Order Number 8921285

Relating measures of maternal responsivity to selected aspects of infant learning and affect

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The University of North Carolina at Greensboro, 1988

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RELATING MEASURES OF MATERNAL RESPONSIVITY TO SELECTED ASPECTS OF INFANT LEARNING AND AFFECT

by

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A Dissertation Submitted to
the Faculty of the Graduate School at
The University of North Carolina at Greensboro
In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Greensboro
1988

Approved by

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APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of the Graduate School at the University of North Carolina at Greensboro.

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November 21, 1988
Date of Acceptance by Committee

November 10, 1988
Date of Final Oral Examination

Meinhold, Patricia Marie, Ph.D. Relating Measures of Maternal Responsivity to Selected Aspects of Infant Learning and Affect. (1988) Directed by Dr. Susan P. Keane. 52 pp.

Twenty mothers and their 12-month old infants were studied during and independent of reciprocal interactions. Mothers were assessed on two measures of responsivity to infant signals: Accuracy of their responses to infant signals on a videotape and the accuracy and contiguity (contingency) of their behavior during a play interaction with their infant. Infant behavior was measured on an acquisition task and during a frustration task. Infant social behavior during the frustration task was measured by approaches to the mother or to the experimenter. In addition, infant affect was rated during each task. These measures were designed to reflect the current emphasis in the developmental and clinical literature on responsivity of maternal behavior and to begin to develop measures of maternal and infant behavior (and their interactions) that are compatible with the experimental learning literature. Chi-square and correlational analyses yielded moderately significant relationships between both measures of maternal responsivity and infant acquisition (with more responsive mothers having infants with shorter times and fewer responses to reach an acquisition criterion) and infant behavior during frustration (infants having more responsive mothers persisted for a shorter time). Infant approaches to their mothers were not related to mothers' responsivity scores in the predicted manner. Infant affect was also not related to maternal responsivity scores in the predicted manner.

Measures of maternal responsivity taken both within and outside of a reciprocal interaction appeared to be useful for predicting some measures of infant behavior under contrived laboratory experiences with contingent and frustrating events. Further research should incorporate additional measures that can discriminate social from non-social infant-environment interactions, examine the applicability of these measures to clinical populations of mothers and infants and examine other measures of learning related to the experimental learning literature.

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INTRODUCTION

From the perspective of major theories of children's social and personality development, social interactions between infants and their caretakers play an important role in how the child comes to respond to others (e.g., Bijou & Baer, 1965; Cairns, 1972; Freud, 1925). The impact of parent-infant social interaction on the development of social, personality, and cognitive functioning in the child has received a good deal of attention for many years and from a wide range of theoretical orientations. The need for research that can demonstrate empirically some of the mechanisms (and effects) of parent-infant influence has recently been intensified by increasing interest in developmental and preventive approaches to child psychopathology (e.g., Cicchetti, 1984).

The earliest investigations of the impact of maternal behavior on infant development documented the deleterious effects of gross "maternal deprivation" on infant cognitive, motor, and social development (for example, the classic observations of institutionalized infants conducted by Rene Spitz and his colleagues; Spitz, 1945; Spitz & Wolf, 1946). Later observational work attempted to describe the discrete behaviors exhibited by normal mothers and infants (e.g., vocalizations, touch) during activities such as feeding or play in natural and laboratory situations (e.g., Ainsworth & Bell, 1969; Brown et al., 1975).

Critiques of these early studies highlighted a number of methodologic and conceptual difficulties (e.g., Blank, 1964; Yarrow, 1961; Yarrow & Anderson, 1978). These included the need to control for variations in context and infant state, difficulties in interpreting results based on observations of infants compromised by institutionalization or neglect, and conceptual difficulties such as defining which features of the parent's interactions were actually the effective ones in producing infant outcomes.

In this project I designed a methodology to resolve some of these difficulties by examining the behavior of normal infants and their mothers, and the interactions of mother-infant pairs in controlled laboratory contexts. Measures of maternal behavior were selected on the basis of recent conceptualizations of mother-infant influences and on the basis of a behaviorally-based theoretical perspective. One motivation for applying behaviorally-based methods and measures to mother-infant interaction research is the potential for relating such research to a broad range of experimental literature concerned with environment-organism influences (e.g., studies of classical and operant learning).

In the past twenty years, two important conceptual developments that bear on the definition of the effective features of maternal behavior have taken place in research on mother-infant influences. First, the impact that the infant him or herself has on the mother-infant interaction has been acknowledged, for example, in discussions of the bidirectional nature of mother and infant behaviors by Ainsworth, Bell, and Stayton (1974), Bell (1968) and Gewirtz (1969)

and in discussions of the ways in which variations in infant temperament might affect mother-infant relationships (e.g., Thomas & Chess, 1977; Thomas, Chess & Birch, 1968). A second, related development has been that many studies of mother-infant interaction have drawn on the concepts of reciprocity or responsivity of maternal and infant behaviors and the accuracy of maternal responses to infant signals. As a result, studies and discussions concerned with the relative timing of mother and infant gaze, touch, vocalization, etc. have proliferated (e.g., Bakeman & Brown, 1977; Brazelton et al., 1975; Fogel, 1977; Lewis & Lee-Painter, 1974; Martin et al., 1981; Stern, 1974). More recent work has continued to reflect this emphasis on maternal responsivity to infant signals.

Seminal discussions of the importance of maternal responsivity have suggested that it is "accurate" and contingent maternal behavior that influences attachment and other aspects of social development (e.g., Ainsworth, Bell, & Stayton, 1974; Thoman, 1974). The "accuracy" of a mother's behavior is determined by the relationship between the mother's behavior and the infant's intention or expressed need. That is, the mother is "contingent" in her response to an infant behavior if her response follows the infant's signal closely in time. Her response is "accurate" if it meets the need signalled by the infant (Ainsworth, Bell & Stayton, 1974). Typically, the infant's intention or momentary "need" is inferred by the observer (e.g., Greenspan & Lieberman, 1980) rather than manipulated experimentally. During an interaction with the mother, an infant is likely to be experiencing moment-to-moment shifts in both the type and

level of motivation or "need" influencing his or her behavior. In this context, some degree of inference about the infant's intention or expressed need is unavoidable. Direct experimental manipulation of the infant's motivational state is one method for avoiding a large degree of inference in assessing the extent to which a contiguous response to infant behavior is accurate as well as contingent.

One consequence of the general conceptual emphasis on maternal responsivity (and consequently on the relative timing of discrete mother and infant behaviors) has been a shift in methodology towards more "microscopic" analyses of the sequence of behaviors that constitute mother-infant interactions. Second-to-second recordings of mother and infant behaviors and application of techniques such as sequential analysis have demonstrated that mothers and their young, normal infants exhibit behaviors that are mutually influential and reciprocal (e.g., Martin, 1981; Thomas & Martin, 1976). Such techniques have typically been employed in research with very young infants. In fact, it is unclear to what extent one should expect moment-to-moment dependencies between the behavior of mothers and their older infants. The temporal parameters of mother-infant interactions may change during development. For example, a mother's instruction to an older infant or young child may influence that child's subsequent stream of behavior in such a way that there are significant dependencies between the mother's instruction and child behaviors that occur two or three minutes later (Martin, 1980). In addition, sequential analyses of mother and infant behavior focus on the probability of <u>any</u> maternal response given <u>any</u> child behavior.

That is, these analyses are sensitive to the temporal and probabilistic relationships between mother and infant behaviors rather than the "content" (for example, the "accuracy" of a maternal behavior given the infant's momentary motivational state).

In addition to the shift in methodology towards more microscopic analyses, another consequence of the focus on responsivity and timing in mother-infant interaction research has been the reliance on measures of maternal and infant behavior taken during reciprocal interactions. That is, mothers and infants are observed while each is serving as the "responsive environment" for the other. Reliance on this type of situation produces information about mothers that is consistently "confounded" by the characteristics of their infant and information about infants that is "confounded" by characteristics of their mother. For example, a mother exhibiting "less responsive" behaviors may do so because of the degree to which her infant produces readable signals.

In recent approaches to maternal-infant interaction research, this effect of each partner on the other is not considered a confound but rather an essential characteristic of social interaction (e.g., Bakeman & Brown, 1977; Cairns, 1977; Lewis & Lee-Painter, 1974; Thomas & Martin, 1976). The implication has been that the "interactive" or mutually influential character of mother and infant behaviors arises out of their interaction and cannot be studied (in fact does not exist) outside that context. That is, important features such as responsivity or reciprocity are characteristics <u>of the interaction</u> rather being characteristics of the two partners' (mother and infant)

behaviors.

This view of interactions has been challenged by learning theorists in discussions of the nature of environment-behavior, behavior-environment, and behavior-behavior relationships. Specifically, operant learning approaches have prescribed independent analyses of the determinants of each partners' behavior and suggest that such analyses can produce a complete account of an interaction (cf., Zuriff, 1985). For example, Skinner (1957) has presented a conceptual analysis of speaker and listener behavior (during verbal interactions) that is based entirely on analyses of the determinants (e.g., antecedent stimuli, reinforcing and punishing consequences) of each partner's behavior. This type of analysis produces descriptions of interactions that rely only on the behaviors of the two partners (and their controlling variables) without invoking an additional level of analysis (i.e., characteristics of the "interaction" per se). The methodology examined in the present study was designed to apply this behavioral perspective to mother-infant interaction by including assessment of maternal and infant behavior outside of reciprocal interactions.

In addition to the conceptual concern with generating descriptions of interactions that rely on the behaviors of the two partners, some important clinical concerns call for research that can begin to "parcel out" the contributions of mother and infant in order to design and evaluate intervention methods. Clinicians often have no opportunity to influence some of the characterisitics of the infant that appear to have an impact on the mother-infant interaction (for

example, general immaturity of neurologic functioning associated with prematurity, chronic medical conditions, or temperamental charateristics). As a result, intervention programs designed to improve the relationship between mothers and infants "at-risk" for developmental delay, abuse/neglect, and the like frequently focus on changing the behavior of the mother toward the infant (e.g., Clark, 1986; Egeland, Sroufe, & Erickson, 1983; Jeremy & Bernstein, 1984; Stott, Musick, Clark, & Cohler, 1983). Information about which features of maternal behavior are important to infant development is critical to the design of intervention programs even though the characteristics of the infant remain an important source of influence over the interaction.

Some maternal characteristics thought to influence infant and child development have been studied outside the context of mother-infant interaction. Mothers of infants who "fail to thrive" in the absence of any relevant medical condition have been evaluated for the presence of psychiatric disorders (e.g., Fischoff, Whitten, & Pettit, 1971) through interviews, MMPI findings, etc. Parental attitudes towards child-rearing practices (assessed through self-report methods) have been related to child outcomes (e.g., Schaefer & Bell, 1958). Although these lines of research have focussed on maternal characteristics per se (outside the immediate influence of infant or child characteristics), they have not employed direct measures of maternal behavior. The relationship between a particular psychiatric diagnosis, for example, and the mother's actual behavior towards her infant has not been elucidated.

Measures of infant behavior that have been taken outside the context of mother-infant interaction include infant responses to a frustrating or problem-solving situation (e.g., a "barrier box" containing attractive toys, that the child could not open; Egeland, Sroufe, & Erickson, 1983). This type of task has been employed primarily with preschool children (the subjects in the "barrier box" study were 42 months old). Standard measures of developmental level (e.g., Bayley scores) have been employed, especially in studies of identified clinical populations such a mother-infant pairs referred because of documented abuse or neglect (e.g., Egeland & Sroufe, 1981). Such measures are likely to be of less value in studies of non-referred infants where the variability in such measures will be less pronounced. In addition, as is the case with psychiatric classifications or child-rearing attitudes of mothers, it is not clear what specific features of infant behavior are reflected in differences in overall developmental scores. Measures of infant behavior are needed that can suggest more specific outcomes and mechanisms of mother-infant influence.

A small number of studies employing a learning-theory or behavior-analytic perspective have assessed characteristics of infant behavior independent of reciprocal mother-infant interactions (e.g., Finkelstein & Ramey, 1977; Gewirtz, 1969; Rheingold, 1961; Watson, 1971; Watson & Ramey, 1972). One approach taken in these studies has been to expose infants to a contrived experience thought to reproduce a critical feature of mother-infant interaction. The infant's responses to variations in the laboratory experience are related

(conceptually) to how variations in maternal behavior might affect infant development.

For example, Watson (1972) suggested that the close contingency between maternal and infant behaviors in everyday interactions plays a critical role in the formation of social attachment and establishes the adult as an important and reinforcing stimulus (i.e., results in the phenomenon of "attachment"). In a short series of experimental studies (Finkelstein & Ramey, 1977; Watson, 1971; Watson & Ramey, 1969; 1972), normal 8-week-old infants were exposed to an apparatus that allowed them to cause a mobile suspended in their line of vision to turn for a brief period by making a small head movement. The mobile was assumed to be a salient and reinforcing stimulus throughout a particular experimental session. Therefore, mobile movements that were contiguous (with respect to head movements) were also "accurate" (responsive to the infant's immediate motivation to see the mobile turn). In these studies, events referred to as "contingent" were in fact both contingent and "accurate". Separate groups of infants experienced a mobile that moved contingently, non-contingently (on a fixed schedule rather than in response to head movements), or not at all. Infants exposed to the contingent mobile exhibited clear increases in their rates of the required head movement compared with both the non-contingent and fixed mobile groups. Experience with the contingent mobile was thought to be analogous to one feature of the natural experience of an infant in interactions with an adult who responded in a highly contingent (and accurate) manner to infant behaviors.

One particularly interesting finding in these studies was the experimental infants' acquisition of a kind of "learning set" after exposure to one or another type of mobile. Specifically, infants who first experienced a non-contingent mobile and then were later exposed to a contingent mobile did not learn to manipulate the mobile during the contingent phase (Watson, 1971). This type of decrement in acquisition after exposure to non-contingent stimulation was also found in a study employing newborn infants (DeCasper & Carstens, 1981). One group of infants learned to control the onset of music by producing sucking bursts of a particular duration. Infants in another group were exposed to music independent of their sucking. Infants who had been exposed to independent (non-contingent) music failed to learn to control the music (by varying their sucking burst durations) in a later session.

These types of results have been offered as examples of "learned helplessness" (e.g., Fincham & Cain, 1986; Watson, 1971), a phenomenon which has been studied in a wide range of organisms (Garber & Seligman, 1980). The use of a preparation involving controlled manipulations of the experience of the subject (as in the studies cited above) can suggest conceptual links to experimental work employing similar manipulations (e.g., learned helplessness experiments). The development of conceptual links between complex, naturalistic infant experiences (i.e., experience with an accurate and contingent versus non-contingent or inaccurate parent) and a separate body of literature based on highly controlled laboratory manipulations (e.g., humans and animals exposed to varying degrees of

contingency between their behavior and an environmental event in a learned helplessness paradigm) could have tremendous value in expanding the analysis of mother-infant influence. For example, the literature on schedule effects, preference for controlled versus uncontrolled events, and the like could be used to suggest mechanisms by which maternal behavior affects infant behavioral outcomes.

Another feature of infant behavior that has been noted after exposure to contingent versus non-contingent stimulation may be of importance to the analysis of the impact of mother-infant interaction on infant development. Infants exposed to contingent events in these studies displayed positive affect (e.g., smiling and cooing at the mobile; Watson, 1971) during the contingent phase. When they were then exposed to non-contingent events they displayed negative affect (e.g., fussing or crying). Infants who first experienced non-contingent events displayed essentially neutral affect during both phases (DeCasper & Carstens, 1981; Watson, 1971).

The present study used a new methodology in an exploratory way to examine maternal and infant behavior both within and outside the context of an on-going interaction. One goal was to begin to develop laboratory measures of maternal behavior that would predict behavioral and affective differences between infants. In addition, the project was designed to provide a preliminary assessment of the sensitivity of these measures to variations in normal (non-referred) mothers and infant behavior and affect. A third major goal was to develop measures of infant behavior that might be related conceptually

to the experimental learning literature (for example through the development of independent analyses of mother and infant behavior).

Infants were given experiences in the laboratory that were designed to reproduce variations in an important feature of mother-infant interaction: the degree of contiguity and "accuracy" of environmental responses to infant behavior. Specifically, infants were observed in a highly contingent and "accurate" laboratory situation (a situation in which their "intentional" behavior was consistently followed by the "appropriate" or "accurate" environmental response) and then in a non-responsive laboratory environment (in which their behavior was followed by no environmental response). If infants' experiences normally vary in the degree of accuracy and contingency that exists between their own and their mothers' behaviors, then infants would be enter the experimental tasks with different histories of the contiguity and accuracy of environmental responses to their behavior.

These different histories should have predictable consequences for infant behavior and affect in responsive and un-responsive laboratory environments. Specifically, infants who have experienced a high degree of accuracy and contingency in their interactions with their mothers can be expected to learn rapidly in a task presenting accurate and contingent responses to the infant's behavior. In addition, their affect should be positive during the task. In contrast, infants who have experienced a relatively low degree of contingency and/or accuracy in interactions with their mothers would be expected to learn less rapidly and their affect should be less positive (more

neutral) during the task.

When infants with histories of highly accurate and contingent experiences with their mothers are exposed to a non-responsive laboratory environment, they should stop responding quickly and should display negative affect. Such an environment should be in sharp contrast to their experiences with their mothers and could be thought of as a brief period of extinction after exposure to a continuous schedule of reinforcement (during accurate and contingent interactions with the mother). Animal subjects exposed to continuous schedules of reinforcement have been shown to display reduced resistance to extinction (i.e., stop responding sooner during extinction) compared with subjects exposed to partial or intermittent schedules. This phenomenon of reduced resistance to extinction after continuous versus partial reinforcement suggests that infants with histories of relatively non-contingent or inaccurate maternal responses should persist longer. In addition, they should have a less negative (more neutral) affective reaction.

These predictions about behavior in an unresponsive environment are somewhat different from those made on the basis of more traditional views of the importance of responsive mothering. For example, mothers who provide highly contingent interactions have been said to engender an enhanced degree of frustration tolerance in their children and their children are expected to persist longer and display less interfering negative affect in frustrating situations (e.g., 42-month children studied by Egeland, Sroufe, & Erickson, 1983).

In this study, the infant's tendency to seek assistance from the mother when faced with a frustration task served as a gross endex of the infant's social attachment to the mother. A separate measure of infant behavior in a non-responsive environment served as a gross index of the infant's social attachment to the mother. The infant's tendency to seek assistance from the mother when faced with a frustration task was measured. Infants that have had experience with a highly accurate and contingent mother should be more likely to seek help from their mother during the frustration (non-responsive) task. That is, they should direct their signals or motivated behavior towards their mother when faced with an unresponsive environment. Infants that had experience with a less contingent and/or less accurate mother should be less likely to seek help at all or should direct their requests to the experimenter rather than to their mother.

In order to explore a method for assessing maternal responsivity outside the context of an interaction, two measures (one taken during an interaction and one taken independently) were designed. Measures taken in the context of on-going interactions with the infant were adapted from a clinical-developmental assessment system developed by Greenspan and Lieberman (1980). This system involves time-interval recording of a range of maternal and infant behaviors. In this study, three categories that relate directly to the assessment of the accuracy and contingency between mother's and infant's behaviors were used: Contingent, non-contingent, and anti-contingent maternal responses. Non-contingent responses are recorded when the infant produces a signal and the mother makes no response or makes a response

that is unrelated to the infant's expressed need; for example, the infant is attending to a toy and the mother tries to attract his attention by speaking to him. Anti-contingent responses are those that are contiguous with infant behavior, but are in direct conflict with the infant goals or signals as interpreted by an observer (for example, when the infant attempts to make physical contact with her, the mother moves further away). Contingent responses are those in which the mother responds accurately and contingently to the infant's signal.

In the Greenspan and Lieberman (1980) scoring system and in this study, "contingent" refers to events that are actually both contiguous with the infant's behavior and "accurate" with respect to the infant's motivation or intention. In addition, maternal behavior was considered contiguous or responsive to an infant signal only if it followed the infants' within 5 seconds (Greenspan & Lieberman, 1980).

In order to provide a separate measure of mothers' ability to read and respond accurately to infant signals, mothers were asked to respond to the signals of infants (other than their own) shown on a video-tape. This allowed for all mothers to respond to the same infant signals. It was predicted that this measure of maternal responsivity would be correlated to some degree with the measure of contingent responses taken during an interaction. That is, mothers' verbal descriptions of the meaning of infant behavior (the infants' apparent intention) and their report of whether or not and in what way they would respond (in accordance with or in opposition to the

infants' signal) should correlate with how they respond to their own infant during an interaction. However, because of the impact of characteristics of the infant himself that could be affecting the mother's responsivity during the interaction session, it is not clear to what degree the two measures of maternal behavior should correlate.

Both of these measures of maternal behavior should predict variations in infant behavior and affect in contingent/accurate and unresponsive laboratory environments. That is, mothers who are more accurate in response to video-taped infant behavior should also be more accurate and contingent during interactions. They should have infants who learn rapidly in an accurate and contingent environment (and display positive affect) and who stop responding quickly, display negative affect, and seek assistance from their mothers in an unresponsive environment. In contrast, mothers who are less accurate in responding to video-taped infant behavior should be less accurate and/or contingent (more non-contingent and anti-contingent) during interactions. They should have infants who learn less rapidly in an accurate and contingent environment and persist longer with a goal-directed behavior, display neutral affect and either seek no assistance or seek assistance from a stranger in an unresponsive environment. Infant affect during an interaction with the mother would also be expected to relate to the degree of accuracy and contingency of maternal behavior. That is, infants with highly contingent mothers should display more positive affect during interactions and infants with less contingent mothers should display

more neutral affect.

A simple acquisition task was designed to serve as a contingent experience for infants. An unresponsive environment was provided by presenting infants with an insoluble problem (a frustration task). A semi-naturalistic play session was conducted in order to assess mothers' contingency in interactions with their infants. A measure of mothers' accuracy independent of an interaction session was taken by asking mothers a set of questions about the behavior of infants on a videotape.

In summary, this study examined the relationship between two different measures of maternal responsivity towards infant signals; one taken during an interaction between mother and infant and one taken independent of interactions. It sought to determine whether these measures are useful for predicting differences in the behavior and affect of normal infants in response to contrived laboratory experiences with accurate/contingent (an acquisition task) and unresponsive (a frustration task) environments. Differences were predicted in infants' rates of acquisition in a contingent (acquisition) environment, persistence during a frustration task, reliance on the mother during a frustration task, and affect during each condition.

METHOD

Subjects

Subjects were 20 mother-infant pairs recruited during well-baby visits to an out-patient pediatric clinic at the University of Maryland Hospital in Baltimore, Maryland. Thirteen male and seven female subjects participated. Participation in the study was voluntary, and subjects were not paid. All mothers arriving for appointments with infants between 11 and 13 months of age were approached about the study (the mean age of infants participating was 12 months). Additional criteria for inclusion in the study were: Full-term birth, no significant medical difficulties, and primary daytime care provided by the mother since birth. Twelve subjects were first-born, and eight had at least one older sibling. Infants included in the study exhibited no significant developmental delays on the basis of routine screening conducted by the clinic (Denver Developmental Screening Test administered within the last 6 months). All mothers recruited for the study received medical assistance funds to pay for their children's medical care, and none were employed outside the home at the time of the study. Fourteen black and six white mother-infant pairs participated.

Setting and General Procedures

All observations were conducted in a room (approximately 6m X

sessions and the mother-infant interaction session were taped and scored later. Infants were given a warming-up period in which to become familiar with the room and experimenter before the first task was presented (5-10 minutes). At the end of this period, mothers were instructed to seat their infant in an infant chair (where the first task was to be conducted) and given a cracker to help acclimate the child to the chair. The first task was begun once the infant sat in the chair without signs of distress. All tasks were presented until either a time or behavioral criterion was met. Seven additional infants who were originally recruited did not acclimate to the testing room and thus were not included in the study. Tasks/conditions were presented in the following order: infant contingent environment (acquisition task), mother-infant interaction, infant non-contingent environment (frustration task), mother responses to video-taped infants. Table 1 summarizes the tasks and conditions and their associated measures.

Contingent Environment (Acquisition Task)

Infants were videotaped in a contingent environment (a simple acquisition task). An arbitrary response (touching a block fixed to their high chair tray) was consistently followed by a 10-second presentation of a salient visual and auditory stimulus. Touching the block was defined as contact with the block by any part of either of the infant's hands, and momentary release of the block was required before another touch was recorded. The task was presented as a free

operant session; no instructions or prompts were given, and no shaping was required since all infants spontaneously touched the block within the first minute.

Equipment for the task consisted of an infant chair facing a blank screen (approximately 70cm from the infant chair) which could be rapidly raised and lowered (allowing the infant to see what was behind it) contingent upon the infant touching the block. The screen concealed a poster of a brightly colored smiling face and several pinwheels that turned continuously. The infant seat had a detachable plastic tray (similar to a high chair tray) with a painted wooden block fixed (flat) in the middle of the front edge of the tray. This was the furthest point on the tray from the infant but was within easy reach. An audiotape was constructed containing a repeating 10-second long part of a children's song allowing for accurate timing of 10-second presentations of the poster and music combination.

Mothers were seated to one side of the infant and instructed not to interact during the task. The experimenter manipulated presentation of the visual and auditory consequences from a position next to the screen and also did not interact with the infant. Consequences were presented after every "touch" response (as defined above) until the infant had produced three consecutive responses with latencies of 10 seconds or less (latencies between responses were measured from the end of the 10-second poster/music interval).

Video-tapes were scored for latency to the first response, latencies between responses, and the total number of responses that occurred before the acquisition criterion was reached. In addition,

infant affect during the task was assessed on a 5-point rating scale (1=predominately negative affect, fuss,y or unhappy; 3=neutral affect, neither enjoying nor disliking the experience; 5=predominantly positive affect, laughing, obviously happy).

Mother-Infant Interaction

At the end of the acquisition task, mother and infant were seated face-to-face in armchairs placed about 70cm apart. The infant's chair was large enough to allow some mobility in the chair without allowing the infant out of contact with the mother. Mothers were provided with several infant toys and given the following instructions;

> Play with (child's name) for a few minutes just like you would at home. Try to pretend I'm not here if you can. You can use the toys or not, whatever you like, I want to see how you usually play together. Also, please don't let him/her get down from the chair until the time is up.

The play interaction was video-taped for 3 minutes from the time the instructions were given. The experimenter remained in the room but out of the mother and infant's line of vision.

Maternal behavior during the interaction session was scored on the basis of the occurrence/non-occurrence of contingent, non-

contingent, and anti-contingent responses to infant signals. A score for maternal contingency during the interaction was based on the number of intervals in which the mother behaved in a contingent, non-contingent, or anti-contingent manner divided by the total number of intervals in which the infant produced a signal times 100 (yielding a proportion or score for each category). In addition, infant affect during the interaction was assessed on the basis of the 5 point scale described above.

Unresponsive Environment (Frustration Task)

At the end of the interaction session, the mother was asked to place the infant on the floor with the toys and to remain in her chair nearby. She was asked not to respond if the infant needed help with the task. Once the infant was actively playing with the toys, the experimenter approached and placed the toys in a clear plastic box with a cover the infant could not remove. The experimenter patted the box and said, "Look, get your toys" and then sat down nearby. The mother and experimenter were seated about 2m apart with the infant on the floor about half way between them. Infants were taped until they either stopped attempting to get to the toys (a criterion of 3 consecutive 5-second intervals without attempts) or spent 3 consecutive intervals approaching the mother. The infant was given the toys to play with following the frustration task.

Sessions were scored for the occurrence of attempts to open the box, approaches to mother, and approaches to the experimenter. In

addition, infant affect was assessed on a 5-point rating scale as in the contingent and interaction sessions.

Mothers' Responsivity (Accuracy of Responses to Tape)

Finally, mothers were shown a videotape of 10 vignettes each depicting an infant in a different situation interacting with an adult (several different infants were shown). Each infant displayed a signal or communication to the adult on the tape. The vignettes ended abruptly just as the adult on the tape was about to respond to the infant. Mothers were asked the following questions after they viewed each vignette: "What does the baby look like he/she wants?", "What would you do if you were in that mother's situation?", "Why?". Mothers' responses to the questions were recorded verbatim and scored later.

Mothers' answers were scored by an assistant who was blind to the behavior of the infants in the acquisition and frustration tasks and to the behavior of the mother during the interaction task. Answers to the first question were scored in terms of the accuracy of the mother's description of the infant's signal. Accuracy was determined on the basis of how the taped infants had actually responded to the adults they were interacting with during taping (e.g., quieting when picked up). The second question was scored in terms of the correspondence between what the mother said the infant wanted and what she would have provided (that is, an "inaccurate" response was one in which the mother said she would have done

something different from what she had said the infant appeared to want). The third question was scored in terms of whether the mother's reasons for her response to the infant were related to what she thought the infant wanted or were related to some other concern (for example, "because the mother looks too busy" was scored as "inaccurate"). Mother's responses to all three questions were summed, yielding an overall "accuracy" score (number correct out of 30 questions).

Interobserver Agreement

All tapes were scored first by the author who remained blind to mothers' "accuracy" (responses to the videotaped infants). Six tapes (30 %) were re-scored by trainees in behavioral pediatrics and clinical psychology. Each trainee viewed and scored a different task so that each remained blind to mother and infant behavior across tasks. Pre-training on interval scoring, affect ratings and scoring mother's accuracy was conducted using tapes taken during pilot sessions with infants not included in the present study.

Overall agreement was calculated for each observational category using the formula:

Agreements/(Agreements + Disagreements) X 100

Interobserver agreement (see Table 2) was lowest for the coding of non-contingent versus anti-contingent maternal responses during the interaction session (ranging from 60% to 90%). Because of the difficulty in attaining high reliability on the distinction between

non and anti-contingent responses, these two categories were collapsed into a single category (not-contingent) with acceptable reliability (86%). No infant approached the experimenter during the frustration task resulting in inter-observer agreement of 0/0 for this category.

RESULTS

General Treatment of Data

For purposes of Chi-square analysis, scores on several variables were broken into "high" and "low" categories (the top 50% of scores was considered "high" and the bottom 50% "low"). Infant affect scores could not be categorized in this way (without generating too few expected observations per cell). Table 3 summarizes the results of Chi-square and correlational analyses for all comparisons tested.

Relationship Between the Two Measures of Maternal Responsivity

The two measures of maternal behavior (percentage contingent responses during the interaction task and overall accuracy in response to the videotape) were highly related ($X = 9.90$, $p < .005$, $df=1$). Variability in characteristics of the infants did not appear to affect mother's responsivity as predicted. Mothers' accuracy scores showed less variability than mothers' percent contingent interactions (ranging from 21 to 30 and from 29% to 95% respectively). Eleven mothers achieved the ceiling score of 30 on the accuracy task.

Mothers' Percent Contingent and Infant Acquisition

The relationship between mothers' percent contingent responses

and two measures of infant behavior on the acquisition task are presented in Figure 1. Both measures of infant behavior in the contingent environment (number of responses to the acquisition criterion and total seconds to the acquisition criterion) were related to mothers' percent contingency in the predicted directions. The relationship between mothers' percent contingency and infant responses to criterion approached significance when both were examined as categorical variables (high versus low), ($X = 3.20$, $p > .05$; $df = 1$) and was significantly negatively correlated ($r = -.5$; $p < .05$) in the direction of more contingent mothers having infants with fewer responses to criterion. Infant total time to criterion was significantly related to mothers' percent contingency as well ($X = 7.20$; $p < .01$; $df = 1$) again in the direction of more contingent mothers having infants who reached the acquisition criterion sooner.

Mothers' Accuracy and Infant Acquisition

The relationship between mothers' accuracy and infant responses to criterion approached significance when these were examined as categorical variables ($X = 3.27$, $p > .05$, $df = 1$), and were significantly negatively correlated ($r = -.63$, $p < .005$) in the predicted direction. Infant time to criterion was significantly related to mothers' accuracy as well ($X = 5.05$, $p < .05$) again in accordance with predictions (i.e., mothers with high scores had infants with fewer responses to criterion and less total time to criterion). The relationship between mothers' accuracy and each of the two infant

measures in the contingent environment is presented in Figure 2.

Mothers' and Infants' Behavior (Frustration Task)

Contrary to predictions, neither the mothers' percent contingent nor the mothers' accuracy scores were related to infant approaches to mother during the frustration task ($X = .02$, $p > .1$, $df = 1$, for each measure). Examination of Figure 3a confirms the lack of relationship between these variables. The other measure of infant behavior taken during the frustration task (number of intervals persisting on the task) approached a significant relationship with mothers' accuracy when these were examined as categorical variables ($X = 3.60$, $p > .05$, $df = 1$), and these variables were significantly negatively correlated ($r = -.49$, $p < .05$), as predicted. Number of intervals persisting on the frustration task was significantly related to mothers' contingent responses ($X = 7.20$, $p < .01$, $df = 1$). As predicted, mothers who were more accurate (accuracy=30) and mothers who had a larger percent contingent responses had infants who persisted for a shorter period of time on the frustration task (Figure 3).

Measures of Mothers' Behavior and Infant Affect Ratings

Infant affect ratings were not related to measures of maternal behavior in the predicted manner. Only one correlation between infant affect ratings and measures of maternal behavior was significant: the relationship between mothers' percent contingency and infant affect

during the frustration task ($r=-.63$, $p<.005$). Infant affect ratings are presented by mothers' accuracy scores in Figure 4 and by mothers' percent contingency in Figure 5. All other correlations between mothers' percent contingency and infant affect and between mothers' accuracy and infant affect were non-significant (see Table 3).

Infant Acquisition Data

Individual acquisition graphs are presented in Figures 6-7. All infants acquired the "touch" response within 13 responses (range= 5-13). Visual inspection of cumulative response data across infants suggests that the infants' responding differed primarily in terms of the number of responses and total time to reach the acquisition criterion. Figure 8 presents the three "best" acquisition graphs (selected on the basis of visual inspection) and their associated measures of maternal behavior and infant affect data. Figure 9 presents the same information for the three "worst" acquisition graphs.

DISCUSSION

In this study, two measures of mothers' responsivity to their infants' behavior were taken: one in the context of on-going interactions (percent of maternal responses that were contiguous and accurate with respect to the infant's intentions) and one taken independent of an interaction (accuracy of the mother's verbal responses to videotapes of infant behavior). It was hypothesized that these variables would be related to one another but that they might differ somewhat because of the influence of infant characteristics on the measure taken during interactions. Both measures were hypothesized to predict infant behavior in a laboratory-based contingent environment (an acquisition task) and in a laboratory-based unresponsive environment (a frustration task). In addition, measures of infant affect in contingent, non-contingent and interaction tasks were predicted to be related to maternal accuracy and contingency scores. A separate measure of social behavior (infant approaches to mother and experimenter in a non-contingent environment) was also predicted to relate to maternal variables. The use of contingent and unresponsive environments and learning-based measures of infant behavior were selected with two goals in mind. First, these situations were selected because of the focus in the current literature on mother-infant interaction on the responsivity (accuracy and contingency) of maternal behavior to infant signals. This selection was also made to begin to develop measures of infant behavior that can track differences in patterns of maternal

interaction in populations of infants not compromised by severe developmental difficulties and that have the potential to be related conceptually to the experimental leterature on learning.

The two measures of maternal behavior were found to be highly related to one another. The measure of maternal "accuracy" (mothers' responses to the behavior of videotaped infant behavior) yielded less variable scores with over half the sample achieving the ceiling score. Mothers who obtained "perfect" accuracy scores also exhibited a higher percentage of contingent responses to their infants' behavior during an interaction. This suggests that this measure of mothers' behavior in this contrived task (responding verbally to infant behavior on a videotape) has some utility insofar as it predicts a direct measure of the degree of contingency of mothers' behavior in an actual interaction. Assessment of the nature of mothers' interactions with their infants (based on a scoring system adapted from Greenspan & Lieberman, 1981) presented some difficulties in obtaining acceptable inter-observer reliability. However, the distinction between contingent responses and "not-contingent" responses was made with acceptable reliability.

Measures of mothers' contingency and accuracy were moderately predictive of infant behavior in a contingent environment (i.e., predictive of the number of responses and total time to reach an acquisition criterion). Mothers who were more accurate and mothers who exhibited a greater percentage of contingent responses to their infant's behavior in an interaction had infants who reached the acquisition criterion faster and with fewer responses. A simple

operant learning task appears to be a useful method for studying variations in infant development that relate to variations in maternal responsivity in a non-referred sample. However, the generality of these findings is somewhat limited by the use of a standardized rather than counter-balanced administration of the laboratory tasks, which makes it impossible to draw any conclusions about the effect that the ordering of laboratory assessment may have had on maternal and infant behavior.

On the basis of the present study, no firm conclusions can be drawn about the specific ways in which differences in infants' scores on the acquisition task were generated. That is, shorter times and fewer responses to criterion could have come about because some infants "learned faster" (because their behavior was more effectively influenced by the contingent environment). However, these infants may also have found the contingent stimulation more reinforcing. In addition to possible difference in the reinforcing value of the poster/music combination, the reinforcing nature of contingent stimulation itself may differ among infants. In his work with younger infants, Watson (1971, 1972) attributed the development of infants' learning ability to increases in their ability to perceive and be affected by contingent events. It is possible that infants who have a history of contingent relationships with their mothers are better able to learn from new contingent experiences, or may find those contingencies more reinforcing.

Two important features of infant behavior related to this distinction (which were not examined in the present study) could be

useful in expanding the relevance of this task to the experimental learning literature. First, infants in this study did not achieve a "steady state" of responding--their behavior was examined only in the context of acquisition of a response. Steady-state responding (where infants have reached a steady, asymptotic rate of responding) would be more closely analogous to measures of learning commonly used in the experimental learning literature. A related measure, behavior under extinction conditions, is another feature of infant behavior that could be useful. For example, infant responses to an unresponsive environment could be examined by extinguishing a response learned in the laboratory (i.e., the response learned in the acquisition phase).

Both measures of maternal behavior were also moderately related to one measure of infant behavior during a frustration task. Infants with mothers who were more accurate and who had a greater percentage of contingent responses spent less time persisting on a frustration task. This result is in accordance with predictions made on the basis of the phenomenon of reduced resistance to extinction following continuous rather than partial reinforcement schedules. However, it is in conflict with traditional viewpoints concerning the impact of responsive mothering on infant responses to frustration (i.e., highly responsive mothering resulting in enhanced frustration tolerance). In this study, infants did not exhibit intefering negative emotions during the frustration task. These emotional reactions have been cited as the basis for poor frustration tolerance (e.g., low persistence) in children with unresponsive mothers (e.g., Egeland, Sroufe, & Erickson, 1983).

Intuitively, the tendency for infants with more responsive mothers to "give up" sooner during the frustration task suggests that these infants were more likely to seek assistance from their mothers. However, infants did not differ in terms of the percentage of intervals they spent approaching their mothers during the frustration task. In addition, no infants approached the experimenter on this task. The two measures of infant approaches to mother and experimenter in a frustrating environment did not relate to maternal behavior in the predicted directions. This suggests that either this measure is not sensitive to variations in infant social behavior or that infant social development is not affected by the types of differences in mother-infant interaction examined here.

Infant behavior in the frustration task may reflect a dimension of infant behavior and experience not directly assessed in the present study. In particular, infants may experience variations in the responsivity of the environment in two ways: through interactions with other people and through interactions with other aspects of the environment (inanimate). These two types of interactions may not be (in fact are probably not) equally responsive to infant behavior. For younger infants, the behavior of adults in face-to-face interactions probably constitutes the majority of environmental events over which they exert direct control. In older infants, where object manipulation and other responses to the inanimate environment have become more prevalent and complex, infant interactions with an unresponsive object (as in the present frustration task) may have become discriminated from responses to people. Specific

manipulations of contingent and non-contingent infant-person and infant-object experience may be a useful extension of the frustration task that could also suggest how maternal behavior differentially affects infant cause-effect behaviors in social and non-social situations.

Ratings of infant affect in each task were not related to maternal accuracy or contingency as predicted (with the exception of a significant relationship between maternal percent contingency and infant affect during the frustration task). Three previous studies that were interpreted as evidence that infants would exhibit different affective responses in contingent and non-contingent environments dealt with much younger infants (i.e., 8 weeks, Watson, 1971, 1972; and newborns, DeCasper & Carstens, 1981). Infants in the present study never acted "fussy" or otherwise displayed strong negative affect. In a non-referred sample of older infants, affect may not be differentially affected by the relationship between responsivity of the mother and variations in the contingency of a laboratory environment. Infants with more contingent mothers did tend to be more neutral during the frustration task than were infants with less contingent mothers, a difference that may suggest something about how disruptive exposure to an unresponsive environment might be to different groups of infants.

Although a moderately predictive relationship was found between maternal status on two measures of contingency and selected measures of infant behavior, separating infant and maternal tasks and measures cannot solve the underlying problem of the mutual influence of mother

and infant behaviors. Clearly a mother who comes to respond in a less contingent and less accurate way may do so because of a history of interacting with an infant who is less affected by contingent responses or who produces ambiguous signals, etc. Campbell (1979) discussed this type of problem in a study concerned with mothers' assessments of their infants' temperaments. She found that mothers who had rated their 3-month-old infants as "difficult" were observed to be less responsive in interactions. At a follow-up at 8 months of age, observers found that these infants were no longer "difficult" (in comparison with matched controls). However, mothers' continued to describe them as difficult and continued to behave in a less responsive manner towards them.

The present study cannot address the causal relationship between mother-infant interaction and infant behavior on experimental tasks. That is, infants who are less responsive in a laboratory-based learning task may well be less responsive to their mother's behavior, leading their mother to interact in less contingent or less accurate ways. The etiology of levels of maternal responsivity cannot be determined on the basis of the present study. In addition, the causal relationship between maternal responsivity and measures of infant behavior cannot be determined (that is, simple correlations between these measures do not show whether maternal characteristics resulted in infant behavior or the other way round). It seems likely, however, that unresponsive interactions between mother and infant, regardless of their origin, can affect infants' responses to subsequent responsive and unresponsive experiences.

In future studies, similar measures of mothers and infants (with possible additions and extensions of methods noted above) could be applied to populations of mothers and infants exhibiting greater variability in parental attitude and interactive skill. It would be important to know, for example, whether such measures are sensitive to changes in maternal and/or infant behavior that are the result of clinical interventions such as parent counselling and training in the management of premature infants, etc. Larger samples of mothers and infants should be studied in order to allow evaluations of other infant and maternal characteristics not assessed in the present study (sex of the infant, race, and whether or not the child is the mother's first).

Another direction for future research is in further evaluation of maternal cognitive appraisals of infant behavior. A number of authors studying maternal characteristics have suggested that the "social-cognitive" aspects of mothering (i.e., the reasons mothers give for their own and their infants' behavior) are of primary importance in characterizing the mother-infant relationship (e.g., Minde et al., 1985; Goshen-Gottstein, 1986). Information about mother's reasons and explanations for their own and infant behavior could be included in an analysis of mothers' responsivity. For example, an examination of how mothers come to make particular attributions about their infant's behavior could be examined and applied to intervention efforts.

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Table 1.

Summary of Tasks and Measures

Task/Condition	Measures
Infant Acquisition Task (Contingent Experience)	Resps. to Criterion Total Time to Criterion Affect Rating
Infant Frustration Task (Unresponsive Experience)	Total Intervals Persisting % Intervals Approach Mo. % Intervals Approach Experimenter Infant Affect Rating
Interaction Session	Mo. % Intervals Cont. % Intervals Non-Cont. % Intervals Anti-Cont. Infants' Affect Rating
Videotape of Infant Behavior (Mother's Accuracy)	Number "Accurate" Answers About Taped Infants

Table 2.

Interobserver Agreement

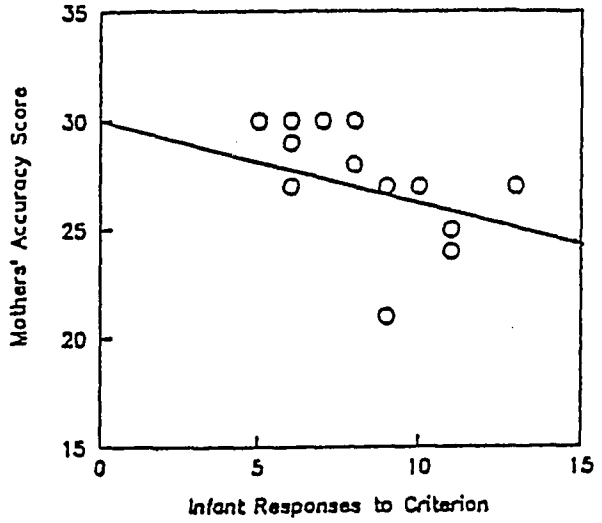
Measure	Range	Mean % Agreement
Infant Responses to Criterion	95-100	98
Infant Total Time to Criterion	95-100	98
Infant Total Intervals Persisting	100	100
Infant Approach Mother	92-100	94
Infant Approach Experimenter	0/0	0/0
Infant Affect-Acquisition	---	83
Infant Affect-Interaction	---	83
Infant Affect-Frustration	---	100
Mother % Non-Contingent	60-95	70
Mother % Anti-Contingent	72-97	78
Mother % Contingent	79-100	86
Mother "Not-Contingent"	79-100	86
Mother Accuracy	90-100	95
Infant Signals Mother	75-97	85

Table 3

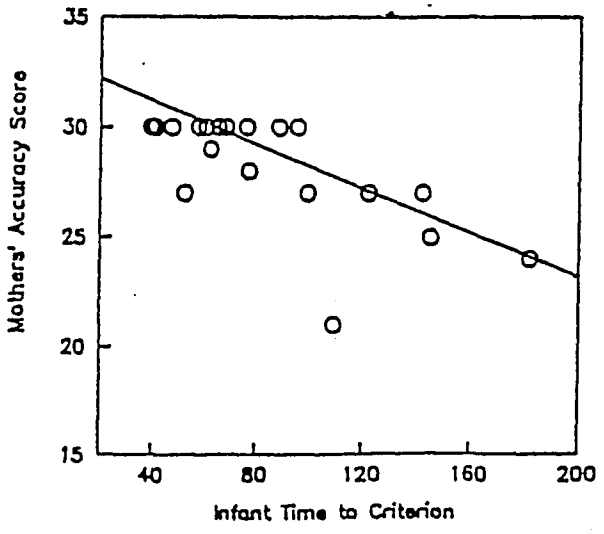
Summary of Statistical Comparisons

Comparison	X	Corr.	Sig.
Mother Accuracy vs. % Conting.	9.90	---	p<.005
Mother % Conting. vs. Resps to Crit.	3.20	---	p>.05
	---	-.50	p<.05
Mother % Conting. vs. Time to Crit.	7.20	---	p<.01
Mother Accuracy vs. Resps to Crit.	3.27	---	p>.05
	---	-.63	p<.005
Mother Accuracy vs. Time to Crit.	5.05	---	p<.05
Mother % Conting. vs. Approach Mo.	.02	---	p>.1
Mother Accuracy vs. Approach Mo.	.02	---	p>.1
Mother Accuracy vs. Infant Persist	3.60	---	p>.05
	---	-.49	p<.05
Mother Conting. vs. Infant Persist	7.20	---	p<.01
Affect-Acquisition vs. Mother Accur.	---	.05	p>.1
Affect-Acquisition vs. Mother Cont.	---	.33	p>.1
Affect-Interact vs. Mother Accur.	---	.02	p>.1
Affect-Interact vs. Mother Cont.	---	.24	p>.1
Affect-Frustration vs. Mother Accur.	---	-.34	p>.1
Affect-Frustration vs. Mother Cont.	---	-.63	p<.005

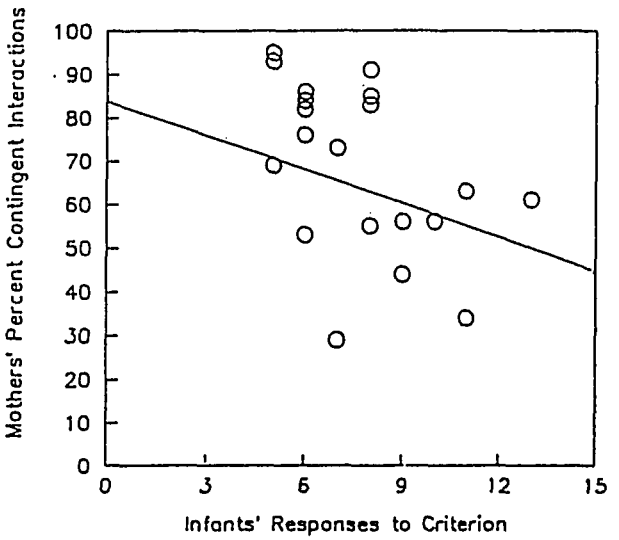
Mothers' Accuracy Scores vs. Infant Responses to Criterion



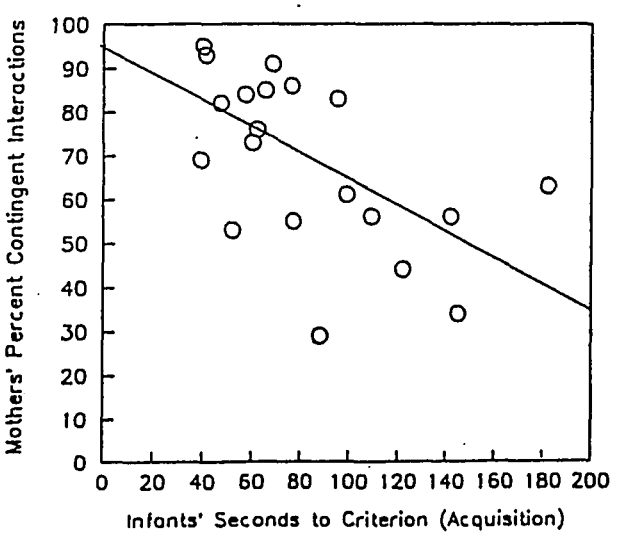
Mothers' Accuracy Scores vs. Infant Time to Criterion



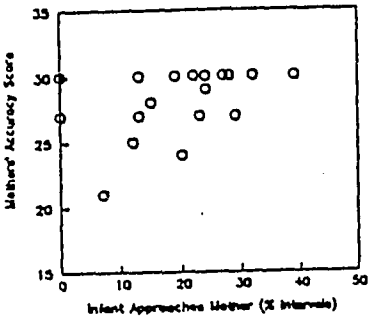
Mothers' Percent Contingent Interactions vs. Infants' Responses to Criterion



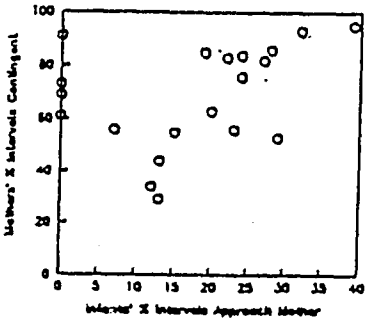
Mothers' Percent Contingent Interactions vs. Infants' Time to Criterion



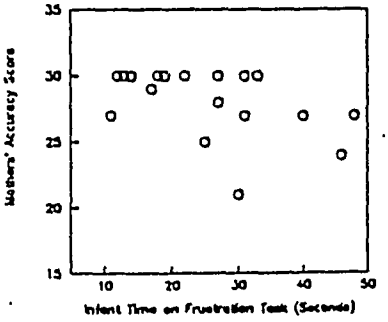
Mothers' Accuracy Scores vs.
Infant Approaches Mother (Frustration Task)



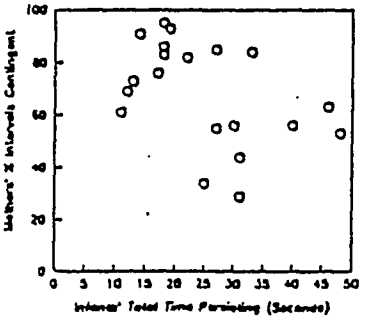
Mothers' % Contingent vs. Infant Approach Mother
(Frustration Task)



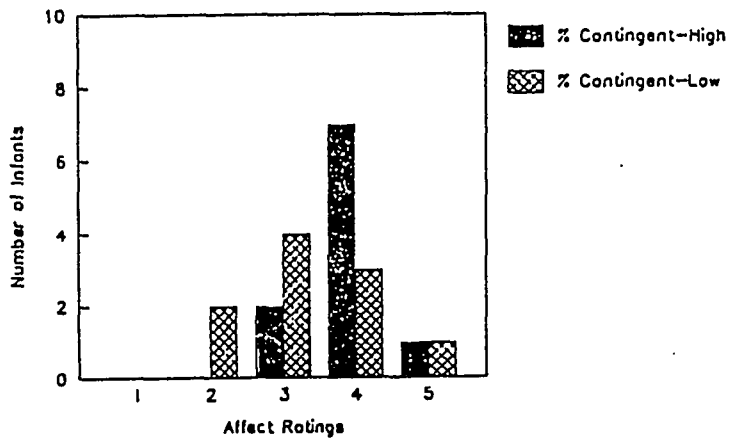
Mothers' Accuracy Scores vs.
Infant Time on Frustration Task



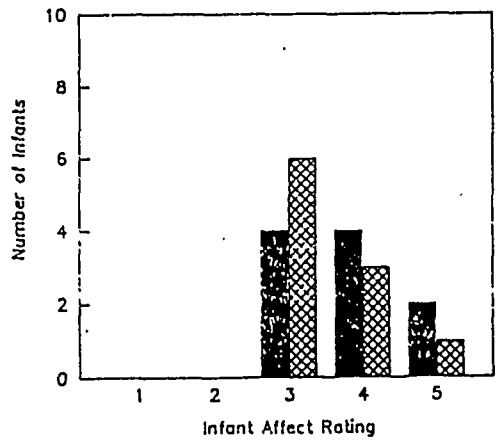
Mothers' % Contingent vs. Infant Total Time
(Frustration Task)



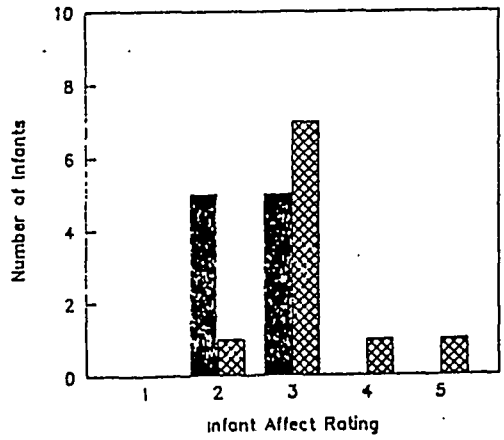
Infant Affect Ratings by Mothers' % Contingent Acquisition Task



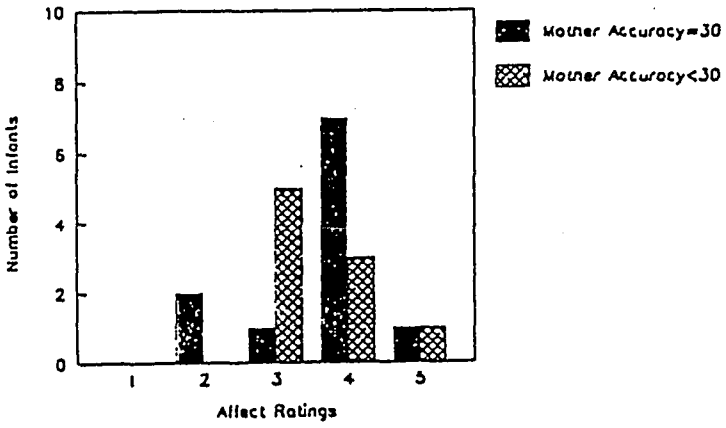
Interaction Task



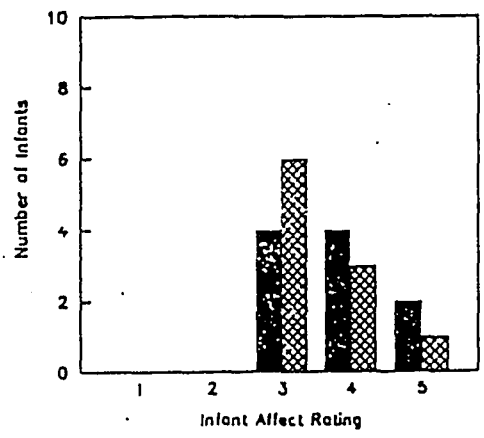
Frustration Task



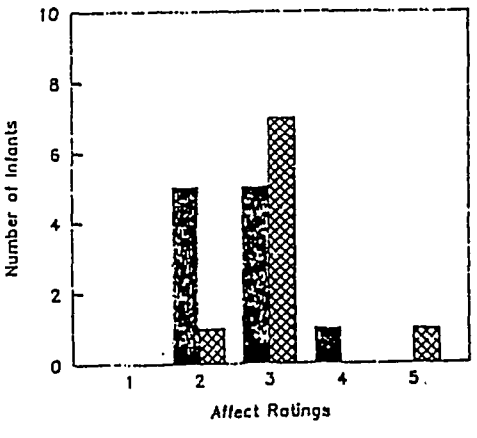
Infant Affect Ratings by Mother's Accuracy Score
Acquisition Task



Interaction Task

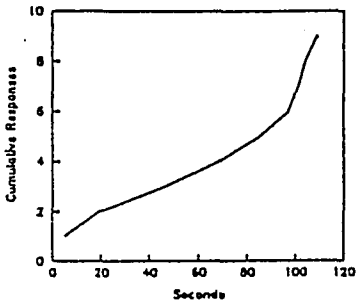


Frustration Task

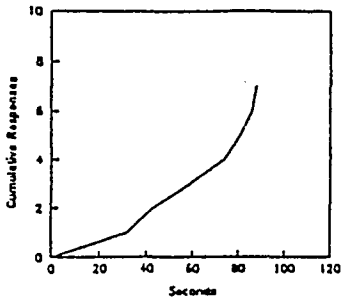


Individual Acquisition Graphs

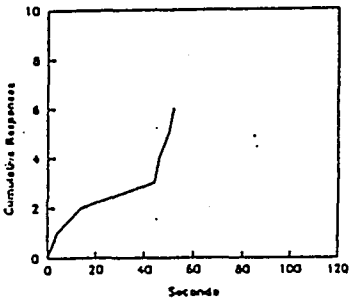
Acquisition, S1



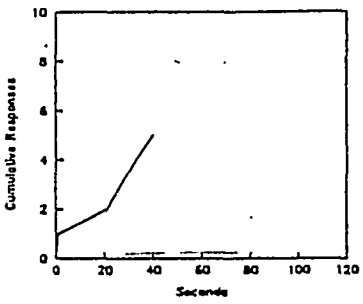
Acquisition, S2



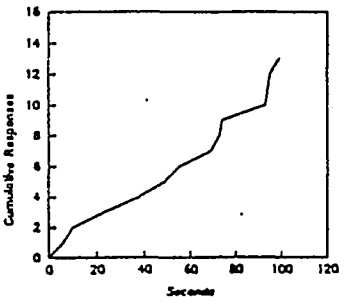
Acquisition, S3



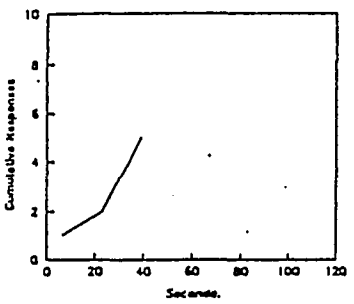
Acquisition, S4



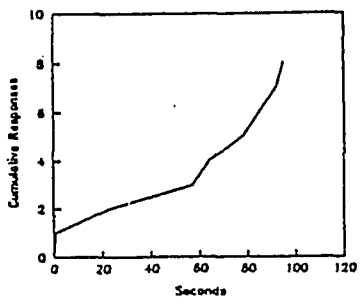
Acquisition, S5



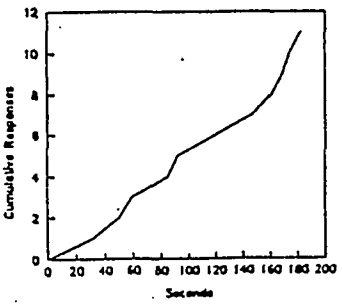
Acquisition, S6



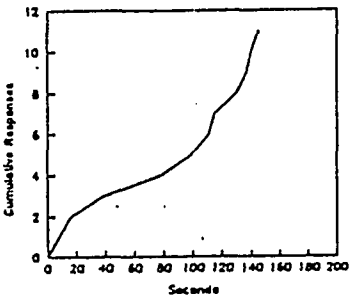
Acquisition, S7



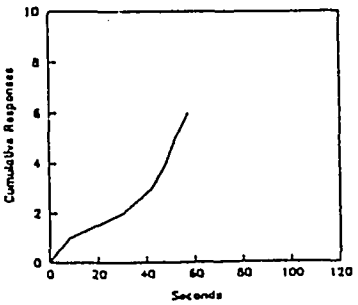
Acquisition, S8



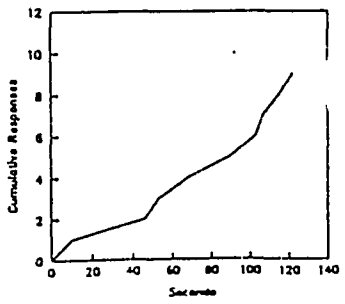
Acquisition, S9



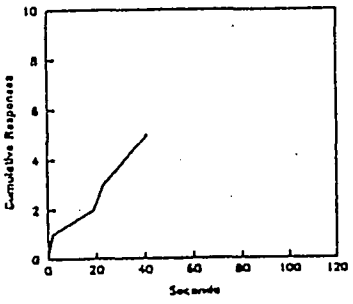
Acquisition, S10



Acquisition, S11

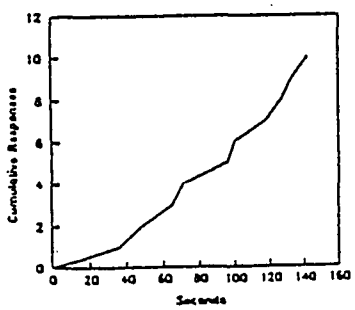


Acquisition, S12

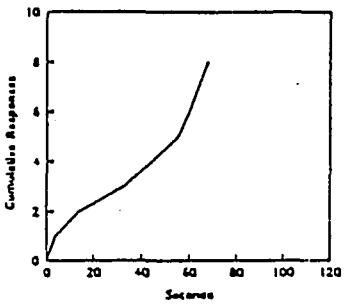


Individual Acquisition Graphs

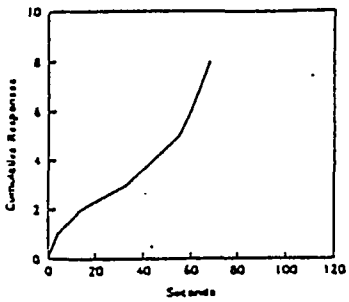
Acquisition, S13



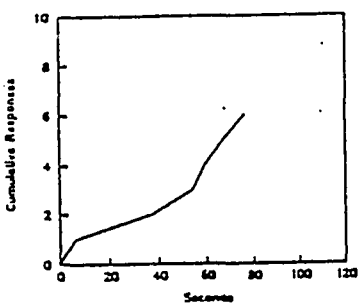
Acquisition, S14



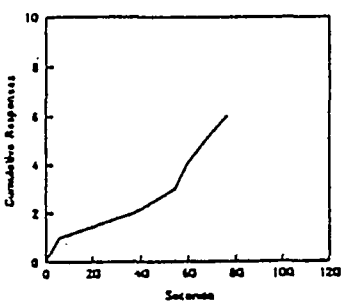
Acquisition, S15



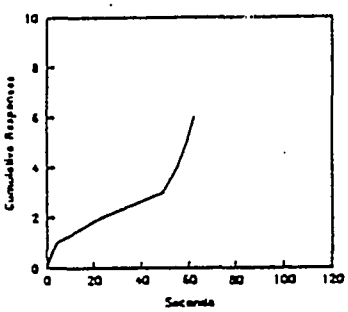
Acquisition, S16



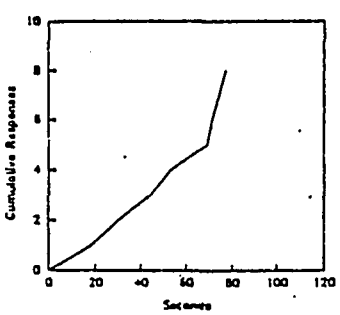
Acquisition, S17



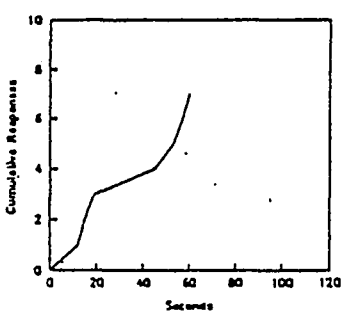
Acquisition, S18



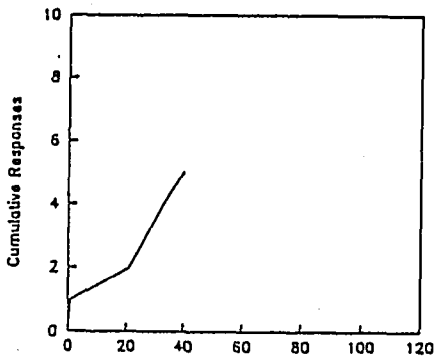
Acquisition, S19



Acquisition, S20



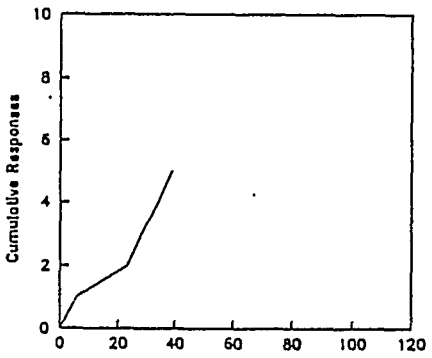
Cumulative Responses Over Time
Acquisition, S4



Mother's Accuracy=30

Mother's Percent Contingent=95

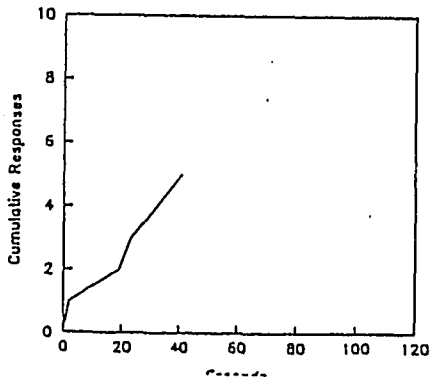
Cumulative Responses Over Time
Acquisition, S6



Mother's Accuracy=30

Mother's Percent Contingency=69

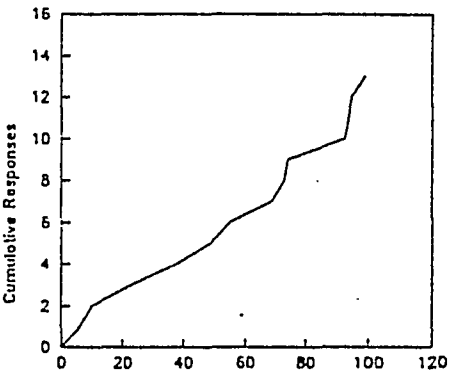
Cumulative Responses Over Time
Acquisition, S12



Mother's Accuracy=30

Mother's Percent Contingency=93

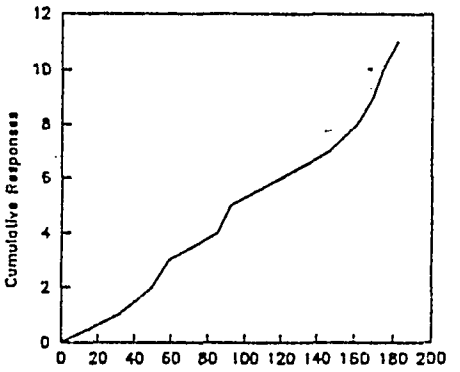
Cumulative Responses Over Time
Acquisition, S5



Mother's Accuracy=27

Mother's Percent Contingent=61

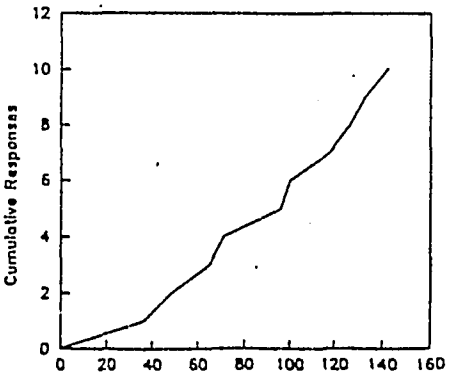
Cumulative Responses Over Time
Acquisition, S8



Mother's Accuracy=24

Mother's Percent Contingent=63

Cumulative Responses Over Time
Acquisition, S13



Mother's Accuracy=27

Mother's Percent Contingent=56