of the direction of the infant vocalization, the same does not hold for the maternal utterance and infant response.

Individual differences in response pattern can also be observed. Table 1 presents the data broken down by sex of infant. Of particular interest is that infant initiated vocalization is responded to more often by the mother if the infant is a male. <u>This is true for every behavior except maternal utterance</u>. However, an infant vocalization in response to a maternal behavior is more likely for a female than a male. Thus, while

<u>total</u> input vocalization data show no sex differences, infant vocalization in response to maternal behavior shows clear sex differences. Individual infant behavior related to a maternal vocalization is again less clear. Only fret/cry is consistent and indicates that maternal vocalization is more associated with female than male fret/cry.

The infant-maternal vocalization data would seem to parallel that of two adults. Vocalization-vocalization pairing is the most common interaction; however, smiling, looking at, and fret/cry (this is uniquely an infant behavior and may be a negative affect component) are all instrumental in both eliciting and reinforcing a member's vocalization. Finally, even within this matrix of behavior, individual differences (as a function of the sex of the infant) in the patterning of vocalization behavior emerge.

A Model of Vocalization Interaction

The communication matrix makes clear that a vocalization can be the response to or the elicitor of behaviors other than a vocalization. A look or smile can serve as an elicitor or response to a vocalization, this for either the infant or mother. Any model used to study the interactive quality of the vocalization between members of a dyad will need to consider this. As one might imagine, the inclusion of all behaviors in any interactive model results in an extremely complex picture. Thus, as an initial step and for the sake of clarity, consider only utterances, or the lack thereof, in an interactive model. Moreover, in order to utilize all of the vocalization data, simultaneous occurrence, rather than only directional vocalization data, will be considered. While this is an oversimplification of the true state of affairs, the data previously presented suggest that vocalization-vocalization relationships by far are the most prevalent.

One way in which to study the sequential quality of the infant-mother vocalizations is to construct a matrix of transitional probabilities (Freedle & Lewis, 1971). To do this it will be necessary to assume each 10-second period as a discrete trial or category. The use of these periods is arbitrary and was determined on the basis of ease of recording as well as obtaining a small time unit. Thus, there is no reason to believe that the sequence of infant and maternal behaviors bear any special relationship to this time demarkation. Nevertheless, this time unit will be used, recognizing that it may be too long a duration and hence may obscure some of the detail in the interaction of the infant and his mother.

Since the data were collected for two full hours, a total of 720 successive 10-second periods exist for each dyad. The vocalization data can be categorized into six states: neither mother nor infant vocalize (0); infant vocalizes alone (1); mother vocalizes alone to infant (2); mother vocalizes alone to some other person (2i); mother and infant both vocalize (3); and mother vocalizes to another person and the infant vocalizes (3i).

Given these states of infant, mother and infant-mother interaction, and the 10-second time unit, we will use the transitional matrix values as a measuring instrument in order to ascertain individual as well as state differences in infant vocalizations.

The transitional or conditional probabilities can be estimated as follows: consider the following succession of states obtained from coding the successive 10-second periods for a particular mother-infant pair: 3, 0, 1, 3, 1, 2, ... Set up a matrix with six rows and six columns labeled 0, 1, 2i, 2, 3i and 3, reading from the top down for the rows and similarly labeled reading from left to right across the columns. Using the above sequence, notice that the first pair of states is 3, 0. Enter a tally in the rows labeled "3" and the column marked "0." The second and third states form the next pair of states which is 0, 1. Enter another tally in the row labeled "0" and the column labeled "1." The next pair of states is 1, 3, so enter a tally in row "1" and column "3" and so on until all successive pairs of states have been tallied. When this is done, sum up the tallies for each row and divide the frequency in each row cell by the sum for that row. These proportions that result in each row are then used as the estimates for the conditional probabilities of the transition matrix. For the data under consideration here, there were 719 tallied entries for each mother-infant pair studied.

Insert Table 2 about here

Table 2 presents the transitional probabilities by sex for each of the vocalization states. From this table it is possible to examine how the vocalization state on trial _n_ + 1 is influenced by the state that occurred on trial _n_. Using this scheme it is possible to investigate a series of interesting and important questions. For example, one might inquire as to the relationship of maternal vocalization (state "2") on trial _n_ on infant vocalization (state "1") on trial _n_ + 1, or the relationship of state "1" on trial _n_ to state "1" on trial _n_ + 1. The general form of the questions center around the probabilities of occurrence of vocalization states in the future as a function of a past state.

In general, the largest conditional probabilities in each row is along the diagonal of the matrix. This indicates that a vocalization state tends to persist over time; that is, these dyads will tend to have long runs of the same state. There are interesting and meaningful other patterns; for example, individual differences in an infant's ability to discriminate toward whom the mother is directing her vocalization. We observe that female infants detect the difference between their mother's talking to them (where they are the object of the mother's directed speech--state "2") and when their mother is talking to someone other than themselves (where someone else is the object of the mother's speech--state "2i"). This fact can be demonstrated by examining the rows of the transitional probability matrix labeled "2" and "2i." If we sum the probability that the infant will vocalize in the next time sequence (sum in each row the column entries "1," "3," and "3i" in which the infant vocalizes), we find that female infants show a significant tendency to vocalize more when the mother vocalizes to them than when she vocalizes to another (sign test, $p<.001$). The same analysis comparing "3" with "3i" indicates that female infants can discriminate the object of the mother's vocalizations (sign test, $p<.07$). These analyses for male infants fail to indicate any ability to differentiate their vocalizations as a function of whether they were or were not the object of their mother's vocalizations ($p<.50$ in both tests). These differences indicate that females may be showing more "advanced" language development even at 12 weeks.

Before turning to SES differences in these conditional probabilities, it is interesting to note that the probabilities of the infant vocalizing in a future time sequence is equally well accounted for by the amount of vocalization the infant exhibited previously (state "1") as well as the amount of directed infant-mother interaction (state "3"). Environmental input--at least maternal vocalization (states "2" or "2i")--is relatively weak in accounting for or influencing subsequent infant vocalization. In fact, it does not appear to be different from state "0" which represents no vocal behavior at all!

Insert Table 3 about here

Table 3 presents the transitional probabilities as a function of SES. Several rather interesting findings emerge. While in general the most powerful influence on the vocalization state of trial *n* + 1 is the same vocalization state on trial *n*, important SES differences appear. First, consider state "1" (infant's vocalization alone) as accounting for the infant's vocalization in a subsequent time. All SES levels have about the same conditional probabilities (.54, .64, .60, .45, .58 for SES I to V respectively). When one considers state "3" (the mother-infant vocalization), one finds clear SES differences with lower SES infant vocalizations being more affected by past mother-infant interaction (conditional probabilities of .34, .36, .55, .41, .63 for SES I to V respectively). Thus, there is no difference in the subsequent probability of a lower SES infant (V) vocalizing considering states "1" or "3" (.58 versus .63). However, there is a difference in the subsequent probability of a higher SES infant (I) vocalizing considering states "1" and "3" (.54 versus .34). This finding is partially explained by observing the effect of environmental impact--maternal vocalization--on the infant's subsequent vocalization. In general, state "2" has little effect on the probability of the infant vocalizing (probabilities of .11 to .24). What is interesting is that there is again an SES level effect with maternal impact having a greater effect for the lower SES levels (conditional probabilities of .11, .12, .21, .16, .24 for SES I to V respectively). Exactly the meaning of this SES difference is not clear.

However, the data suggest that the mother's vocalization (either alone as in state "2" or in conjunction with the infant as in state "3") does not facilitate the higher SES infants' vocalization. This may be a function of the fact that the mothers' vocalizations cause these infants to listen rather than vocalize. Previous work with middle class infants using human voices suggests that mother's voice does have the effect of inhibiting infants' vocalizations (Kagan & Lewis, 1965). This interpretation is further supported by observation of some specific subcycles in the conditional probability matrix. Consider the 3 to 3 cell and 3 to 2 cell in the matrix. In the 3 to 3 cell the lower SES infants have a higher probability of continuing to vocalize as their mothers vocalize than the higher SES infants, whereas in the 3 to 2 cell it is the higher SES infants who appear to stop vocalizing once their mothers and they were vocalizing. This can be seen even more clearly in the 2 to 2 and 2 to 3 subcycles of the matrix. In the 2 to 2 cell we find the higher SES infants (I) more likely to remain silent while their mothers are vocalizing than the lower (V) SES infants, while it is the lower SES infants who are more likely to start vocalizing when their mothers are vocalizing than the higher SES infants (cell 2 to 3).

Differentiation differences as a function of SES are also evident and reveal a pattern which tends to dovetail with these other differences. In the comparison of the differentiation between mother vocalizing to the infant (infant as object--state "2") or mother vocalizing to someone else (infant not as object--state "2i"), there is an SES difference such that higher SES infants show greater differentiation. The percentage of infants showing greater vocalization to "2" as compared to "2i" is .82, .62, .73, .50, .60 for classes I to V respectively. Interestingly this SES effect can be accounted for more by the female infants (1.00, 1.00, 1.00, 0.33, 0.50 for classes I-V respectively). Observation of the other differentiation states, "3" and "3i", fails to indicate that higher SES infants show greater differences than lower SES infants. Thus, it is only when they are listening rather than talking that higher SES infants show this differentiation effect as compared to lower SES infants. Here again is support for the relationship between vocalization differentiation and listening. We have suggested from several of the other vocalization analyses that there may be important individual differences in subsequent differential vocalization as a function of previous listening behavior (as in states "2" and "2i"). When the infants are themselves vocalizing, these individual differences cease.

What are we to make of this sequential analysis? This analysis indicates a highly complex and sophisticated communication relationship in the vocalization of the 12-week-old infant and its mother. Individual differences both in terms of SES and sex of the infant indicate that this communication network is highly specific and is already affected by factors known to make their appearance at a much later time--a time when formal linguistic properties of vocalization are present!

Situational Features of Vocalization

One of the assumptions underlying the theme of this discussion is that linguistic competency grows out of the communication matrix and that, moreover, the study of language development must emphasize the issue of function rather than structure. We also believe that context is the prime carrier variable for shared meaning.

Given this assumption it would follow naturally that a study of the context of the communication matrix of the mother and her infant should be undertaken. To do this is not easy and what we will present is a first attempt at its exploration. Context is such an encompassing concept and so unexplored that a short description is all that is presently possible. In the following discussion we shall only refer to the vocalization data of mother and infant, restricting our analyses to frequency of occurrence data. None of the sequential interaction data presented earlier is yet available for observation by situation. However, even at this level of analysis it soon becomes clear that the context of the vocalization of either mother or infant exerts an effect on the communication network.

Initially it appeared reasonable to assume that context might be defined by the space in which the infant and mother were located. For adults physical space usually carries with it a high degree of contextual meaning. Thus, a kitchen has associated with it food, eating, drinking, certain somatic sensations and the like, whereas the bedroom as a space is associated with sleeping, quiet play, etc. With this in mind we first attempted to observe the infant-mother communication matrix as a function of physical space. Recall that the observer marked the location and general category of activity for each of the 120 minutes of observation and we utilized this in order to study context.

Much to our surprise we discovered that the physical space or location by function of a 12-week-old infant was not yet differentiated by his caretaker. The child typically was not fed in the kitchen, played with in the living room or family room, washed in the bathroom, and put to sleep in the bedroom. Each of the activities most usually associated with a room in the house was performed by and large in any room. Physical space, such as a room, then, could not be used as a clear indicator of context.[6]

In order to study context, another approach was considered. For this analysis we observed in what enclosure or where in a room a child was situated; for example, eight specific categories seemed to account for almost all of the observed time: infant seat, playpen, mother's lap, crib or bed, couch or sofa, floor, diaper changing table or bath tub, and jumper or swing. An "other" category was included to include the few remaining cases.

Insert Table 4 about here

The data across sex and SES level are presented in Table 4. First, it was necessary to determine the distribution of time the infants spent in these situations. The data of Table 4 indicate that, across all infants, mother's lap was the most common situation in which the awake infant was observed. Crib/bed and infant seat were the next most frequent situations, while jumper, floor, and playpen were the least frequent. Both sexes show this same relative distribution of situation frequencies; in fact, the rank-order correlation between sex is .95. Of interest, however, are a few differences which were observed. Female infants tended to spend more time in the infant seat (Mann-Whitney U test, $p < .10$), crib/bed ($p < .10$), couch/sofa, and changing table, while males spend more time in the playpen, mother's lap ($p < .05$), floor, and jumper. Interestingly the sex differences in situation vary along what seems to be a restrictive versus nonrestrictive activity dimension with girl infants generally being placed in situations which allow for <u>less</u> vigorous, muscular activity, while for boys the reverse is true.

SES differences in total time spent in a particular situation are also apparent (see Table 4). While there is relatively high agreement across situations as a function of SES (Friedman analysis of variance; $X^2r = 32.3$, df 8, $p < .001$), general differences emerge. Mother's lap is the most frequent situation for all SES levels, while crib/bed is next highest for the higher SES levels and infant seat for the lower SES. The playpen and jumper were the lowest situational frequencies for the highest SES levels, while only floor emerged as the lowest situation in any consistent way across the lower SES levels. In terms of mean data the only striking differences between SES class I and V are in time spent in crib/bed ($I > V$, $p < .10$), floor ($I > V$, $p < .001$), and mother's lap ($V > I$, $p < .05$).

The frequency of location data, then, indicate that although there are consistencies in terms of where the infant is located by the mother, individual differences as a function of sex and SES level exist. Of concern to our discussion, however, is not the situational differences *per se*, but whether it is possible to observe vocalization differences as a function of these situations. Recall that it is our hypothesis that these situations help form the bases for acquiring meaning and, if true, should be extremely important in the acquisition of subsequent language skills.

Keep in mind that an analysis of the content of mother's verbal utterances in each situation would be the most ideal form of data collection but as a first approximation we must be satisfied with the frequency of vocalization data independent of content.

Insert Table 5 about here

Table 5 presents the relative frequency of vocalization for infant and mother with respect to the total amount of time the infant spent in that situation. Thus, although infants spend more time on their mother's lap than in any other situation, the data of Table 5 indicate that infants vocalize most often per unit time in their playpens, next most often on the floor and infant seat, while they vocalize least on their mother's laps and in their cribs or on their changing tables/bathtubs.

While there was high agreement between the sexes in terms of the amount of time in these situations, there is no relationship (rho = .08) between girls and boys percentages of vocalizations across these situations. Hence, we cannot attribute the observed differences to different number of exposures to these situations. For boys the infant seat and floor yield the most relative vocalization, while for girls it is the playpen and floor. The least vocalization for boys is the crib and sofa, while for girls it is the mother's lap and infant seat (discounting the "other" category). Exactly why this sex difference exists is not clear. However, observation of the mother's relative vocalization data might reveal the reason. One might assume that mother's vocalization would be associated with (1) infant vocalizations, (2) infant quieting and no vocalization, or (3) unrelated. The data of Table 5 indicate that mother's relative vocalization over all infants was greatest for floor, changing table/bathtub and sofa and least for playpen, crib, and jumper. Interestingly, while there was no relationship across situation for girls and boys relative vocalizations, mothers' vocalization across situation was consistent across sex (rho = .67, $p < .01$). The correlation of infant to mothers relative vocalization indicates that over all infants there is no relationship (rho = -.15), although there is a slight indication that mother's vocalization is associated with lack of infant vocalization. The correlation for each of the sexes indicates a rho of -.30 for boy-mother vocalizations and -.27 for girl-mother vocalizations as a function of situation.

The data for sex differences suggest, then, that the infant's relative vocalization across situation is sex specific and independent of the maternal vocalization. Vocalizations occur most frequently when the infant is relatively free of physical restraint as when it is in a playpen or on the floor, and vocalizations occur least when the child is on the mother's lap. The data suggest that one dimension of these situations or the underlying semantics of location may be the acquisition of constraint versus non-constraint.

SES differences, both for the infants and their mothers, also appear in Table 5. Observation of the infant data indicate that there are SES differences in relative vocalization as a function of situation. Comparison between SES levels I and V indicates a negative rank-order correlation of -.54 ($p < .10$) such that situations in which high SES infants vocalize, low SES infants do not. Situations which are restrictive, such as mother's lap, infant seat, changing table/tub, were associated with relatively <u>more</u> vocalization for the lower SES infants and relatively <u>less</u> vocalization for the higher SES infants (by Mann-Whitney U tests p .002, .001 and .05 respectively). Likewise, floor, playpen, and sofa--nonrestrictive situations--were associated with more vocalization for the higher SES and less vocalization for the lower SES infants.

These social class differences in infant behavior seem only partially related to maternal vocalization. Thus, while infant vocalizations were inversely related as a function of SES, there was a positive rank-order correlation between SES level I and V mothers' vocalization associated with these situations (rho = .40). The relationship between infant-mother vocalization as a function of SES and situation is somewhat more complicated.

For SES level I there is no relationship between infant-mother relative frequency of vocalization as a function of situation (rho = -.05) whereas there is a positive relationship for level V infant-mother vocalization (rho = .54, $p < .10$).

The situational analysis has only utilized frequency of vocalization data. However, we are currently investigating the directional relationship between mother and infant as a function of situation. Like the frequency data, differences as a function of situation appear. Preliminary examination of four infants' conditional vocalization states by situation suggest to us that some situations influence the likelihood of discriminating state "2" from "2i," whereas others fail to do so. But what of the situational differences we have reported? These differences parallel much of what we have reported before. For example, the data on using the floor as a situational setting indicate decreased use of this situation as SES level decreases. Thus, the lowest SES level mother <u>never</u> puts her infant on the floor. Why might this be true? Could it be that the floor for the poor is a dangerous place for their infants: cold, uncarpeted, and rat-infested? This, of course, is generally not the case for the middle class. Thus, situations produce differences quite early as a function of social class.

One particularly interesting individual difference in situations has direct parallel with the earlier analyses. From some of the interaction data we found that lower SES infants were more responsive to their mother's vocalization (by vocalizing more when their mothers vocalized). In this situational analysis these infants also show (1) greater correlation with mother's vocalization over the various situations and (2) vocalize in those situations where they are relatively restricted. We suspect that relatively restricted situations are associated with being nearer to or unable to get away from the mother.

Situational determinants of vocalization have only been hinted at by these data. The kind of data necessary for determining precise effects is not yet available. Remarkably, the data do show that there are infant vocalization differences as a function of situation, and that these are not invariably influenced by maternal vocalization, this by 12 weeks of age!

Discussion

When we started this investigation we suspected that our theme and the data collected would probably lead to more unanswered questions and confusion than light. In some sense this was deliberate in that we wished to initiate an unorthodox approach to developmental issues regarding language. Recall that our general theme was that there exists from birth a communication network between the infant and its mother and that the anlagen of language is developed of and from aspects of this communication system. Given this general belief, a myriad of problems befell us. For example, how should we define the communication network between these two members? What are the relevant behavioral dimensions? In terms of specific linguistic issues we were confronted by trying to study the emergence of meaning in the absence of formal language, itself a most complex issue. Some clues to direct us in this theoretical struggle were already available. In particular Bloom (1970) believes that some utterances probably have multiple meaning and that context may be critical in order to make the utterance unambiguous.

Recently, Fillmore (1968), among others, has placed emphasis on a semantic analysis of language in contrast with the primarily syntactical approach, and in doing so has suggested to us such semantic notions as location of, direction, object of, etc., as being useful concepts in analyzing language development. These kinds of semantic notions can more readily be brought to bear in specifying what underlying concepts may be operating within the general communication network which we have tried to elaborate. Thus, it seemed possible to find ways to measure the communication system of the infant and its mother and to isolate some sequences in given contexts which might be considered as semantic dimensions.

Before returning to this it is important to restate some of the more general findings about the communication network between infant and mother. The data have made it clear that the general communication network made up of the infant and its mother is more than just the vocalizations of each. Thus, a mother's smile may follow or a mother's look may precede an infant's vocalization. Likewise, an infant's smile may follow or an infant's cry may precede a mother's vocalization. The network is a complex web wherein the repertoire of each member actively interacts with the other. Vocalizations (infant and mother), therefore, may not be the only relevant data in understanding the unfolding process of meaning and language acquisition. This should not be surprising in that developmental processes are by their nature elaborate transformational processes wherein a particular behavior may not have an identical behavioral precursor.

If this is so it is important to consider that the communication network we have described is in some sense limited in that it includes only the infant-mother and not the infant-world. In this context, Bruner's (1968) speculations are extremely interesting. Bruner proposes a similarity between manipulative hand skills and some formal language skills--specifically the notion of subject and predicate--and suggests that in infant action in the world of objects, one may find direct precursors of some of the formal aspects of language. In addition, Bruner casts doubt upon the use of babbling, at least using only its phonetic aspects as an adequate base for searching for language prerequisites. To this we must concur; rather than study the phonetic aspects of babbling as critical, it is in the communicative aspect of babbling in interaction with other infant behaviors and the mother's behaviors that precursors may be found.

But something still was gained from narrowing our attention to just vocalization: in particular, we argued that some of the sequential properties of the infant-mother vocalization states carried important information about the discrimination of who was the object of the mother's vocalizations. The transitional matrix contained useful information which demonstrated that by 12 weeks of age some infants (especially females) are better able to differentiate whether or not they are the objects of their mothers' vocalizations. Thus, the possible precursor of "object" (something acted upon regardless of whether it is a speech act or any other) is already imbedded in the early communication system. The sequential analysis also has been valuable in demonstrating the wide and varied patterns of infant-mother vocalization generating interaction data that bear directly on issues of vocalization chaining. Finally, not to be excluded, is the value of prediction of subsequent infant vocalization by use of this model. A complex conditional probability matrix would undoubtedly go a long way in telling us what are the important measures of a communication system which can predict subsequent vocalization measures.

The inclusion of "location of" as an important semantic notion at 12 weeks cannot be argued without qualifications. Location must be considered in the specific context of the infant in his physical space (e.g., constrained space versus nonconstrained space). From any number of theoretical positions it seems arguable that one aspect of differential meaning is derived from the infant in his various physical spaces. We have found that situations alter the pattern of infant vocalizations at 12 weeks: thus, it appears that these infants are sensitive to situational differences. Whether they conceptualize this difference in any more formal way is impossible for one to assess without controlled studies.

Location, context, and meaning are intimately related. This can be exemplified by a rather interesting experience. B is a 13-month-old female infant who is sitting in a high chair in the kitchen. She is holding an apple and is told on several occasions to either "Bite the apple" or "Throw the apple." B in this situation always bites the apple and never throws it; however, when placed on the floor of a playroom and given the same two sets of instructions, she always throws the apple but never bites it. We would argue that in some sense the meaning of the particular command is determined by the context in which it is uttered.[7] Observation of the infant and its mother make clear that physical place, nature of activity, and specific language dimensions covary; in the kitchen one eats and talks about food, hot-cold, in-out, messy-clean, etc.

Location, in terms of specific situations, has been described and it is interesting to note the vast difference in location and the spontaneous vocalization activity associated with them. It may not be too far off the track to hypothesize that the infant who is allowed to roam freely (those placed on the floor or in playpen as opposed to infant seat, etc.) may be better able to develop such semantic notions of direction. Thus, in some very specific and, unfortunately, undefined way, situations can carry a vast array of semantic information: how this "information" eventually alters the formal language system is still unspecified.

The communication network, even of the 12-week-old infant and its mother, is a nonrandom, sequential, and situationally determined system suggesting a wide variety of activities which, on their face, are reminiscent of the more formal linguistic properties--especially the semantic ones--found at later ages. Individual differences in these activities are considerable, and we should like now to turn to some of them before concluding with some information relating these early individual differences to more formal linguistic properties of these same children at two years of age.

Individual differences in infants' vocalizations by 12 weeks of age, whether in terms of the general communication matrix, sequential analysis or situation, are considerable. There are approximately 20 times as much difference in vocalization output from the most to the least vocal infant, and these differences are not lessened even when the infants are compared in similar situations. In the present paper we have chosen to talk about individual differences along two dimensions, the sex of the infant and the socioeconomic background of the family. Note that our intention is not to demonstrate differences as a function of these variables, but rather to utilize them in order to unravel the process producing differences in vocalization and its consequences. For example, knowing that there are differences in amount of time spent on the floor as a function of SES allows us to disregard the SES differences and concentrate on the effect of time on the floor on vocalization differences.

Sex differences were observable at all levels of analysis. While infant girls overall did not vocalize more than boys, the general communication matrix data make clear that girls vocalize more in response to a maternal behavior than boys. Moreover, boys show less differentiation than girls in terms of their vocalization as a consequence of whether or not they were the object of their mother's vocalization. These data suggest that the female infant appears, by 12 weeks, to be more advanced in her vocalization use (communication skill) than males. Since there is some evidence that girls are precocious in their language development, these early differences appear consistent with this theme. They do raise the question as to the source of these differences. Because of the age of these subjects the question of biological factors becomes suspect. While these certainly cannot be excluded, it is important to note that maternal behavior differences, as a function of the infant's sex, also appear by this time. In fact, Moss (1967) has shown maternal behavioral differences as early as 3 weeks, and subsequent research will probably indicate that maternal behavior differences as a function of the infant's sex exist from the first contact with the child. For these 12-week-olds, mothers of girls talk more to them than to boys. Moreover, and most striking, while mothers of boys are more generally responsive to a boy's vocalizations than mothers of girls, this holds for all maternal behaviors except vocalization where the reverse is true. Thus, the specific vocalization-vocalization act occurs more for female than male infants. Situational differences also make clear the differential environmental factors and make attempts at theoretical untangling of the biological and learning determinants untenable.

The socioeconomic background of the infant was also effective in demonstrating individual differences and again raises the specter of biological advantage vis-à-vis early vocalization and subsequent language skills. Again it must be remembered that while these infant differences are observed at a very young age, it is also possible to observe maternal differences. With this in mind, it is possible to "explain" individual differences as a function of the influence of the mother behaviors rather than as a function of genetic differences. While we cannot determine the source, the data suggest that the higher SES infants are more "advanced" in their vocalizations, at least in terms of being able to differentiate between being or not being the object of the mother's vocalization. What, perhaps, is even more interesting is the relationship of lower SES children's vocalization with that of their mothers. The data from the sequential as well as situational analyses suggest that lower class infants' vocalization is sustained by their mothers' vocalization and also that lower SES mothers' vocalizations are more effective in eliciting a vocalization from their child, that is, the vocalizations of higher SES mothers seem to inhibit the vocalizations of their infants; the reverse seems to be the case for lower SES groups. The cause for this is unclear; however, data on social class differences in vocalization response to their infants' vocalizations suggest that higher SES mothers are more likely to respond with a vocalization than lower SES mothers (Lewis & Wilson, 1972). This differential vocalization response pattern may be affecting the listening-vocalization pattern of the infant. It is apparent that the different SES groups are learning different things--some quiet as a consequence of maternal vocalization while others increase their vocalization.

Up to this point in our investigation we have presented a wide variety of data bearing on the communication network of the infant and its mother and have been able to show wide individual differences. It has been our intention to argue that these parameters of behavior (within the communication network) and individual differences revealed by them are relevant to subsequent formal linguistic skills. Up until this point our comments have been speculative; however, because we have been following these children we can report, albeit preliminarily, the relationship between communicative behavior at 12 weeks and formal linguistic skills at two years. The data for the first three children to complete the study are available.

The linguistic data collected at two years can be divided into three aspects: (1) collection of spontaneous utterances; (2) a language comprehension task; (3) a "standard" test of language. The collection of spontaneous utterances took place in a naturalistic free play situation (Goldberg & Lewis, 1969) in which the child and its mother played together in a room filled with toys. Data were collected on tape and transcribed, and the following measures of linguistic development were obtained: mean utterance length; number of semantic distinctions, such as location, subject-verb, verb-object, direction, etc.; maximum semantic complexity within the most complex utterance of each child; and, finally, sequential analysis of the mother-child predications. The language comprehension task involved obtaining the child's knowledge of specific linguistic aspects, these being prepositions (locations, direction), subject-verb-object relationships, and adjective contrasts. The final task was a standard language test--Peabody Picture Vocabulary Test--where both a comprehension and production score were obtained.

Interestingly, at age two these various language measures tend to order the available three subjects in the same manner. At two years of age Pam showed the most linguistic development, followed by John and Pat. We might add that each of these children are from the highest SES level, and that their mothers' vocabulary scores from the WAIS were about equal. Now we shall turn to the 12-week communication network data and see what measures collected at this early age are related to subsequent linguistic skill at age two. In each of the three areas of study at 12 weeks (general communication matrix, sequential analysis, and situations) we find these three subjects are similarly ordered as at two years. For example, the total amount of infant vocalization and quiet play as well as the total amount of maternal play at 12 weeks occur maximally for Pam and minimally for Pat. Much more startling is the sequential data; Pam, John, and Pat, in that order, show greater differentiation between mothers' vocalization directed or not directed toward them.

The data must be viewed as preliminary; however, the results do suggest that the communication network at 12 weeks of age is a rich area of study and may well be developmentally linked with the more formal linguistic skills which emerge in the second and third years of life. We recognize the teasing quality of our speculations but present them because we are encouraged that the data regularities at 12 weeks which we have uncovered thus far may prove to be a more fruitful foundation for tracing out developmental links between a variety of early behaviors and later linguistic ability than current theorizing about language development might suggest.

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Footnotes

[1]This research was supported in part by a grant from the Spencer Foundation.

[2]We use the term mother although we recognize that anyone may serve as a caregiver and constitute a member of the dyad.

[3]We use meaning and semantics synonymously.

[4]In some sense one might consider the study of genetic epistemology in the first two years as an attempt to deal with this. However, Piaget has committed himself to consider only very special aspects of meaning--cognitive as opposed to affective--and has, for the most part, linked most higher forms of cognitive activity with language.

[5]Although we have not mentioned the syntactical aspects of the communication network, we do not wish to imply that it is not present. For example, "object of" can be defined as a syntactical as well as a semantic notion. See Fillmore (1968) and Kernan (1970) for a discussion of the newer emphasis of semantics in contrast with the primarily syntactic models of language and/or language development.

[6]Interestingly enough, further observation of infants' activities in their homes does reveal that by 12 months of age the physical space was well differentiated, with rooms associated with specific functions.

[7]We cannot rule out the possibility that the child would have engaged in these activities regardless of whether anything was said to her. Even so, specific behaviors have become associated with specific settings.

Table 1

A Portion of the General Communication Matrix of Infant and Maternal Behaviors as They Relate to the Vocalizations of Each

Maternal Behavior	Mean number of 10-second intervals when infant initiates vocalization; mother responds with:			Mean number of 10-second intervals when infant vocalizes in response to mother initiated:		
	Total	Male	Female	Total	Male	Female
Touch	1.08	1.50	0.55	5.16	4.07	6.55
Hold	0.80	1.29	0.18	5.60	3.64	8.09
Vocalize	34.24	32.07	37.00	23.20	18.43	29.27
Look	2.36	2.86	1.73	6.40	4.79	8.45
Smile	2.76	2.86	2.64	5.88	4.64	7.45
Play with	0.48	0.57	0.36	7.88	5.71	10.64
Change	0.12	0.21	0.00	0.72	0.93	0.45
Feed	0.32	0.57	0.00	0.80	0.57	1.09
Rock	0.12	0.21	0.00	0.04	0.07	0.00
Vocalize to others	1.00	1.29	0.64	0.12	0.00	0.27
Read/TV	0.12	0.14	0.09	0.20	0.29	0.09

Infant Behavior	Mean number of 10-second intervals where mother initiates vocalization; infant responds with:			Mean number of 10-second intervals when mother vocalizes in response to infant initiated:		
	Total	Male	Female	Total	Male	Female
Vocalize	23.20	18.43	29.27	34.24	32.07	37.00
Movement	2.40	2.57	2.18	10.88	11.50	10.09
Fret/cry	2.16	1.93	2.45	18.68	16.86	21.00
Play	1.40	1.71	1.00	2.32	3.00	1.45
Smile	11.24	9.79	13.09	2.40	2.86	1.82

Table 2

Conditional Probabilities of Vocalization States by Sex of Infant (N = 44)

			Trial n + 1						States involving infant vocalizations
	States		0	1	2	2i	3	3i	Σ 1, 3, 3i
Trial n	0	M	.654	.095	.138	.062	.041	.009	.145
		F	.625	.101	.167	.057	.046	.005	.152
	1	M	.352	.446	.073	.025	.087	.017	.550
		F	.412	.408	.075	.015	.077	.014	.499
	2	M	.280	.024	.492	.070	.125	.009	.158
		F	.233	.029	.551	.059	.124	.004	.157
	2i	M	.194	.027	.087	.587	.028	.076	.131
		F	.201	.013	.113	.608	.021	.044	.078
	3	M	.172	.089	.303	.045	.364	.027	.480
		F	.149	.071	.340	.025	.400	.015	.486
	3i	M	.131	.077	.060	.270	.075	.387	.539
		F	.183	.094	.089	.251	.120	.262	.476

Table 3

Conditional Probabilities of Vocalization States by Social Class Level of Family [a,b]

	States		Trial n + 1: 0	1	2	2i	3	3i	States involving infant vocalization Σ 1, 3, 3i
Trial n	0	SES I	.634	.076	.171	.084	.030	.001	.107
		II	.711	.089	.137	.030	.030	.003	.122
		III	.591	.103	.160	.069	.065	.013	.181
		IV	.671	.098	.136	.047	.045	.006	.149
		V	.619	.149	.135	.028	.062	.007	.218
	1	SES I	.467	.459	.100	.035	.056	.025	.540
		II	.650	.573	.089	.028	.065	.000	.638
		III	.331	.438	.063	.012	.144	.014	.596
		IV	.414	.341	.099	.035	.092	.019	.452
		V	.337	.489	.065	.015	.079	.016	.584
	2	SES I	.300	.031	.515	.078	.070	.006	.107
		II	.295	.032	.526	.053	.093	.001	.126
		III	.189	.031	.548	.053	.170	.009	.210
		IV	.192	.028	.587	.062	.127	.003	.158
		V	.250	.055	.458	.056	.173	.009	.237
	2i	SES I	.212	.017	.102	.630	.011	.027	.055
		II	.216	.015	.084	.628	.030	.027	.072
		III	.217	.023	.094	.522	.053	.091	.167
		IV	.164	.023	.080	.623	.025	.084	.132
		V	.136	.033	.128	.530	.028	.114	.175
	3	SES I	.251	.098	.356	.050	.234	.014	.346
		II	.174	.048	.426	.043	.300	.009	.357
		III	.120	.082	.297	.028	.450	.023	.555
		IV	.188	.067	.371	.032	.319	.023	.409
		V	.172	.099	.329	.039	.500	.031	.630
	3i	SES I	.218	.113	.097	.290	.089	.194	.396
		II	.286	.048	.143	.333	.048	.143	.239
		III	.129	.075	.080	.279	.104	.333	.512
		IV	.118	.078	.029	.373	.049	.353	.480
		V	.219	.143	.095	.314	.181	.429	.753

[a] SES I is the "highest" social class as determined by the Hollingshead Scale (based on occupation and education levels).

[b] This table is constructed from more than 31,000 10-second intervals.

Table 4

Mean Number of 10-second Intervals Spent in Each Situation

	Infant seat	Play-pen	M-lap	Crib/bed	Couch Sofa	Floor	Table/Tub	Jumper	Other
Total	100.9	29.2	288.4	118.2	46.2	28.0	62.5	26.7	19.9
Male	80.2	33.0	329.5	91.6	42.0	35.1	52.9	29.7	24.0
Female	121.6	25.4	247.4	144.8	50.5	21.0	72.1	23.7	15.8
SES									
I	111.8	18.8	231.8	204.8	51.0	19.5	54.8	12.0	15.8
II	108.5	11.5	222.5	163.1	44.2	48.0	60.7	19.1	41.5
III	88.2	64.8	308.4	75.6	30.6	38.8	68.4	27.6	15.0
IV	112.8	00.0	286.8	68.4	51.6	32.4	52.8	99.6	14.4
V	90.6	36.0	387.0	67.2	57.6	00.0	69.6	9.6	00.0

Table 5

Relative Frequency of Occurrence of Infant and Maternal Vocalizations as a Function of Amount of Time Spent in Each Situation

	Infant Vocalization								
	Infant seat	Play-pen	Lap	Crib	Sofa	Floor	Table/tub	Jumper	Other
Total	.233	.303	.171	.214	.200	.285	.216	.228	.211
Male	.308	.261	.183	.186	.170	.292	.225	.200	.228
Female	.179	.400	.150	.210	.227	.278	.207	.277	.137
SES I	.113	.345	.107	.204	.280	.350	.153	.130	.130
II	.222	.175	.097	.166	.133	.203	.153	.155	.240
III	.160	.460	.208	.280	.214	.345	.174	.420	.145
IV	.297	----	.168	.155	.320	.160	.200	.213	.180
V	.337	.050	.244	.262	.126	----	.464	.230	----
	Maternal Vocalization								
	Infant seat	Play-pen	Lap	Crib	Sofa	Floor	Table/tub	Jumper	Other
Total	.338	.257	.404	.325	.474	.518	.475	.365	.337
Male	.332	.265	.313	.385	.481	.562	.447	.393	.298
Female	.350	.243	.441	.272	.468	.466	.503	.310	.387
SES I	.244	.100	.342	.270	.480	.430	.456	.495	.240
II	.395	.300	.400	.318	.553	.600	.425	.170	.285
III	.376	.297	.423	.408	.562	.455	.630	.400	.535
IV	.312	----	.460	.625	.320	.553	.496	.130	.350
V	.407	.180	.398	.216	.205	----	.340	.515	----