Infant learning in the context of early social interaction: Contrast effects in infant eye gaze duration as an indicator of maternal availability and contingency

Teresa Kamman
The University of Montana

Follow this and additional works at: http://scholarworks.umt.edu/etd

Recommended Citation
INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

ProQuest Information and Learning
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA
800-521-0600

UMI®
Permission is granted by the author to reproduce this material in its entirety, provided that this material is used for scholarly purposes and is properly cited in published works and reports.

**Please check "Yes" or "No" and provide signature**

Yes, I grant permission √

No, I do not grant permission

Author's Signature: [Signature]

Date: 12/14/01

Any copying for commercial purposes or financial gain may be undertaken only with the author's explicit consent.
Infant Learning in the Context of Early Social Interaction: Contrast Effects in Infant Eye Gaze Duration as an Indicator of Maternal Availability and Contingency

by

Teresa Kamman

B.A., Edgewood College, 1991
M.A. University of Montana, 1999

Presented in partial fulfillment of the requirements for the

Degree of Doctor of Philosophy

The University of Montana

December 2001

Approved by:

Lynne Koester, Ph.D., Chair

Allen Szalda-Petree, Ph.D., Chair

Dean of the Graduate School

Date
Infant Learning in the Context of Early Social Interaction: Contrast Effects in Infant Eye Gaze Duration as an Indicator of Maternal Availability and Contingency

Directors: Lynne Koester, Ph.D.; Allen Szalda-Petree, Ph.D.

This study examined the behavior of six-month-old infants during interaction with mothers for evidence of infant learning about both immediate and long-term maternal availability. Forty mother-infant dyads were videotaped during two types of interaction. First, infant gaze duration was measured during a modified version of the Still-face procedure: a) baseline face-to-face Play; b) 90 degree Turn-away; c) standard Still-face (Tronick, Als, Adamson, Wise, & Brazelton, 1978); d) Still-face Reunion; e) a “Loud face” episode (mothers interacted using any modality except vocal behavior); and f) Loud face Reunion. Second, maternal contingency was measured during a Free-play session, in which mothers and infants played on the floor with toys. It was hypothesized that infant eye gaze during face-to-face interaction would show incentive contrast, occurring when rewarding incentives, such as maternal attention, are shifted up or down within a single behavioral context. Positive contrast (i.e., elevated responding above what is seen at baseline when high reward levels are re-instituted after a downshift) was predicted among all infants in the Still-face Reunion, when mothers re-engaged their infants after maternal withdrawal. Because of its link to prior history of reward deprivation, negative contrast (i.e., diminishment of behavior below baseline when incentives are decreased) was predicted to occur in the Still-face episode, an impoverished interactive situation, only among infants whose mothers demonstrated lower contingent responding relative to noncontingent behavior during Free-play. Significant positive and negative contrast effects suggested that expectancies regarding reward magnitudes were formed by infants according to information provided during social interaction. Conversely, contrast effects were not associated with scores reflecting maternal contingency. Further investigations to examine the external validity of the current conceptualization of contingency by an application to exceptional populations are indicated.
Acknowledgements

The completion of this thesis was made possible through the generous assistance of the following individuals: Richard Pyfer, Candace Crosby, Meg Traci, Linda Thomas, Julie Bean, Jessica Gundy, Naoko Mori, Rebecca Folkerts, Tina Dolce, Erin Roach, Melissa Shoupe, Jena Halverson, and Christina Hill.

I would particularly like to thank my committee. To Paul Silverman (who gave me my first chance), Lynne Koester (whose inquiries into the area of infancy research continue to inspire all of her students), Nabil Haddad (who taught me how to teach and whose support has been unflagging), Delbert Kilgore (who demonstrates the generosity of time and knowledge that allows interdisciplinary questions), and to Allen Szalda-Petree (who shaped the question, with erudition and forbearance).
# Table of Contents

Abstract .................................................................................................................................... ii  

Acknowledgements ................................................................................................................ iii  

List of Figures ........................................................................................................................... v  

List of Tables ........................................................................................................................... vi  

Chapter

1. Introduction ................................................................................................................... 1  

2. Methods ....................................................................................................................... 37  

3. Results ........................................................................................................................ 45  

4. Discussion .................................................................................................................... 47  

References .............................................................................................................................. 53  

Figures and Tables ................................................................................................................. 67  

Appendices

I. Parent Recruitment Letter ............................................................................................. 73  

II. Statement Of Consent To Participate In Research .................................................... 74  

III. Instructions to Subjects ............................................................................................... 75  

IV. Coding Protocols .......................................................................................................... 76
List of Figures

1. Repeated measures ANOVA conducted on mean proportion.....................67
2. Repeated measures ANOVA conducted on mean proportion.....................69
List of Tables

1. Paired samples $t$-tests comparing mothers' social behaviors........................71
CHAPTER 1: INTRODUCTION

Infant interaction with the primary caregiver is generally held to make important contributions to development, particularly in the areas of socio-emotional functioning. A tradition of research links the development of early effectance motivation and interpersonal expectations, such as attachment and the development of trust, to experience occurring in the context of parent-infant interaction (Bowlby, 1969; Lamb, 1981). The patterning of early dyadic, face-to-face interchange has been proposed to contribute to the ontogeny of such diverse behaviors as reciprocity (Brazelton, Koslowski, & Main, 1974), language (Snow, 1989), and the sense of self (Sroufe, 1989).

Face-to-face interaction, in particular, is associated with a number of developmental tasks for infants. These include the toleration and modulation of varying levels of arousal, the regulation of emotion, and the ability to appropriately interpret and respond to the social conventions governing interaction (Kopp, 1982; Stifter & Braungart, 1995). Infants are presumed to use the more sophisticated behavioral organization of caregivers as a guide until they can successfully modify their own behavior (Gianino & Tronick, 1988).
While the quality of early social interaction has, in general, been found to covary with indices of child adjustment, little direct evidence has been found identifying infant behavior as a learned response within the dyadic context. Studies relating infant behavior to maternal variables have either measured behavior that is potentially transitory, occurring due to the situational context, or have relied on correlations, describing associations that may be due to intervening variables, rather than reciprocal responding provided by the caregiver.

This study was conducted to examine the early social behavior of infant eye gaze for evidence of learning specific to the ongoing interaction between caregiver and child. Little is known about the ontogeny of learned social behavior. While studies of infant learning have explored the acquisition of responses that may very well be factors in social situations, such as the involvement of infant state as a marker for learning in appetitive (feeding) situations (Clifton, Siqueland, & Lipsitt, 1972); the passage of time as a variable in learning about temporally-related events (Little, Lipsitt, & Rovee-Collier, 1984); and the establishment of ratios between baseline and conditional probabilities during the distress-relief sequence of infant soothing (Lamb, 1981), the role of associative mechanisms in early social development remains to be clarified.

The current study anticipated that associative learning, specifically incentive contrast, is measurable in infant behavior during social interaction with caregivers. Thus, the study sought to document contrast effects in total duration of infant eye gaze as maternal incentive was shifted over six different face-to-face interaction episodes. Overall, it was expected that infants would show contrast effects in gaze as the amount of maternal
reward varied from the enriched play behavior of the baseline period, to decrease in the still-face episode, and then again increase as baseline was reestablished.

It was also anticipated that the maternal contingency observable within mother-infant dyads would be a factor contributing to infant’s incentive contrast learning. The study thus sought evidence that the appearance of contrast effects in infants whose mothers demonstrate contingent responding would reflect differential associative learning about the availability of maternal reward compared to those infants whose mothers interactions are noncontingent in quality. A history of interactional deprivation was anticipated to predict deficits of infant learning, resulting in a lack of contrast effects in infant eye gaze when the amount of maternal reward was shifted.

**Features of Early Social Interaction**

Early social interaction has features that clearly differentiate it from other abilities relevant to knowledge acquisition. Direct investigation, the systematic exploration of objects, centers primarily around manipulating objects and bringing them into direct contact with the sense organs (Rochat, 1989). The attentional components of object investigation are characterized by concentrated looking in order to inspect or examine (Ruff, 1986) and are quite different from infant attention to a communicative partner. In exchanges with a responsive adult, infants’ behavior is uniquely marked by positive affective expressions, vocalizations, and alternations of gaze (Legerstee, Corter, & Kineapple, 1990).

Additionally, information-gathering opportunities for infants other than early social exchanges, such as direct investigation and observational learning (i.e., the internalization of another’s action without the necessity of direct enactment; Bandura, 1989), are
relatively opportunistic and are frequently directed toward novel aspects of the environment. In contrast, face-to-face social interaction is highly patterned, with a dialogic form similar to conversation (Beebe, Jaffe, Feldstein, Mays, & Alson, 1985); is a sought-after exchange, specifically with a few familiar conspecifics; and involves multiple repetitions of similar behaviors that change slowly, becoming more organized over time.

Face-to-face social interaction may also be distinct from other early social behaviors. *En face* interaction begins earlier than other forms of social exchange. The time spent in face-to-face play peaks between the ages of 2 and 4 months (Keller & Gauda, 1987). Thus face-to-face engagement has an earlier developmental onset as compared to social referencing (i.e., using another person’s response to an unfamiliar person, object or event as a guide to one’s own affective response or behavior), an ability that peaks at 8 months (Baldwin & Moses, 1996). Similarly, although joint attention to objects with a parent appears as early as 2 months of age, this behavior does not reach mature levels until 18 months (Butterworth & Grover, 1988).

The capacity to engage in a face-to-face exchange rests upon foundational skills that are surprisingly complex and still incompletely understood. Infants exhibit perceptual and attentional biases that predispose them to respond as if social stimuli have greater salience than other types of stimulation (Bowlby, 1969). Early social behaviors, such as emotional expressions or eye gaze, are initially governed prepotently by exposure to particular stimuli, but then, over the course of development are used in an increasingly intentional manner toward complex cognitive ends (Sroufe & Waters, 1976). For example, the development of infant attention toward face-like stimuli begins as a
preferential tracking of moving faces, consistent with the functioning of the early-developing superior colliculus pathway. Only later do infants demonstrate preferred fixation and habituation to faces, over other types of stimuli, when cortical pathways mature (Johnson, 1990).

Adding to the complexity of the study of early reciprocal exchange is the multipurpose nature of infant social behaviors. As an example, eye gaze not only controls perceptual access to the environment, but is also a means of regulating physiological arousal. Arousal may be increased by gaze toward novel, stimulating percepts or may be decreased by gazing away from stimulation that is too intense. The normative fluctuations in the physiological arousal modulated by eye gaze appear to, in turn, have regulatory effects on infant emotional responding (Field, 1981), and on overall dyadic communication (Kaye & Fogel, 1980).

**Infant Eye Gaze**

Eye gaze is an integral element of the social behavior repertoire, expressed contemporaneously with those other social mediums of facial expressions, gestures, vocalizations, and touch (Keller & Gauda, 1987). Eye contact toward a caregiver stimulates responding by the adult (Osofsky, 1976) as well as increases the probability of vocalizing by the infant (Kaye & Fogel, 1980). Even among nonhuman primates, the rate of vocalizing between infant and adult has been seen to be 100 times higher during periods of eye contact than in off-gaze periods (Biben, 1994).

However, it is not clear whether dyadic eye gaze conforms to the "call-and-response" pattern of interaction that is derived from a verbal communication model. Verbalizations between adults during face-to-face interaction result in a series of on-off cycles of
vocalizing and pausing. However, examinations of moment-by-moment coordination of individual response modalities used in dyadic interaction, such as mother-infant looking, show little evidence of bidirectionality (Jaffe, Stern, & Peery, 1973; Hayes, 1989). Thus, while it has been found that, overall, mother-infant dyadic behaviors are coordinated in an alternating turn structure (Jaffe, Beebe, Feldstein, Crown, & Jasnow, 2001), other studies have demonstrated that patterns of mutual mother-infant gaze only marginally depart from what would be expected by chance (Messer & Vietze, 1988).

Cohn and Tronick (1988) observed that multimodal indices of infant and mother behavior showed a two-way influence at 3, 6, and 9 months of age, while single modality measurements, such as mutual gaze, failed to show this mutual directionality. In an attempt to reconcile these conflicting findings, the authors reasoned that individual, discrete behaviors are best understood conjointly, reflecting the integration of specific behaviors toward complex goals of social exchange. It may be that eye gaze is embedded within larger communication modules where the nonverbal kinesics are organized around more molar “ideas,” such as the rhythmic timing of turn-taking (Jaffe, et al., 2001).

An example of the development of multiple pathways that converge to modulate infant state is given by research on infant calming. Orally delivered sucrose will behaviorally calm a crying 2-week-old infant, reducing heart rate, metabolic rate, motoric activity, and elevating pain thresholds in a manner that suggests the release of endogenous opioids. However, by 4 weeks of age, infants will not calm unless the sucrose is administered along with eye contact by the experimenter (Zeifman, Delaney, Blass, 1996).
Eye gaze also interacts with social reinforcers. Infants were found to increase vocalization upon the administration of the social reinforcement of smile, touch, and language, but only when the infant could see the adult's eyes. Eye contact did not by itself increase vocalization, but instead appeared to act as a setting event for the organization of behavior (Bloom, 1975).

Such research suggests an increasingly elaborate interconnection of behaviors over the course of development. The normal setting for the interdependence of these competencies is the context of interaction with the caregiver.

**Maternal Interaction and Infant Eye Gaze**

Maternal regulation may be a prominent factor influencing infants' social use of eye gaze, since newborns have been observed to join the gaze of their mother rather than vice versa, and mothers continue to gaze after the infant has stopped (Messer & Vietze, 1984).

However, infant gaze seems also to play a regulatory role when maternal interaction departs from normative levels. In response to under- and over-stimulation, infant gaze demonstrates a U-shaped function. infants averting their gaze more when interacting with a passive or highly active maternal partner, than with a moderately engaged partner (Stifter & Moyer, 1991).

Gaze aversion during interaction with mothers is preceded by negative facial affect, such as frowning, grimacing, crying, as well as elevated heart rate. The change in physiological indicators (such as heart rate) that decrease after gaze has been directed elsewhere, has led to the conclusion that gaze aversion is an index of infant stress (Field, 1981). The regulatory role of infant gaze during social interaction extends to both intensely negative (e.g., interaction with a stranger), as well as intensely positive
emotional (e.g., an extended game of peek-a-boo with mother) encounters (Campos, Emde, Gaensbauer, & Henderson, 1975; Stifter & Moyer, 1991).

Thus, gaze behavior is sensitive to the quality of immediate interaction. However, infant eye gaze is also thought to reflect the history of the dyad's quality of interaction. Keller and Gauda (1987) found that 10 week-old infants could be described as displaying one of three patterns of eye gaze toward caregivers: Low gaze, high gaze, or gaze avert (i.e., a failure to gaze at parents). These patterns, in turn, were associated with parental responding to infant signals and acceptance of infant "topic" of interest, with the parents of gaze averters demonstrating the lowest acceptance of infants' interest. Longitudinal follow-up revealed that averting infants had significantly greater developmental delay (e.g., speech delays, compulsive behavior, sleeping disorders, and separation problems), charted at 2, 3, 4, 5, and 6 years of age.

Thus, eye gaze appears to serve a dual role during ongoing interaction. First, it may act as a mediator of ongoing, affectively charged events. Second, gaze behavior may reflect social expectancies developed over time, indicating the quality of the interactive exchange.

Contingent Caregiving and the Quality of Early Social Interaction

The quality of parenting thought to promote later positive outcomes for children has been described as responsive (Ainsworth & Bell, 1969), sensitive (Belsky, 1984), and synchronized (Stern, 1977). Studies attempting to operationalize this style of caregiving have focused on interactions within the parent-child dyad that involve behavioral contingencies, where one member's behavior is sequentially dependent or contingent upon the responding of the other member.
Early research examining the effects of maternal responding on infant behavior has focused on the ability of mothers to attend to their infant's signals of distress in a contingent manner. Ainsworth found in her longitudinal Baltimore study of 23 mothers and infants that mothers who were more responsive to infants' cries, who fed their infant in a manner more contingent upon the infant's hunger (Ainsworth, Blehar, Waters, & Wall, 1978) and who paced their face-to-face interactions more responsively to infants' bids for interaction (Blehar, Lieberman, & Ainsworth, 1977) had children who demonstrated greater attachment security at 1 year of age. Conversely, less responsive mothering was associated with attachment insecurity. Because maternal behavior demonstrated more stability in the first 6 months of infant life than did infant behavior, and because maternal behavior in each quarter-year studied was seen to predict infant behavior in the next quarter, it was concluded that later infant behavior occurred as a result of style of caretaking (Bell & Ainsworth, 1972; however, see Goldsmith, Bradshaw, & Rieser-Danner, 1986).

The findings regarding the outcomes for children experiencing more responsive and positive early mother-infant interaction has led to the understanding that the quality of early relationships is multiply determined. The combined influence of demographic variables, social support, and maternal personality have been found to significantly cluster on the maternal interactional variables of sensitivity, intrusiveness, responsiveness, negative and positive affect in intuitively meaningful ways (Fish, Stifter, & Belsky, 1993). In a similar vein, mothers' reported emotional experiences, their expressive behaviors, and personality traits were significant predictors of infant security attachment (Izard, Haynes, Chisolm, & Baak, 1991.)
Thus, wider indices of parenting competence map well onto the nurturant aspects of caretaking. Specific measures of nurturance, such as proportion of vocalizing, smiling, imitating, and touching, have been found to be associated with later child measures of attachment (Clarke-Stewart, 1973), autonomy (Baumrind, 1967), and social competence (Sroufe, Schork, Motti, Lawrowski, & LaFrenere, 1984). However, the parenting behaviors that have been identified as instrumental in these adaptive child outcomes have been only broadly defined. Thus, Baumrind (1967) investigated parental “warmth” and “communication” as qualities importantly associated with enhanced autonomy and competence in children. Unfortunately, it is not well known how these parental behaviors act to promote successful adaptation to the environment or at what point during development accrued effects are first discernible (Maccoby & Martin, 1983).

The issue of causal conclusions drawn from distal measurements is of special concern given some doubts regarding the potential of early experience to exert long-lasting effects on development (Kagan, 1996). And while an increasingly popular notion is that early experiential influences interact with the greater plasticity of the infant brain to set or solidify functioning, particularly socioemotional functioning (Dawson, 1994) the identification of specific early mechanisms within the infant that might support such an influence is only beginning to be made.

The two most influential areas demonstrating infant effects following from maternal behaviors have been in the areas of pathological maternal interaction and microanalytic analyses of interaction. The first of these concerns the effects of extreme departures from an expectable style of caregiver interaction. Abnormal interactive experiences occurring early in development are presumed to contribute to infant social withdrawal (Field, 1977).
and depression (Field, Healy, Goldstein, & Guthertz, 1990). Concordantly, animal studies of repeated early maternal separation have documented altered behavioral and neurochemical responses to conditioned and unconditioned reinforcers (Robbins, Jones, & Wilkinson, 1996).

While the effects of severe departures from normative levels of caregiving and nurturing are uncontested, it still remains to be discovered whether these abberant maternal behaviors operate on infant behavioral organization in a graded, or all-or-none fashion. It is suggestive that one study, including mothers with either a current or past history of depression, did not find the risk of depression to correlate with either maternal or infant smiling and gazing during interaction, presumably due to lower overall levels of depression than have been captured in other studies. The infants of mothers with a history of depressive symptoms did, however, look significantly longer at mothers when they smiled, as well as showed a preference for photos of a smiling female stranger (Striano, Brennan, & Vanman, in press). Studies such as these point to the possibility that child outcome may be strongly mediated by interactive history, but that we are obligated to define adult interactive variables with greater specificity in order to discern their impact.

Because the diagnosis of a caregiver with a mental disorder, such as depression, has not been sufficient to either capture demonstrably lower levels of positive engagement and sensitivity or to predict a poor child outcome, such as insecure attachment (Campbell & Cohn, 1997), it appears that the definitive factor for child-effects may lie in the specific interactive exchange. Similarly, a prospective study comparing infants from family environments having multiple risk factors with those from unexceptional
environments failed to find differences in infant social functioning, even using global parenting measures (Bayley & Schafer, 1964). Findings such as these support the notion that specific features of the caregiver's responses to infant's signals are best considered as independent components of parenting (Keller, Lohaus, Volker, Cappenberg, & Chasiotis, 1999).

Microanalytic studies have focused on the special features observable in parental behavior, specifically the sequential, turn-taking structure of dyadic exchange. These close analyses have identified important theoretical constructs such as mutual regulation, the idea that, although caregivers hold the preponderance of instrumental power in the dyadic relationship, infants also contribute to the regulation of the interaction by affectively signaling their needs (Gianino & Tronick, 1988).

The mutual regulation model refined the older idea that maximizing the synchronous matching of behaviors in the dyad also maximizes optimal outcomes for the infant (Schaffer, 1977). Because temporal microanalytic coding has failed to find mother-infant synchrony as a good fit for the data, it has been instead posited that mismatches in interaction between caregiver and infant allow the infant to perform interactive repairs that will form the basis of later self-regulation (Tronick & Cohn, 1989).

Temporal analyses of global interaction have shown clear relationships between maternal behavior and subsequent infant responding. Isabella, Belsky, and von Eye (1989) examined the co-occurrences of maternal and infant behavior within 15-sec interaction epochs at 1, 3, and 9 months of age. They found that those exchanges rated, a priori, higher for interactive quality (e.g., infant fuss/cry - mother soothe) were observed more frequently among dyads where the infant was securely attached at one year than
among dyads with higher rates of asynchronous interaction (e.g., infant explore – mother stimulate).

In part, the failure of infant eye gaze to conform to a monotonically increasing relationship, lock-stepped with increasing quality of maternal interaction, may be due to its U-shaped responding. Infants of mothers with a history of depressive symptoms looked significantly longer at mothers, particularly when the mother smiled, than did infants whose mothers had never been depressed (Striano, Brennan, & Vanman, in press). This is reminiscent of the report that when individual differences in visual attention toward the mother were examined, infants given the attachment classification of avoidant showed a higher degree of maternal facial coordination than infants otherwise classified, including securely attached infants (Malatesta, Culver, Tesman, & Shepard, 1989).

An issue attendant upon the question of the scope and specificity of caregiver influences is that of direction of influence in early dyadic interaction. This question asks how much direct control of developmental processes is exerted by the caregiver. Models of infant adaptation, such as the mutual regulation model, propose that, if infant internal states are successfully controlled by joint regulation, then natural infant capacities are available for allocation to cognitive exploration and mastery, important factors in the development of a sense of agency (Tronick & Weinberg, 1997).

Such models emphasize nativistic capacities, the inherent abilities possessed by all infants to guide complex behaviors. Because infant capabilities at birth are known to include perceptual, attentional, and exploratory strategies that allow an active search for information (Gibson & Spelke, 1983), the precocial infant described by these data is best characterized as an active participant, affecting its own development and not merely a
passive receiver of input from the environment. Some theorists have suggested that the inherent capacities of the infant to actively participate in the dyad, along with the "goodness of fit" of the mother, are sufficient to ensure normal development (Windle & Lerner, 1986). While the concept of the "good enough" mother may accurately characterize the relatively wide range of infant experience sufficient for adequate development, it leaves unanswered the question of what parental behavioral characteristics are needed, expected, or desired.

An alternative model regarding the scope and specificity of parental influence is the down-regulation model. The concept of down-regulation describes maternal input as an external regulator of multiple infant systems, each with a critical period open for tuning by specific, compatible features of the dyadic environment (Hofer, 1981). Infant systems are conceptualized to be loosely connected and potentially free-running with few controls, requiring maternal stimuli to coordinate and modulate their levels.

These infant systems are experience-expectant (Greenough & Black, 1992), meaning that they are only free for modification, unlike the experience-dependent systems, which require input signals from the environment in order to develop. For example, the experience-dependent visual system requires stimulation from visible light sources in order to develop. Very differently, experience-expectant systems, such as the appetitive reward systems of hunger, thirst, and socio-affective functioning are inseparable from the organism itself. Thus, they inevitably develop along with the organism, but will readily modify according to whatever environmental inputs are available during certain critical periods. A commonality of experience-dependent systems is that their motivation appears to be affectively guided, frequently directed by positive and negative affect.
The down-regulation model makes specific predictions about the infant's physiological systems that are affected by individual maternal affordances. In animal models maternal touch affects infant growth hormone production; maternal milk influences heart rate and endorphin binding in the central nervous system; and maternal body warmth affects neuroendocrine response (Hofer, 1984). Additionally, the controlled manipulation of maternal affordances among rat pups can produce predictable behavioral styles: Hyperactive locomotion can be induced by administering warmth while withholding tactile stimulation, heart beat, and scent.

In summary of the above research it may be said that, although infants are active participants in the dyadic exchange through behaviors in their social repertoire (i.e., looking, facial expressions, and vocalization), the quality and structure of their exchange may depend upon the specific input and timing of interactive components. To date, the most robust evidence that human infant behavior is intimately linked to caregiver behavior has been provided by research utilizing the still-face procedure (Gusella, Muir, & Tronick, 1988).

The Still-face Procedure

The Still-face procedure consists of three short episodes of mother-infant interaction. In the first episode, the mother is instructed to play, face-to-face, with her baby as she does at home. Next, after a brief turn-away to 90 degrees in relation to her infant, the mother is asked to face her baby with a still, neutral face and to refrain from any interaction. Finally, the mother is asked to resume her normal interaction. Each episode lasts two or three minutes (Tronick, Als, Adamson, Wise, & Brazelton, 1978).
The Still-face procedure has been used to experimentally study infant responses to shifts in maternal expressive behavior. Employed with infants between 2 and 9 months of age, the phase of infancy when face-to-face interaction is thought to be most salient, the paradigm is considered to model the violation of infants' social expectations in interaction with the caregiver. Studies utilizing the Still-face procedure have contributed to the understanding of infant coping (Gianino & Tronick, 1988), the effects of maternal depression (Cohn & Tronick, 1983), and infant communication (Tronick, 1989).

A consistent finding across studies utilizing the Still-face procedure is that when mothers present a still face to the infant following a baseline period of face-to-face interaction, infants show an increase in gaze aversion (Toda & Fogel, 1993). Supporting the conclusion that this maternal unavailability has a stressful effect on infants is the concommitant finding that during the still-face 'separation,' infants show changes in heart rate indicating increased arousal (Stoller & Field, 1982) and a decrease in smiling (Gusella, Muir, & Tronick, 1988) and self-stimulating or stereotyped behaviors such as increased motor rhythmicities or sucking, thought to be the infant's attempt to regulate the distress caused by the maternal withdrawal (Stifter & Braungart, 1995). The reunion after the Still-face episode, when normal interaction is resumed, may bring about a return to baseline levels of gaze or may elicit crying and fussing (Fogel, Diamond, Langhorst, & Demos, 1982).

Differences in maternal interactional style have been studied for their associations with infant responses in the Still-face situation. Less than optimum mothering, identified as undercontrolling, intrusive, or disengaged, has been associated with a lower rate of attentional bids made by infants when mothers were still-faced, as compared with infants
whose mothers responded contingently (Tronick, 1982). In addition, the latency of infant gaze at the onset of the Still-face has been identified as having associations with maternal interactional style, with 'immediate look and smile' corresponding to responsive mothering while 'immediate look' and 'late look' were associated with less contingent caregiving (Stoller & Field, 1982).

While the research is suggestive, little empirical evidence exists to connect these interactive perturbations to known mechanisms that might result in lasting effects on a child's cognitive, social, and emotional potential or, where infant behavior is maladjusted, to indicate that lack of adjustment was learned in the early social interaction. In order to make the claim that parental effects upon infants are longer-lived than the immediate situation, it must be demonstrated that learning occurs as a direct result of parental behavior.

**Infant Learning and Contingency Detection**

The detection of contingency may be a fundamental mechanism of learning, present at birth (Gewirtz & Palaez-Nogueras, 1992). Young infants' visual expectancies demonstrate that the contingencies between different environmental events are an important dimension of responsiveness to the environment. For example, Canfield & Haith (1991) reported that as early as six-weeks of age, infants showed both anticipatory visual fixations and faster reaction times to those fixations when exposed to repeated sequencing of lights in the left and right visual fields. Additionally, infants appeared to prefer (as measured by visual fixation) filmed events with a temporally synchronous sound track over events with an asynchronous audio accompaniment (Bahrick, 1983).
Thus infants demonstrated the capacity to organize stimuli as a function of environmental events that are temporally linked to other events of interest.

In addition, the principle of a contingency or correlation between a neutral, learned stimulus and a biologically important signal is a fundamental aspect of current models of classical conditioning (Rescorla & Wagner, 1972). Contingency can be either positive, predicting the joint occurrence of CS and US, or negative, where the CS predicts that the US will not occur (Rescorla, 1968). Thus, the model can account for learning about events that probabilistically go together and can also account for learning that certain events tend not to be associated.

Contingency detection may be a larger category of learning that subsumes the prediction of associated environmental events as well as the acquisition of responses to control the resulting consequences. Very young infants have been observed to readily perform head-turning in order to have a light turn on. This has been described as if the infants were intrinsically motivated to enact changes on their environment in a manner that involved the desire for novelty, and mastery of competence (Papousek & Bernstein, 1969).

The reinforcement properties for infant effectance motivation seem to be contained in the infant's behaviors themselves. Thus behavioral contingencies involving the linking of exteroceptive and interoceptive sensations have been proposed to have relevance for knowledge regarding causality, intentionality, and self-awareness (Papousek & Papousek, 1982). For example, during noncontingent experiences (e.g., the extinction of learned contingencies), infants have been observed to exhibit many interim orientations of body and head, making their eventual decrease in responding appear as if they were habituating
to the head turning, rather than to the CS of the light (Papousek & Bernstein, 1969). Such findings support the idea that organisms learn operantly by associating their own response with that of the reinforcer (Bolles, 1972).

The connection between external and internal events suggests how mastery and control may organize learning situations in a way that optimizes the information contained in the event. For example, when the presentation of a potentially threatening stimulus (a noisy toy monkey) was accompanied by infants' own behavioral contingency, more frequent positive affect and less frequent negative affect was observed as compared to conditions when the toy was activated without any signal as well as when the toy activation was preceded by a tone (Gunnar, Leighton, & Peleaux. 1984).

Exposure to uncontrollable aversive stimuli results in the diminishment of subsequent learning and also in alterations of neurochemical (e.g., opioid system) and hormonal (e.g., corticosteroid system) changes, that do not follow controllable aversive events (Maier, Laudenslager, & Ryan, 1985). Controllability is also a factor in how rewarding events are experienced: The highly reinforcing inter-cranial self-stimulation, where rats engage in instrumental responding to receive electrical pulses delivered to the ventral tegmental area in the midbrain, results in different patterns of brain activation than does noncontingent stimulation delivered by an experimenter to the same area (Porrino, Espisito, Seeger, Crane, Pert, & Sokoloff, 1984).

Intervening emotion may exert influences on learning in the context of contingency. The link between contingency, controllability, and affective response is robust throughout the child literature. The violation of contingency has been related to infant frustration (Alessandri, Sullivan, & Lewis, 1990). Infant facial and behavioral responses show...
positive affect (i.e., joy, surprise, interest) during acquisition of contingency learning and show negative emotion (i.e., anger, sadness, fear) during extinction of contingency relations (Sullivan, Lewis, & Allesandri, 1992).

The connection between contingency and emotion suggests a mechanism whereby noncontingency might suppress learning. Exposure to uncontrollable stressors has been found to activate the opioid system, leading to effects that include immunosuppression, decreased pain sensitivity, and diminishment of the acquisition of learned responses to both aversive and appetitive stimuli (Maier, et al., 1985).

Prior exposure to events that are noncontingent appear to diminish the capacity for contingency detection in the same learning scenario. For example, DeCasper and Carstens (1981) compared the nonnutritive sucking of neonates exposed to two different contingency conditions, presentation of recorded music contingent upon non-nutritive sucking and the presentation of music not contingent with any infant behavior. One group of infants was exposed first to the contingent condition. This group acquired the behavior of sucking to hear the music play and also showed an increase in activity and negative affect in the subsequent noncontingent episode. Infants exposed first to the noncontingent condition, failed to acquire sucking in the subsequent contingent condition and demonstrated little affective response.

Contingency detection involves effects that extend beyond the contingency relations themselves. Dunham, Dunham, Hurshman, and Alexander (1989) found that infants exposed to noncontingent social interactions showed significantly longer average looks away from a nonsocial stimulation (i.e., a display of lights synchronized to tonal
elements) than did infants first exposed to an adult contingently responding to infants’
vocalizations with “Hi [baby’s name]” and a tummy rub each time the baby vocalized.

Thus, it is unlikely that such effects are purely mediated by emotion since prior
exposure to noncontingency diminishes the ability to detect later behavioral
contingencies involving the same stimuli, even when the stimulus is likely a positive
experience for the infant (Tarabulsy, Tessier, & Kappas, 1996).

Thus, developmental differences may accrue in affective responding according to the
infant’s history of control over the environment. Monkeys reared in a standard laboratory
environment where they had access to manipulanda controlling delivery of food, water,
sugar pellets, and treats showed less fear to a strange mechanical toy and more
exploration of a novel playroom, as compared to monkeys reared yoked to this first group
for receipt of reinforcers (Mineka, Gunnar, & Champoux, 1985).

Previous research has reported that contingency relations are particularly salient
during interaction (Tarabulsy, Tessier, & Kappas, 1996). Maternal contingent
responsiveness in face-to-face interaction has been found to coincide with positive infant
affect, and arousal, (Gable & Isabella, 1992). Infants encounter contingencies most
frequently in dyadic interactions, which may form the organizational structure for
responding during all behavioral contingencies. Thus, Watson (1979) described infants
using social behaviors (e.g., smiling, cooing) directed toward inanimate objects when the
objects “responded” contingently to the baby’s action. Patterns of contingency may
provide the infant, in particular, with information in regard to expectancies.

Much of early social experience may be concerned with establishing the significance
of important environmental events and discovering how expectancies and consequences
are related. Therefore, it is of interest whether a mechanism of associative learning that
has been demonstrated to allow organisms to compare reward magnitudes, referred to as
incentive contrast, may be applicable. Because early social learning occurs in the context
of the early caregiving relationship, it is germane whether incentive contrast can be
observed in face-to-face interaction.

The Study of Incentive Contrast

Incentives are stimuli capable of evoking motivated behavior that does not depend, per
se, upon reinforcement (Bolles, 1972) such as food, water, opportunity for sex, parental
caregiving behavior and filial attachment. Infant behavior toward caregivers is regarded
as a class of social behavior that depends upon a special behavioral system parallel to
those supporting mating or parental behavior (Bowlby, 1982). Parental attention has been
identified as an unconditioned stimulus for the infant, having primary reinforcing effects
much like food or water (Harlow, Harlow, & Suomi, 1971), and interaction within the en
face dyad is readily describable as mutually reinforcing (Lamb, 1981).

Early research in the area of motivating rewards and incentives suggested that the
quality of a reward has a direct influence on learning and performance. Thus, behaviors
of interest are generally at elevated levels for high amounts of reward compared to
behavior enacted for low amounts of the same reward. For example, rats will bar press at
higher rates for a 10 pellet reward than they will for a 1 pellet reward.

The study of incentives was greatly expanded when it was found that rewards did not
always operate on behavior in a straightforward, monotonic fashion. In a study of cues
used by nonhuman primates to obtain rewards after a delay, Tinklepaugh (1928)
described how the substitution of a desired and expected reward (i.e., banana) with a less
prized and unexpected reward (i.e., lettuce) led to subject's refusal to eat the lesser reward. In this study, monkeys who would eat lettuce regularly as a reward, provided it was acting as the sole incentive, rejected lettuce at the end of a learning task when the expected reward was a piece of banana. This study was the first to report an experimental situation where reward quality was varied and the resulting behavior of subjects was recorded.

Subsequent research confirmed that the value of an incentive is relative to the juxtaposition of other rewards in the same context. Studies of incentive contrast demonstrated that as reward levels are shifted up or down, producing the experience of successive levels of reward, responding would reflect the previous experience before the shift. The administration of several reward magnitudes, presented in one context such that the levels are compared, will generate different response levels than will those same reward magnitudes by themselves. This phenomenon is referred to as incentive contrast.

The first study designed to explicitly examine incentive contrast was conducted by Crespi (1942). The running speed of rats in a straight alley was found to be slower for animals shifted from a large reward to a small reward than it was for animals trained with the small reward throughout the experiment. Similarly, running speed was found to be higher for rats shifted from a small reward to a large reward than it was for rats receiving the large reward throughout.

Incentive contrast is seen to occur in two ways. Rewards that are shifted up from lower levels produce the elevated responding above what is seen at higher absolute levels, known as positive contrast. Similarly, downward shifts lead to the diminishment
of behavior below levels associated with low absolute reward levels, known as negative contrast.

Although early reports of instrumental positive contrast effects are convincing (Crespi, 1942; Zeaman, 1949), positive contrast has been a more elusive phenomenon than negative contrast. The failure to find positive contrast in a way that is symmetrical to negative contrast has been discussed in two ways. First, it has been proposed that positive contrast does not exist. By this view, positive contrast is merely an artifact stemming from the failure to use unshifted controls. Using a preshift measure as a control (e.g., Crespi, 1942; Zeaman, 1949), will be misleading if performance rates are still being trained to representative levels (Spence, 1956). Second, positive contrast has been seen as particularly sensitive to ceiling effects, whereby subjects cannot demonstrate elevated behaviors because they are already performing at asymptote (Bower, 1961). Thus, the potential for the effect is present, but the effect cannot be measured.

However, more recent reviews of experimental findings in the incentive contrast area indicate that both positive and negative contrast are bona fide phenomena, although occurring in response to different parameters (Flaherty, 1996). While the potential variables influencing both positive and negative contrast are multiple, it has been concluded that, in general, the factor most predictably affecting positive contrast is delay to receive the reward, while negative contrast is most reliably affected by prior reward deprivation (Flaherty, 1996).

In addition, because studies of contrast were the first to be concerned with the quality and the evaluation of differing rewards, they also were among the first to give meaning to behaviors surrounding the acquisition of a reward. Tinklepaugh (1928) recounted
subject’s behavior surrounding the incentive diminishment. Monkeys exhibited gross motor, vocal, and facial behavior that observers described as “anger,” “frustrated,” “surprise,” and “disappointment.”

- In the case of negative contrast, the organism’s behavior appears more random and less organized, but at the same time is marked by strategies that may lead to the discovery of new opportunities (such as search behavior), engender motivational changes in others (such as negative affective displays), or involve a change of state (such as cessation of responding or sleep). These behaviors accompany the “depression effect” of decreased goal-oriented behavior (i.e., negative contrast), while the “elation effect” of positive contrast is due to increases in goal-oriented behavior (Crespi, 1942). The adjunctive behaviors attending negative contrast have been construed to indicate the expectancy involved in goal-directed behavior, and have also been seen as evidence of causal factors operating to produce contrast effects. Therefore, early interpretations of the cause of relativity effects among animals who experienced a downshift or upshift in reward often utilized emotional descriptors such as depression, elation, frustration (Amsel, 1958; Crespi, 1942), or specifically dismissed the importance of contrast as epiphenominal of emotional factors (Hull, 1952).

However, it is difficult to see contrast effects as entirely dependent upon emotion. Importantly, contrast effects often lack the transitory quality that would identify them as, at core, an emotional response (Flaherty, 1996). Instead, after the reward shift has been made, contrast effects tend to endure over the course of the experimental trials. In short, contrast effects appear to indicate learning.
A final complexity regarding the study of contrast must be noted before turning to its investigation among human infants. In the roughly five decades of research on contrast effects, a number of separate domains of contrast have been identified. These areas of study are defined by the type of experimental preparation used. All involve exposure of subjects to the experience of reward relativity, but accomplished in somewhat differing ways. Two broad areas may be defined. Behavioral contrast utilizes separate schedules of reinforcement density, one more enriched than the other, to elicit the different rates of operant responding through which contrast (i.e., an overshoot or undershoot of controls) may be exhibited. These preparations differ from those utilized in studies of incentive contrast, where behavior is examined over multiple discrete trials to gain a reward.

Most of the experimental evidence informing the current study has been drawn from studies of incentive contrast using successive contrast, where subjects are first exposed to one reward and then subsequently shifted to a different level of the same reward, in repeated shifts.

While the majority of studies exploring successive contrast have used a single shift of a reward, a precedence for repeated shifts does exist in the literature. Crespi (1942) and others have found evidence of positive contrast in the running speed of rats after implementing a double shift where training involved a large reward (L), followed by a shift to a small reward (S), and finally a return to the large reward again (L) (Benefield, Oscos & Ehrenfreund, 1974; Calef, 1972; McCain & Cooney, 1975; Shanab, France & Young, 1976; Shanab & Spencer, 1978). It must be noted that a number of these studies emphasize the SL shift (McCain & Cooney, 1975; Shanab & Spencer, 1978). However, a
repeated-shifts preparation may enhance the opportunity for discerning reward disparity (Flaherty, 1996).

**Contrast Effects in Infants**

The documentation of contrast effects among infants consists of a small number of studies that were concerned, primarily, with corroborating the existence of infant learning ability. Lipsitt & Kaye (1965) measured rates of nonnutritive sucking among infants who experienced an expected reward, a rubber nipple, versus a degraded reward, a rubber tube. These sucking rates were compared against the rates of two control groups, one group who sucked on a nipple across trials and another who sucked on a tube. Mean sucking rate for the nipple following exposure to the tube was higher than for the nipple-alone control group, demonstrating positive contrast. Conversely, no negative contrast occurred, since the mean suck rate on the tube following presentation of the nipple was not lower than the mean rate of the tube-only controls.

The first study to show that infants compare the incentive values of a consummatory reward was conducted by Kobre & Lipsitt (1972). The study measured rates of sucking in newborns who received two alternating shifts, each time shifted from water to a sucrose solution. Again, control groups were used to chart the mean sucking rate of infants receiving only water or only sucrose. Rates of sucking for the shifted group to the presentation of water were significantly lower than sucking by the water-only controls, evidencing negative contrast.

In a third report, Fagen & Rovee (1976) examined the operant response rates of foot-kicking to reward shifts by varying the components of an overhead mobile. Because this work used instrumental responding, rather than a reflexive response like sucking, the
three-month-old infants were first trained to make a legkick response to move either two, six, or ten identical components on the mobile. In the first experiment, infants were trained to stable responding. Then the rank order of preferred number of mobile components was determined, according to the order of average footkick rates. Footkick responses to the 10-component mobile were lowest, presumably due to the excessive complexity of visual information, while kicking to the six-component mobile was highest, supporting the notion that intermediate values of stimulation were the most rewarding. In the second study, after acquiring the response, all experimental infants were shifted to a two-component mobile. A group presented with a two-component mobile throughout acted as the control.

In this experiment, the authors hypothesized that negative contrast would be seen in infants shifted from six- to two-components (i.e., from a more-preferred to a less-preferred number of stimuli) as they increased their footkicks over the 2-2 control group. It was also hypothesized that positive contrast would be seen in the infants shifted from 10- to 2-components (i.e., from a less-preferred to a more-preferred number of stimuli) as rate of footkicks decreased to a level below the 2-2 control group.

The findings disconfirmed the proposed hypotheses. Instead, it was the group shifted from six- to two-components that increased (rather than decreased) the rate of responding above that of the control group. Because all but one of the infants shifted from 10- to two-components experienced significant distress postshift, the finding for this group was compromised. However, in a replication of these findings (Mast, Fagen, Rovee-Collier, & Sullivan, 1980), positive contrast was found among the up-shifted infants, as they increased their kicking to a two-component mobile above the level they had kicked to.
move a ten-component mobile and above the 2-2 control group. Again, negative contrast was not found in the group shifted from a six- to two-component mobile. To explain the failure to find negative contrast, it was concluded that down-shifted infants kicked harder to provide the same visual stimulation from a two-component mobile as they had achieved with a six-component mobile.

As in the animal literature, the findings for negative and positive contrast among infants were not symmetrical. It is of interest that most of the significant findings among infants have been demonstrations of positive contrast. The research on contrast effects in infant behavior suggests the possibility that contrast is a mechanism that may be observable in other domains of infant functioning. Additionally, there may be some features of contrast that make it particularly likely in early social interaction.

Applicability of an Incentive Contrast Model to Parent-Infant Interaction

A number of parallels between the incentive contrast research and the infant social interaction literature suggest that an experimental comparison may be of interest. First, both contrast effects and early dyadic exchanges describe interactions of the organism with varying environmental availabilities, such as amount of parental stimulation. Parenting may be seen as an affordance that is enriched when caregivers turn their attention to the needs of the infant and degraded as parents turn away, such as to replenish the resources necessary to the continuation of family life. Thus, it would be maximally adaptive for infants to learn about the availability of caregivers in such a way that would increase infant social behaviors when adults return their attention to the infant after a distraction. This would occur in the event of positive contrast.
An adaptive argument for observations of negative contrast among infants during social interaction with caregivers might specify that, in caregiving contexts that are generally impoverished but marked briefly by elevated levels of nurturance, infants' behavioral energy during parental unavailability should diminish *below* the previous level expended in order to conserve valuable resources. This pattern would conform to negative contrast.

In the animal literature, reward deprivation may be the most reliable factor influencing the appearance of negative contrast (Flaherty, 1982). It must be noted that, because instrumental responding itself requires deprivation as a source of motivation (Timberlake & Allison, 1974), depriving animal subjects of food or water has been a traditional component of incentive contrast preparations.

That caveat aside, if deprivation is a factor in the appearance of negative contrast, infants experiencing deprived levels of maternal incentive may be more likely to exhibit the diminished goal-directed responding, typical of food-deprived animals when levels of consummatory rewards are lowered, due to the imperative that resources be preserved.

Strengthening the case for an examination of negative contrast effects among infants are those reports of infant behavior occurring in the experimental use of the Still-face. These behaviors are reminiscent of animal adjunctive behaviors during negative contrast. During the still-face, infants engage in adjunctive behaviors, or "negative reactivity," that supplants the goal of social communication behaviors typical of interactive episodes. Infant gaze aversion, rhythmic self-stimulation, and other self-directed behaviors such as sucking, supplant organized social behaviors (Stifter & Braungart, 1995).
The multistage hypothesis proposed by Flaherty (1996) to describe the behaviors seen in nonhuman animals during negative contrast may have particular applicability to human infants during loss of maternal accessibility. Immediately after reward reduction, search behavior may indicate the expectancy of a previous level of reward. A second stage of negative contrast is associated with higher levels of physiological stress and, finally, eventual recovery. Flaherty (1996) noted the parallels of his animal research with Bowlby’s (1969) description of infant reactions to maternal separation.

Thus, a contrast model applied to infant behaviors during the still-face may help clarify the behavioral elements of disorganization and coping. During maternal withdrawal, infants have been described as utilizing adjunctive-like strategies to both regulate and cope with negative reactivity and to indicate lack of self-regulation without the organizing presence of the caregiver. The dual view of these behaviors is especially problematic if the same behaviors are used to operationally define opposite hypothetical constructs. A contrast model might explicate how this small subset of behaviors is used differentially both to organize behavior and as a communicative signal that disorganization is occurring.

While contrast effects have been documented to include behaviors that may be regarded as conscious and purposeful toward relative incentives by both animals (Tinklepaugh, 1928) and humans (Weatherly, Melville, & McSweeney, 1996), contrast behavior also occurs in the absence of elaborated cognition. For example, it is doubtful that the lick rates of infant rats, which can be manipulated to increase or decrease according to the sucrose content of the presented solution (Flaherty, Becker, & Checke, 1983), is a behavior that co-occurs with conscious perception. The fact that contrast
effects can be seen to operate outside the realm of intentional behavior makes them a possible vehicle for learning about relationship patterns over the early stages of development.

The incentive contrast literature remains silent regarding the accrual of reward-relativity learning over time. Theoretically, at least, it might be argued that contrast effects exist as a mechanism for making comparisons during specific encounters with a given reward. Such a mechanism might be most adaptive if it provided a flexible, rather than set, source of information regarding a resource that changes at each encounter. Evidence from behavioral contrast, where responding is measured in consumatory contexts, seems to indicate in-context specificity. However, given the actual occurrence of contrast in early social situations, the parameters may be quite different.

Finally, it is tempting to conjecture that a finding of contrast effects among the early social behaviors of infants can aid in explaining particular features of the caregiver-infant interaction that do not fit well into a reinforcement model. Maxwell, Calef, Murray, Shepard, & Norville (1976) found that positive contrast was obtained in rats, if they were shifted to a large reward during the negative contrast of the small reward. Positive contrast did not occur if the shift took place after the negative contrast had diminished, despite the reinstitution of the large reward. This finding might have a relationship to the finding of Ainsworth & Bell (1969), that infants whose mothers attended to them as they cried, cried less later in childhood. In the event that contrast was a factor in the Ainsworth & Bell (1969) study, the implementation of higher maternal reward during negative contrast, as indicated by crying, would stimulate the reappearance of behaviors
associated with positive contrast, as indicated by the reinstitution of goal-directed social behaviors.

**Purpose of the Study**

The current study examined infant eye gaze during varying levels of maternal reward in order to detect the presence of contrast effects during social interaction. To test this question regarding infant learning, the study utilized the Still-face experimental procedure to examine whether contrast was measurable during a LSL successive presentation of maternal reward. The Still-face procedure provides a situation for infants where maternal reward is present at presumably baseline levels (L), then degraded (S), then present again (L). Maternal reward presented at baseline (Face-to-Face Play) was decreased in the Still-face episode and then returned to approximately baseline levels in the Reunion episode. Positive contrast was determined by comparing duration of infant eye gaze in the baseline Play episode with gaze duration in the Still-face Reunion. Negative contrast was determined by comparing duration of infant eye gaze in the Still-face episode with gaze duration in the baseline Play episode.

Two additional episodes were included in the face-to-face interaction. In a “Loud-Face” segment, mothers interacted in any way that they chose while withholding the use of their voice. A Loud-face Reunion episode followed. This interactive perturbation was presumed to offer a discrepant, although not necessarily inferior, experience of maternal reward. In it, mothers generally used facial, tactile, and gestural modalities, of an exaggerated nature.

The Loud-face and Loud-face Reunion were included in order to rule out the confound that proposed increases in infant eye gaze may have occurred merely as a result of
"relief" following a discrepant episode or by an attention-driven mechanism, such as dishabituation (Thompson & Spencer, 1966). The study included another check of infant responses in the face-to-face interaction: Frequencies of maternal behaviors were recorded in order to examine whether increases in infant gaze in the Still-face Reunion were due to a concomitant increase in mothers' positively-valenced social behaviors, rather than to the reward relativity of the episode shifts.

The current study also addressed whether contrast effects in infant eye gaze reflected prior deprivation of incentive (Flaherty, 1996). Then contrast would occur differentially according to the prior reward history of dyadic interaction. The study focused on maternal contingency as a logical index of maternal reward. Interactional deprivation has been shown by the child literature to be broadly defined as a lack of contingent responding on the part of the caregiver. In instrumental terms, the contingent response for the infant is the ability to influence the mother's behavior toward the goal of mutual social interaction.

Contingent maternal responding to attentional bids (i.e., mother smiles, moves toward or touches infant in response to infant signal such as reaching toward or vocalizing to mother) was assessed during the Free-play session. Noncontingent maternal responding was assessed by recording both the frequency of maternal responding in the absence of bids as well as the frequency of infant bids that occur without a subsequent maternal response during that session. Mothers act noncontingently when they either dismiss the infant's bids by intruding with mother-directed behavior or fail to respond in any fashion to those bids. Maternal sensitivity during interaction has been found to be a stable
characteristic, demonstrating little variation early in infancy (Lohaus, Keller, & Voelker, 2001).

The idea that mothers would be more likely to exhibit a wide range of behaviors in the free-play session than in the face-to-face session was confirmed by preliminary analyses of piloting videotapes: Mothers exhibited numerous and varied demonstrations during free-play of both the presence and lack of contingency, such as the rapid introduction of a new object into the ‘playstream’ with or without referencing the child’s attention, as well as the acceptance or rejection of infant’s attempts to become physically close. This wide range of behaviors provided a sampling of characteristic maternal behavior in a session that did not appear to present much evaluative pressure for mothers, thus lessening subject reactivity.

The link between contingency and contrast effects has been established by Rovee-Collier’s footkick preparations (Fagen & Rovee-Collier, 1976; Mast, Fagen, Rovee-Collier, & Sullivan, 1980). The purpose of the current study was to investigate whether contrast learning occurs during early social interaction, and whether this learning was differentially exhibited according to prior history of contingency.

Hypotheses

It was first hypothesized that associative learning occurs in the context of the early parent-infant dyad. Specifically, it was anticipated that contrast effects, or variations in responding to a reinforcement that overshoots or undershoots baseline behavior, would be observed to regulate infant behavior during shifts in maternal behavior.

Hypothesis 1: Because delay of reinforcement has been identified in the contrast literature as the most significant factor in the appearance of positive contrast (Flaherty, 1980),
1986), it was anticipated that all infants would show positive contrast in duration of eye gaze in the Reunion episode of the Still-face procedure relative to the Face-to-Face Play (baseline) episode. A corollary of this hypothesis is that infants would not show elevated responding of eye gaze duration following the Loud-face, an episode that increased maternal responding in a discrepant, but not degraded, manner. If infants increased responding above baseline in the reunions following both the Still-face and the Loud-face episodes, then an attentional, rather than a contrast, hypothesis would be more tenable.

Secondly, it was hypothesized that contrast learning would reflect the prior history of reward. Among infants from contingent dyads, previously reinforced opportunities for contingent learning were anticipated to produce a longer stage of search behavior, offsetting negative contrast during the Still-face episode. Conversely, infants from noncontingent dyads were anticipated to show decreases in eye gaze when faced with maternal unavailability as compared to infants from contingent dyads, where recovery from a down-shifted reward is a far more common experience. Thus, contrast effects were anticipated to occur differentially in the Still-face episode, depending upon the opportunities for contingent learning.

**Hypothesis 2:** Due to the effects of interactional deprivation, it was hypothesized that infants in dyads with a mother identified as noncontingent during Free-play would more likely decrease duration of eye gaze in the Still-Face episode (i.e., negative contrast) as compared to infants in a dyad with a contingent mother.

Taken together, the study's hypotheses reference the idea that, not only do infants use comparative processes within social interaction, but that these same processes can act as a
source of information regarding long-term social expectancies and the availability of caretakers' responding.

CHAPTER 2: METHOD

Participants

Forty mothers and infants were observed during a series of interactions utilizing both the traditional Still-Face paradigm and controlled variations of the Still-face. Subject names were obtained from local newspaper birth lists and parents were contacted when the infant was at or near the target age, between 21 weeks and 27 weeks old. An introductory letter (see Appendix I) was sent first, and participants were called approximately 3 days later. Infants (19 boys, 20 girls) were approximately 6 months old (M = 186 days; age ranged from 151 days to 215 days).

Criteria for inclusion were age and the absence of significant developmental delays as assessed by the Ages & Stages screening measure filled out by mothers at intake. The demographic factor of maternal age was also gathered at intake. Additionally, no mother indicated any other ethnic identification than Caucasian. Mothers' age ranged from 20 to 37 years (M = 28).

Thirty-nine of the 40 mothers recruited allowed their videotape to be used in the final analysis. (One mother requested that her videotape be used only for the piloting of the procedure). Thus, face-to-face interactions of 39 infants were coded for contrast effects. Of these subjects, technical problems were encountered with the sound recording on five tapes. Consequently, a reduced number of subjects comprised the group coded for maternal contingency (n = 34).
Setting and Materials

The observations were conducted in two rooms on the campus of The University of Montana (in the parent-child observation room maintained by the developmental area of the Psychology Department and in a room at The Montana University Affiliated Rural Institute on Disabilities). Every effort was made to obtain equivalence in the two videotaping settings. For example, in both settings, the investigators operated the cameras and switcher from positions that hid the investigators, as well as the equipment, behind cloth screens. Face-to-face and Free-play interactions were videotaped using a split-screen mixer (Sima SFX-M), with two separate digital video (DV) cameras (Panasonic and JVC).

Procedure

Approval by the Institutional Review Board for Research on Human Subjects (IRB) was given for both a pilot study to refine the experimental procedure and for the study itself. Mothers were greeted at the drive-up to the laboratory, given a parking permit, and directed to a parking space. In a private reception area, the investigator read over the consent form to the mother, answered any questions, and obtained the mother's signature.

The signed consent was obtained from the mother before the observation began (see Appendix II). The consent form stated the right to withdraw at any time and the right to confidentiality, as well as described the nature of the procedure. The consent form asked for permission to videotape the interaction and notified the mother that she would be compensated ten dollars for her time whether or not she completed the observational procedure. If infants showed signs of fussiness or crying that were not easily remedied by feeding, changing, or soothing strategies before or during the observation period, the
mother was excused and received the ten dollars. Only one mother was excused for infant fussiness before the procedure began. She was paid the gratuity and not included in the data set.

After intake, the experimenter accompanied the mother and infant to the observation lab. First, all dyads were conducted through the Still-face Procedure. Babies were placed in an infant seat on a table directly in front of and facing the mother, with no toys or other objects provided. Brief instruction was given to mothers at the start of the procedure, with the information that an experimenter would signal the start of each episode (see Appendix III).

The face-to-face interaction segments occurred as follows: (a) Baseline Face-to-face Play: Mother was instructed to interact with her infant just as she would normally do at home (2 minutes); (b) Turn Away: Mother turned in her seat to position herself at a 90 degree angle to her baby. Mother remained still at this time, without vocalizing or exhibiting facial expression (30 seconds); (c) Still-Face: Mother turned back toward baby, looking at baby but without any communication or emotional expression (2 minutes); (d) Still-face Reunion: Mother resumed normal interaction, as in the first episode (2 minutes); (e) Loud Face: Mother played with infant again, but did not to speak or vocalize (2 minutes); (f) Loud face Reunion: Mother resumed normal interaction again (2 minutes).

Mothers and infants were given a brief intermission (approximately 5 minutes) while the observation lab was re-arranged for the Free-play. Dyads were then videotaped for 25 minutes while seated on a padded mat on the floor with a wide variety of toys arranged on portable shelving within arms reach of the mother.
After the videotaping, mothers and infants were escorted back to the reception room, where mothers were given the developmental screening measure, verbally debriefed (see Appendix III), allowed to ask any questions they chose, given a written debriefing, and given their monetary gratuity.

Measures

*Infant Eye Gaze:* Infant eye gaze was measured in the standard Still-face of nonverbal communicative modalities used by mothers of young infants (Traci, Koester, & Swisher, 2001).

Two undergraduate research assistants, blind to the study’s hypotheses, independently coded duration of infant eye gaze at mother in six episodes of face-to-face interaction. A reliable system of coding the onset and offset of eye gaze was used to derive duration for each gaze (see Appendix IV; Koester, 1995). Infant eye gaze was scored for all six episodes in their entirety. Due to the continuous nature of the dependent variable, inter-rater reliability was established using a Pearson’s product-moment correlation, $r = .896$.

*Measure of Maternal Contingency.* The coding of maternal contingency during the Free-play session was conducted according to a checklist developed by the author (see Appendix IV). This aspect of the procedure was exploratory. Coding items were developed during piloting based on the clinical experience and judgment of a therapist with 13 years of experience. Both Contingent and Noncontingent behaviors were identified from watching six pilot tapes. Observations of contingent and noncontingent behavior were recorded as frequencies of behavior.

Both the Contingent and Noncontingent behaviors were classified in an a priori manner into 4 categories: Active Contingency, Passive Contingency, Active
Noncontingency, Passive Noncontingency. The category of “Active” was intended to capture behaviors that apply the mother’s play, teaching, or control agenda to the infant’s ongoing behavior. The “Passive” category was intended to reflect mothers’ behaviors that form a background to the infant’s chosen topics of interest.

The videotapes were coded by two observers, blind to the study’s hypotheses, using the contingency checklist to record the mother’s contingent and non-contingent behaviors. Behaviors were specified as mutually exclusive members of each category. The observers viewed each tape in real time as well as frame-by-frame. The interval between infant and maternal behavior was determined by coding the onset and offset of a randomly chosen 25% of the data (i.e., 9 tapes). The mean contingency interval (i.e., where mother responded to an infant behavior with a behavior of her own) was .6 seconds. This met the requirement that maternal behaviors coded as contingent occur within a 1-second interval after the infant’s behavior (Malatesta & Haviland, 1987).

Reliability analysis of the contingency coding was established on 30% of the data (i.e., 12 tapes). An analysis of inter-rater reliability yielded a Cohen’s kappa of .792.

Because mothers’ behaviors occurred almost exclusively in reference to the task of play and interaction with their infants, all observed maternal behaviors were coded as either contingent (i.e., responding to the infant’s need or topic of interest) or noncontingent (i.e., enacted despite infant bid or focus of play). Due to the nature of the floor play, maternal behaviors included not only nurturance and play, but also maternal control (e.g., mothers’ preventing the infant from precarious situations, putting things in mouth, etc).

Contingency behaviors were defined as dyadic reciprocity that did or did not (i.e.,
noncontingency) facilitate topics of importance to the infant. Subsumed under the broad headings of “Active” and “Passive” were these categories: Active Contingency (mother responded directly to an infant bid for interaction); Passive Contingency (mothers’ vocal, tactile, visual behavior supported or marked the infant’s interest in the environment or, alternatively, waited for opportunity to support); Active Noncontingency (mother set topic of interest, despite infant attention, or acted in a manner oblivious to infant’s behavior); and Passive Noncontingency (mother ignored or failed to respond to a direct infant bid for maternal attention).

Mothers were given a score (i.e., the sum of the observed frequencies) in each category, Active Contingency, Passive Contingency, Active Noncontingency, and Passive Noncontingency. Additionally, all mothers received a Total Contingency score (i.e., Active and Passive Contingency combined) and a Total Noncontingency score (i.e., Active and Passive Noncontingency combined). Finally, each mother was ascribed a Total Ratio score, calculated by dividing total Contingency and Noncontingency into the Total Contingency score. The Total Ratio score was conceptualized to reflect the mother’s relative use of contingent behaviors to noncontingent behaviors. The relative
use of contingency-to-noncontingency provided an estimation of overall maternal style of responding to the infant.

The checklist of maternal behaviors was piloted on a sample that included mothers in therapeutic treatment for issues of parenting. The therapist-referred mothers' contingency-to-noncontingency ratio was substantially below the level of community-recruited mothers (Kamman, Bean, Gundy, Koester, & Szalda-Petree, 2001). Because of the small number of mothers in the pilot sample with documented histories of child abuse and neglect (n = 3), this finding provided only a limited support for this exploratory measure.

**Maternal Face-To-Face Behavior.** A list was made of mothers' behavior during the six episodes of the Face-to-face interaction from 6 randomly chosen tapes. All observed maternal behaviors were listed. A coding protocol was determined (see Appendix IV) and all tapes were consensus coded by two undergraduate research assistants blind to the study's hypotheses. The two coders conducted the coding independently, and then compared their coding of each tape. All disagreements of behavior categorization were reviewed by the coders and a judgment was made regarding the category of the behavior. No reliability analysis was conducted for this coding.

**Developmental Screening.** The Ages and Stages Questionnaire (ASQ) was developed to identify developmental problems in infancy (Bricker & Squire, 1999). The questionnaires are designed for completion by parents for children of various ages (from 4 – 48 months of age). The current study used the version appropriate for infants six months of age. The experimenter read the 30 developmental questions, written in
straightforward language at a sixth-grade reading level, to mothers after the observational procedure. No child was excluded from the study on this basis.

Data Reduction. Although the maternal contingency measure was deemed exploratory, the study differentiated three groups of maternal contingency. On the basis of the Total Ratio score, dyads were assigned to either a Low Contingency (i.e., scores within the range of a therapist-referred sample; Kamman, Bean, Gundy, Koester, & Szalda-Petree, 2001; n = 7), High Contingency (n = 6), or Medium Contingency (n = 23).

Design

The study employed a repeated-measures design, with Episode (Baseline Play, Turn-Away, Still-Face, Still-Face Reunion, Loud-Face, and Loud-Face Reunion) as the within-subjects factor. The dependent measure, duration of infant eye gaze, was coded for all episodes of the face-to-face procedure and reported as proportions of gaze for the entire episode (i.e., gaze duration/ total time of episode). The episodes of interest were the Still-face episode (for negative contrast) and the Still-face Reunion episode (for positive contrast), although the remaining episodes were relevant for comparison purposes.

The study used an unselected sample of dyads thought to be broadly representative of the total population of mothers and infants in Missoula, MT in terms of maternal contingency and noncontingency. However, it must be noted that frequencies of these behaviors have not previously been reported.

The study examined whether the dependent measure, duration of infant eye gaze, changed significantly, within-subjects, over levels of the independent variable of Episode in a manner consistent with positive and negative contrast. Also investigated was whether eye gaze duration varied systematically, between subjects, according to the
quasi-independent variable of Group membership in a dyad characterized by low, medium, or high maternal contingency.

CHAPTER 3: RESULTS

Because of the likelihood of attrition during the procedure in this population and the importance of retaining as much data as possible given the small sample size, missing data were handled by the substitution of group means for the relevant episodes. In this case, the mean proportion of gaze during the episode was entered in place of the missing data. Mean substitution was not necessary for episodes related to the primary hypothesis (i.e., Baseline Play, Still-face, or Still-face Reunion). Only during the last two episodes (i.e., Loud-face and Loud-face Reunion), when it was most likely that infants would experience fatigue or impatience with restraint of the car seat, was the session ended early due to infant discomfort (n = 4).

To determine whether the shape of these data were consistent with the presence of contrast effects, they were subjected to a repeated measures ANOVA. The within subjects test revealed a significant overall difference in infant eye gaze across episodes ($F(5, 190) = 17.807$, $p < .001$). Post hoc simple linear contrasts comparing eye gaze in the baseline Play episode to all subsequent episodes indicated that infants demonstrated significant increase in eye gaze in the Still-face Reunion, relative to the baseline Play ($F(5, 38) = 5.35$, $p < .05$) and significant decrease in the Still-face episode ($F(5, 38) = 16.96$, $p < .05$). The first result supported the first hypothesis: Infants showed a pattern of eye gaze in the Still-face Reunion consistent with positive contrast (See Figure 1).
Infant eye gaze in the Loud-face Reunion episode did not significantly increase above the baseline Play episode ($F(1, 3) = .002, p > .05$). This suggests that an attentional model, where eye gaze in the reunion episodes was a function of infant re-orientation after habituating to the previous episode, is an unlikely fit to the data.

In order to address the possibility that increased gaze during the Still-face Reunion was confounded by increased maternal reward during the base Play (i.e., that it was not a true return to baseline), a series of paired samples t-tests were conducted to compare maternal behaviors encouraging reciprocal infant social behavior (i.e., smile, wide eyes, open mouth, move in close, play a game, and talk) between the baseline Play and Still-face Reunion episodes. No significance was found between the frequency of these behaviors occurring in the two episodes (see Table 2).
The significant overall decrease in eye gaze during the Still-face relative to the baseline face-to-face Play episode suggested a failure of support for the study’s second hypothesis. This was corroborated conducting a 6 (Episode) X 3 (Group) repeated-measures ANOVA ($F(5, 165) = .507, p > .05$), confirming that no significant differences were demonstrated in eye gaze duration during down-shifts in maternal incentive according to the contingency experienced in the dyad (see Figure 2). Thus the second hypothesis of the study, that negative contrast would be a feature particular to infants experiencing low contingency, was not supported.

---

CHAPTER 4: DISCUSSION

The current study investigated infant social behavior for evidence of early learning in the social context. It was presumed that young humans modulate their social interaction in accordance with fluctuating availability of parental incentives in the environment, and do so in a manner that reflects that they track the within-context shifts of both rewarding and stressful interactions.

Support for the study’s first hypothesis, that learning occurs in early social interaction, was suggested by the finding that infants demonstrated an elevated increase (i.e., above what was expected given baseline levels) in eye gaze after a maternal delay. The pattern
of this responding is consistent with other studies that have reported such elevations as positive contrast.

However, the study's second hypothesis, that infant increases and decreases of eye gaze across shifts in maternal incentive would reflect levels of maternal contingency responding, was not supported. Thus infants from dyads characterized by higher levels of noncontingent maternal responses, relative to contingent responses, were not distinguished by negative contrast in the low reward episodes. Instead, the overall response among infants in the sample was significantly decreased eye gaze when mothers' social interaction was degraded. Thus, infants demonstrated behavior changes accompanying shifts in reward magnitude in both a negative and positive direction.

It is unlikely that infants' gaze behavior across episodes was due simply to a series of attentional shifts. If this were the case, similar gaze durations would have been observed in both the Loud-face and Still-face episodes. Similarly, the Still-face Reunion and Loud-face Reunion episodes should have then produced indistinguishable mean levels of infant gaze.

It must be noted that the use of pre-shift values as a control presents problems for the interpretation of results. Given the complementary findings of both depressed and elated eye gaze, the positive contrast suggested here may merely reflect a performance that reached the level of goal-directed responding only in the second play interaction. This is a problem that can present false positive contrast, as subjects increase their facility over the course of successive trials (Spence, 1956). However, it is unlikely that infant eye gaze lacked "training," since face-to-face gaze represents a normative interaction between mothers and infants.
On the other hand, the study suggests that infant gaze during baseline play was not at asymptotic levels. Rather, there was available "behavioral space" for positive contrast to occur. This is especially interesting, given the intermittent, non-regular nature of infant eye gaze that has been suggested to reflect a need to "attend away" (Field, 1981) in order to process the intensity of even normally occurring \textit{en face} interactions. It appears reasonable to posit, then, that the systematic increases in gaze due to an up-shift in maternal reward were nontrivial. Furthermore, non-essential increases of eye gaze seem an unlikely interpretation of the elated gaze in the Still-face Reunion, since gaze is a behavior that seems to reliably increase physiological arousal.

The study attempted to address the objection that an appearance of positive contrast might actually be due to an increase of mother's incentive behaviors, rather than an elevated response with other factors remaining equal. The contribution of discrete, maternal social behaviors to the face-to-face interaction did not appear to be a factor in elevated infant eye gaze duration. Thus the contrast-like gaze patterns seem specific to the infants' functioning in the social interaction, rather than an artifact of up-shifted maternal reward in the Still-face Reunion.

A serious problem for the study is the possibility that infants had different previous exposures to face-to-face play, a threat that was not controlled for in this study. In this case, infant eye gaze may have interacted with prior exposure to practicing the interactional "task." However, given the conformance of infant gaze to behavior predicted by contrast theory, it is more likely that such interactions would have interfered with the appearance of contrast, rather than produce gaze patterns that falsely mimicked contrast effects.
More serious is the fact that, while multiple shifts should increase the interpretability of contrast findings, the Loud-face may have actually been a less-preferred experience for the infant. In this case, it would comprise a situation appropriate for the appearance of negative contrast, and constitute a failure to find negative contrast.

A parallel problem may have been posed by the late appearance of the Loud-face Reunion, coming at the tail end of a long procedure for infants of this age. Without counterbalancing, the current study is inadequate to discern the effects of fatigue upon eye gaze levels in the Loud-face and Loud-face Reunion episodes. Counterbalancing the Still-face and Loud-face episodes would also greatly increase the confidence with which these gaze effects are accepter to reflect contrast.

In addition, alternative explanations for the findings must be considered. The traditional account of decreased infant gaze in the Still-face has been that disorganization of social behaviors, such as gaze, directly reflects the experience of stress (Ciaranello, 1988). This is an entirely possible causal factor of gaze decreases in the current study, but fails to well-explain gaze increases. Perhaps more useful, is a conjecture of 'violation of expectancy' during negatively decreased gaze and 'confirmation of expectancy' during positively increased gaze. However, this brings the discussion around again to contrast, since explanations of symmetrically appearing contrast effects have relied on such formulations (Flaherty, 1996).

An additional issue for the current study is that of the failure of eye gaze contrast to interact with history of contingency experienced by the infant. Given the influence that contingency has demonstrated over infant task performance (Dunham & Dunham, 1990)
and learning (DeCasper & Carstens, 1981), it is noteworthy that no relationship was seen between contrast and history of maternal contingency.

However, it is not possible, given the exploratory nature of the contingency measurement, to conclude that the obtained contingency scores reflected the hypothetical construct in a valid manner. If the concept of contingency, as it has been conceptualized here, is to be validated, future research must examine the occurrence of contingent and noncontingent behaviors in a population of mothers verified to have problems of parenting.

Future research with an exceptional population may also aid in explicating a contradictory finding in the Still-face literature. Studies of maternal interaction have documented both that infant gaze was significantly higher at parents who accepted their topic of interest (Keller & Gauda, 1987) and that infant gaze was significantly higher toward parents with whom the infant was insecurely attached (Malatesta, et al., 1989). Only by measuring infant gaze behavior against clearly understood antecedents of maternal interaction can these disparate findings be reconciled.

The manner by which infants learn about social and emotional information is frequently represented as occurring through cognitive processes, such as category recognition and perceptual analysis. According to this viewpoint, after the beginning of the second year, infants are reported to actively interpret the referential messages of others to extract important information about the surround (Baldwin & Moses, 1996). However, cognitive theories fail to account for how infants may engage in pre-cognitive learning. Such learning would provide support for adaptive behavior about social availabilities that vary widely across family and cultural situation.
The presence of incentive contrast was hypothesized to be least one means of learning available to infants, supporting the retention of information specific to early interaction. Infant social behavior has been described primarily in terms of ongoing exchanges with mothers during face-to-face interaction. However, early dyadic social exchanges are also presumed to be important in the development of behavioral self-regulation (Kopp, 1982). In turn, children's regulatory capacities and willingness to modulate multiple levels of behavior are considered part of the hierarchical behavioral organization that ultimately contributes to later aspects of socialization, such as compliance and emotional regulation (Donovan, Leavitt, & Walsh, 2000).

While the present study was unable to address how learning in the context of immediate maternal reward may reflect past experience within dyadic interaction, it tentatively presents contrast learning as a mechanism by which infants may negotiate ongoing shifts of maternal social availability.
REFERENCES


Beebe, B., Jaffe, J., Feldstein, S., Mays, K., & Alson, D. (1985). Interpersonal timing: The application of an adult dialogue model to mother-infant vocal and kinesic...


Figure 1: Mean proportion of infant eye gaze across Episodes for all infants.
Figure 2: Mean proportion of infant eye gaze across Episodes by Groups.
Table 1: Paired samples $t$-tests comparing mothers' social behaviors in the baseline Play episode with mothers' social behaviors in the Still-face Reunion episode.
<table>
<thead>
<tr>
<th>PAIR</th>
<th>MEANS</th>
<th>SD</th>
<th>SE</th>
<th>t</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Play Smile -</td>
<td>5.433</td>
<td>2.25</td>
<td>.41</td>
<td>.732</td>
<td>.470</td>
</tr>
<tr>
<td>SR Smile</td>
<td>5.133</td>
<td>.41</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Play Eyes -</td>
<td>.97</td>
<td>1.77</td>
<td>.32</td>
<td>-1.13</td>
<td>.266</td>
</tr>
<tr>
<td>SR Eyes</td>
<td>1.33</td>
<td>.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Play Mouth -</td>
<td>2.00</td>
<td>2.52</td>
<td>.46</td>
<td>-3.62</td>
<td>.720</td>
</tr>
<tr>
<td>SR Mouth</td>
<td>2.17</td>
<td>.46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Play Move -</td>
<td>3.90</td>
<td>3.40</td>
<td>.62</td>
<td>-5.91</td>
<td>.559</td>
</tr>
<tr>
<td>SR Move</td>
<td>4.27</td>
<td>.62</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Play Game -</td>
<td>1.67</td>
<td>1.38</td>
<td>.25</td>
<td>1.33</td>
<td>.895</td>
</tr>
<tr>
<td>SR Game</td>
<td>1.63</td>
<td>.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Play Talk -</td>
<td>14.83</td>
<td>4.01</td>
<td>.73</td>
<td>1.73</td>
<td>.094</td>
</tr>
<tr>
<td>SR Talk</td>
<td>13.57</td>
<td>.73</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX I

Dear Parent, November 15, 2000

We are writing from the University of Montana to ask if you would like to join our study about how mothers and infants play together. This study will help us understand mother-infant relationships and how infants grow and change. Most studies usually look at mothers and infants who live in large cities. This study will describe how mothers and infants from smaller cities or rural areas relate to one another.

In this study you will be videotaped playing with your baby like you do at home. This study will take place in the Curry Health Center on the UM campus. It will take about one hour. A thank you gift of ten dollars will be paid to you for your help with this project.

Taking part in this study involves little risk. Your baby may become tired at some point while you are playing. If you think that your baby has “had enough,” you are free to end the session and you will still be given dollars.

After the videotaping, we will ask a short list of questions about your baby’s development, and you will have a chance to discuss any concerns you may have about your baby.

All information about you or your baby will be entered into a computer and known only by a code number. Your name and your baby’s name will never be used in any report of this observation. Your identity will be totally confidential. The videotapes will be kept locked at the University of Montana and used only for research projects or teaching purposes (with your permission). Only code numbers will identify written information and videotapes. The videotapes will be kept for ten years.

We will call in about 3 days to see if you would like to participate. If you have any questions before then, call our supervisor, Dr. Lynne Koester, 243-4003, or Dr. Tony Rudbach at the University of Montana, 243-6670.

Thank you for taking the time to read this letter. We hope you will consider joining us.

Candace Crosby
549-4088

Teresa Kamman
327-9835 (evenings)

Meg Ann Traci
243-4956
APPENDIX II
INSTRUCTIONS TO SUBJECTS: MOTHER-INFANT INTERACTION PROJECT

Face-to-Face Interaction

Mom, we’re going to go through six different types of play. Before each type, I'll give you specific instructions about what to do next. In this first type, play with your baby just as you would at home. In 2 minutes, I'll give you directions about what to do next (2 minutes).

Now, I'd like you to turn and swivel in your chair, to face the wall (30 seconds).

Now I'd like you to turn back to your baby, but don't play with your baby. Just sit facing your baby; and please, no facial expressions, touching, or talking (2 minutes).

Now, go ahead and play with your baby again like you do at home (2 minutes).

For the next few minutes, continue to play with your baby without the use of your voice. Please have fun, but no sounds with your voice (2 minutes).

Now play again with your baby as you do at home (2 minutes).

Free-Play

Mom, there are no special instructions for this session, although, if it’s convenient, somewhere in your play, hold the baby on your lap, have the baby on his/her belly and on his/her back (25 minutes).

Verbal Debriefing

Thank you for helping us with this research. We are studying how mothers and babies play together because it can give lots of information about babies’ first relationships. For example, it will tell us more about how babies learn from their mothers and what mothers do to keep the attention of their baby while they are playing. Do you have any questions about what we did today? Here is a written explanation of our study and numbers you can call if you think of anything else you would like to ask us about in days to come. We also have a list of community resources because some mothers find this a handy list to have available.
APPENDIX III

MATERNAL CONTINGENCY INVENTORY CHECKLIST

I. Instructions to coders

Be prepared to make multiple passes through the tape in order to a) attend to the specific behavior of the mother, but also b) the wider context of the interaction. For example, mother may pleasantly offer her baby something to play with, but if it interrupts the organized, concentrated play of the baby, it is coded as an instance of a noncontingent behavior.

Some tapes will have a full-frame version of one side of the split-screen Floor-play that has been dubbed at the end of the tape. Thus, if a segment of tape is problematic, you may check to see if this extra record of the Floor-play is available.

II. Checklist

Check each instance of the following behaviors as it occurs under “Frequency” and note time-code of onset and off-set under “Duration.” If a particular behavior occurs in a ‘flurry,’ (e.g., mom offers toy intrusively to baby multiple times in the space of one minute) then code each instance as one and record the onset and offset of the whole interactional event.

A. Contingency Inventory

1. Verbal Behavior

☐ Mother comments on child’s behavior as it is ongoing (e.g., mom supports baby’s mouthing behavior by saying “It’s OK to eat it” or by verbally following baby’s activity “You’ve got the pink bunny”). (Passive contingency)

☐ Mother responds to infant’s vocal bids. (Active contingency)

☐ Mother extrapolates ‘language’ from baby’s communication. Mom seizes the opportunity to respond while shaping language. (Passive contingency)

2. Visual Factors

☐ Mom references child before introducing new play. (Passive contingency)

☐ Mom responds to infant visual bid. (Active contingency)

☐ Mother engages infant’s visual interest by going “into” the toy that the baby is already attending to. Mom builds new interest for the baby and ‘asks the question’ of engagement in an elaboration of the thread of play. (Passive contingency)

3. Tactile Factors

☐ Mom responds to tactile bids by baby. (Active contingency)

4. Affective and Attachment Factors

☐ Mother responds to infant’s cry or negative affect. (Active contingency)

☐ Mother responds to infant’s smile or positive affect (Active contingency)
Mother responds to infant’s within-bounds exploration with ‘allowance’ (i.e., this might involve facilitative helping of child’s activity, but score here only if mom assists child-directed behavior, then withdraws for child to continue activity). (Passive contingency)

Mother responds to out-of-bounds exploration with control (Active contingency)

Mother uses opportunities for interaction (e.g., baby sneezes and mother comments upon, makes a game out of. sympathizes, imitates, or otherwise uses baby’s behavior to indicate that she is in attending). (Active contingency)

Mother gets attention of neutral baby. (Active noncontingency)

5. Support and Training of Regulation

Mother stimulates vigorously (this may have a rhythmic quality setting it apart from a behavior like “showing” or “saying” in any modality (i.e., with rattle, demonstrates a stimulating toy, etc.) accompanied by waiting behavior (see below). (Active noncontingency)

Mother makes postural adjustments to enhance possibility of interaction (e.g., mom turns baby, who is lying on back, around so that mother’s face will be perceived by baby as upright). (Passive contingency)

B. Noncontingency Inventory

1. Verbal Factors

Mother does not respond to infant vocal bid. (Passive noncontingency)

Mother interjects verbally as child is actively engaged: But only coded if comment is not related to child’s activity (changes or interrupts baby’s topic). (Active noncontingency)

Mother verbally frames child’s need in a manner contrary to the child’s behavior (e.g., Mom takes neutral object, such as a toy, from baby saying “You don’t need that.” This is distinguished from mom taking dangerous object, such as a small toy part from the baby. The latter instance would be coded as above under contingent ‘Affective Factors: Mother responds to out-of-bounds exploration with control.’). (Active noncontingency)

Mother’s verbal comment on her own lack of care around baby (e.g., bumps baby’s head) is inappropriate or trivializes event. (Extrapolated noncontingency)

Mom comments didactically on toy that baby is not interested in or has not been allowed to interact with. (e.g., “Look, Mickey is a boy and Minnie is a girl.” Without presenting figures for interaction). (Passive noncontingency)

Mother reframes a behavior by her baby into a self-reference (e.g., Baby yawns and mothers refers to her own fatigue). (Passive noncontingency)

2. Visual Factors

Mom does not reference child visually during play. (Extrapolated noncontingency)

Mom does not respond to infant visual bid. (Passive noncontingency)

Mother “crashes” into baby’s space without warning. (Active noncontingency)
3. Tactile Factors

- Mom makes no physical contact with baby during play. (Extrapolated noncontingency)
- Mom does not respond to tactile bids by baby. (Passive noncontingency)
- Mother physically stimulates with no bid from baby. (Active noncontingency)
- Mother's physical movements do not take into account baby's presence (e.g., Score here if mother manipulates toy such that it strikes baby or bumps a desired toy out of baby's reach). (Extrapolated noncontingency)

4. Affective Factors

- Mother does not respond to infant's cry or negative affect or responds without soothing. (Passive noncontingency)
- Mother does not respond to infant's smile or positive affect. (Passive noncontingency)
- Mother responds to infant smile with neutral or negative affect. (Active noncontingency)
- Mother does not allow infant's within-bounds exploration (i.e., this involves use of control over child-directed behavior when it is an appropriate child activity). (Active noncontingency)
- Mother does not respond to out-of-bounds exploration with control (Passive noncontingency)

5. Regulation Factors

- Mother changes toy or game without referencing baby (Active noncontingency).
- Mother interrupts baby's concentration or game (e.g., mom takes baby's hand away from a toy) (Active noncontingency).
- Mother resists or rebuffs infant's attempt to be physically close. (Passive noncontingency)
- Mother performs an activity with no reference or contingency to either the 'playstream' or some other aspect of the environment (e.g., mother comes from behind and starts combing baby's hair while baby is concentrating on something intensely). Mother's behavior occurs randomly without an attempt to integrate it meaningfully into the baby's experience. (Active noncontingency)
SUBJECT INFORMATION AND CONSENT FORM

Principal investigators: Sue Forest, Ph.D., Lynne Koester, Ph.D., Paul Silverman, Ph.D.  
Department of Psychology, University of Montana, Missoula, MT  
406-243-4521

Graduate student project assistants: for more information or to schedule appointments:  
Candace Crosby, 549-4088; Teresa Kamman, 243-6345; Meg Ann Traci, 243-4956

This consent form may contain words or concepts that are new to you. If you have any  
questions, you can ask the person who gave you this form.

Research Purpose  
This study will help us understand mother-infant relationships. It will also help us  
understand how infants grow and change. By simply watching mothers and infants  
playing together, researchers have learned a great deal about parenting and infants. Most  
studies usually describe mothers and infants who live in large cities or metropolitan areas.  
This study will describe how mothers and infants from smaller cities or rural areas relate  
to one another.

Research Procedure  
In this study you will be asked to play with your baby like you do at home. You will also  
be asked to play with your baby without talking. Finally you will be asked to sit quietly  
with your baby. These playful interactions will be videotaped. Later on, researchers can  
then watch the videotapes and keep track of the different ways you and your baby  
interact. When your baby is a few months older, you may be contacted again. We hope  
you will want to participate in our follow-up study.

This study will take place in the basement of the Curry Health Center on the UM campus.  
It will take about one hour.

Participation Payment  
A gratuity of ten dollars will be paid to you for assisting us in this project.

Risks/Discomforts  
Taking part in this study involves minimal risk. Your baby may become tired at some  
point in the study. If you think that your baby has "had enough", you are free to end the  
observation. Simply tell one of the research assistants present in the room. Let them know  
that you think your baby is too tired to continue. Additionally, a research assistant will be  
watching your infant. This research assistant will stop the study if your infant seems too  
unhappy to continue.

Benefits  
You may not directly benefit from taking part in this study. However, it will tell parents,  
day care providers, and doctors more about how to support infant development.
Confidentiality
The videotapes will be kept at a secure and locked location at the University of Montana. Your identity will be kept confidential. Dr. Lynne Koester and Dr. Sue Forest will be responsible for authorizing use of the tapes. The tapes will be used for research projects, as part of research training, and for teaching purposes. Copies of the tapes will not be made for any other purpose. Your name and your baby’s name will never be used in any report of this observation. Only a subject code (i.e., a specific number) will be recorded on all written documents and videotapes. The videotapes will be kept for ten years.

Compensation for Injury
Although we think there is minimal risk involved in this study, the following liability statement is required in all University of Montana consent forms.
In the unlikely event that you are physically injured as a result of this research as a result of negligence of the University or any of its employees, you may be entitled to reimbursement or compensation pursuant to the Comprehensive State Insurance Plan established by the Department of Administration under the authority of M.C.A., Title 2, Chapter 9. In the event of a claim from such physical injury, further information may be obtained for University Legal Counsel (Prepared by University Legal Counsel, March 14, 1986).

Voluntary Participation/Withdrawal
Your decision to take part in this research study is entirely voluntary. You may withdraw from the study at any time. Withdrawal will not affect any community services or gratuity to which you are entitled.

Questions
If you have any questions about the research now or during the study contact one of the principal investigators or assistants listed at the top of this document. If you have any questions regarding your rights as a research subject, you may contact Tony Rudbach at the Research Office, University of Montana, 243-6670.

Subject’s Statement of Consent
I have read the above description of this research study. I have been informed of the risks and benefits involved, and all my questions have been answered to my satisfaction. Furthermore, I have been assured that any future questions I may have will also be answered by a member of the research team. I voluntarily agree to take part and to have my child take part in this study. I understand I will receive a copy of this consent form.

Printed Name of Subject

Subject’s Signature

Date Approved by UM IRB: Sept 1, 2000
Approval Expires on: Aug 31, 2001

IRB Chair
DIRECTIONS FOR CODING MOTHER'S BEHAVIOR

• First, fill in the subject info (tape number), the date and your name.
• Enter a start time and a finish time for the segment where it says “TIME:”
• Write the onset time of each behavior in proper column. This is done so you can reference where in the tape the behavior occurred, and so you can consensus code the tapes.
• Finally, total up the number of behaviors in each category and enter this number at the bottom.

Definitions:

NO SMILE: any time the mother is not smiling at the baby. Be sure to note that just because the mother is not smiling does not necessarily mean she is frowning.

WIDE EYES: any time the mother opens her eyes wide and looks at the baby. It may resemble a look of surprise or interest.

MOVE IN CLOSE: any time the mother moves in closer to the baby. If the mother starts close, and this position stays constant, do not code it as 'move in close'. Only code it if the mother moves in closer.

NO PHYSICAL CONTACT: any time the mother is not touching the baby.

DIRECT ATTENTION ELSEWHERE: any time the mother tries to direct the baby’s attention to another object in the room.

TALK TO BABY: any time the mother speaks to her baby using words (not noises).
Code these even if they are not audible to you. That is, if you know the mom is whispering because you can see her lips moving.
• Will not apply in loud face, the mother has been directed not to use her voice.

MAKE VOCAL NOISE: any time the mother makes a sound with her mouth, which is not a word. This will include clicking with her mouth and “ooh, ah” etc. (Note that this is not a noise made by her hands, which would go under clapping).

CLAP, SNAP ETC.: any time the mother claps, snaps, taps the chair or makes any other noise that seems to be an attempt to get the baby’s attention or entertain the baby.

OPEN MOUTH: any time the mother opens her mouth (may be in combination with wide eyes).

GAME: any time the mother engages in a game with the baby. (e.g. peek-a-boo, patty-cake).

FROWN: any time the mother frowns at the baby, this can also be a brow furrow. This is an expression of negative emotion.

FOLLOW BABY’S ATTENTION: any time the mother follows the baby’s gaze to an object, or displays interest in something the baby has first displayed interest in.

• None of the behaviors should occur during still face because the mother has been directed not to use any facial expression, touching or talking. However, sometimes the mother makes slight facial movements or slips and talks etc. This is why a sheet has been included to code still face behaviors.
• If more than one behavior occurs at a time, record both behaviors in the proper places. For example, a mother might be opening her mouth and doing wide eyes simultaneously.
• Make any relevant notes at the bottom of the coding sheet.
• Some of the columns have an IMITATE area. Enter the onset time there if the mother did that behavior in imitation of the baby.