

The Role of Maternal Affect Mirroring on Social Expectancies in Three-Month-Old Infants

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The role of maternal affect mirroring on the development of prosocial behaviors and social expectancies was assessed in forty-one 2- to 3-month-old infants. Prosocial behavior was characterized as infants' positive behavior and increased attention toward their mothers. Social expectancies were defined as infants' expectancy for affective sharing. Mothers and infants were observed twice, approximately 1 week apart. During Visit 1, mothers and infants were videotaped while interacting over television monitors for 3 min. During Visit 2, infants engaged in a live, 3-min interaction with their mothers over television monitors (live condition) and they also viewed a replay of their mothers' interaction from the preceding week (replay condition). The order of conditions was counterbalanced. Maternal affect mirroring was measured according to the level of attention maintenance, warm sensitivity, and social responsiveness displayed. A natural split was observed with 58% of the mothers ranking high and 42% ranking low on these affect mirroring measures (HAM and LAM, respectively). Infants in the HAM group ranked high on prosocial behaviors and social expectancy—they discriminated between live and replay, conditions with smiles, vocalizations, and gazes. Infants in the LAM group ranked low on these variables—they gazed longer during the live condition than during the replay condition, but only when the live condition was presented first; however, they did not smile or vocalize more. These findings indicate that there is a relation between affect mirroring and social expectancies in infants.

INTRODUCTION

It has been well documented that the quality of mother–infant relationships is important for infants' social, emotional, and cognitive development (Bowlby, 1979; Bruner, 1990; Freud 1940/1949; Stern, 1985; Trevarthen, 1979). In particular, optimal infant–caregiver social interactions facilitate infants' social expectancy or primary intersubjectivity. Optimal social interactions are characterized by sequentially dependent responding (turn taking) between infant and caregiver during which the dyad can achieve a social interactive state in which the infant's optimal level of emotional affect and attention is maintained. Stern (1985) defines such affective interactions as “mirroring” or “empathetic responsiveness” of caregivers to infants' expressions of affect. Infants' social expectancy or primary intersubjectivity is defined as an awareness of shareable feelings, and is presumed to be the consequence of the affective interactions that infants have with their caregivers.

Dysfunctional mother–infant interactions are characterized by a lack of behaviors that encourage sustained optimal levels of interacting (Field, 1995; Seligman, 1975; Watson, 1985). For instance, depressed mothers spend less time looking at, touching, and talking to their infants; show little or negative affect; and often fail to respond contingently to infants' signals. The infants in turn show abnormal activity levels and less positive affect. It appears that because of

frequent exposure to the dysfunctional behavior of their mothers, the infants themselves develop a dysfunctional style of interacting (Field, 1984, 1992, 1995).

As a result of the discoveries of the effects of social interaction on the behavioral organization of young infants, the study of parent–infant interactions has increased in recent years to identify which factors may be responsible for infants' functioning. Laboratory studies in which maternal depression was simulated by asking mothers to assume a “still face” in front of their infants found that when 2- to 3-month-old infants were presented alternately with responsive and unresponsive people (mother and female stranger), infants smiled and vocalized to responsive people but got upset when people refrained from communicating with them. This distress was not a function of a general lack of activity, because infants did not become upset when objects—dolls with faces, partial faces, or no facial features—remained immobile (Ellsworth, Muir, & Hains, 1993; Fogel, Diamond, Langhorst, & Demos, 1982; Legerstee, Corter, & Kienapple, 1990; Legerstee, Pomerleau, Malcuit, & Feider, 1987; Tronick, Als, Adamson, Wise, & Brazelton, 1978). Nor can these findings be explained as resulting from an absence of familiar responses of the mother to which infants had become accustomed, be-

cause infants do not become upset when mothers begin talking to other people (Murray & Trevarthen, 1985).

Researchers began to ask whether the distress of infants may be due to a lack of contingent responding. Parental behavior may be contingent on their own intrusive memories as a result of poverty, abuse, or other unresolved traumatic events, rather than being related to the feelings of their infants (Gergely & Watson, 1999). Consequently, empirical studies on early mother–infant interactions have begun to examine the role that social contingencies in these interactions play on the social behavior of infants (Bigelow, MacLean, & MacDonald, 1996; Hains & Muir, 1996; Legerstee, 1997; Murray & Trevarthen, 1985; Nadel, Carhon, Kervella, Marcelli, & Reserbat-Plantey, 1999; Rochat, Neisser, & Marian, 1998). In a pioneering design, Murray and Trevarthen (1985) investigated infants' sensitivity to maternal social contingencies by varying the parameters of the interaction in infants 3 months of age and younger. Four infants between 6 and 12 weeks of age interacted with their mothers through a closed-circuit TV setup. In the live condition, the infants interacted with their mothers in real time. In the replay condition, the infants were presented with a videotape of their mothers' previous interactions. Thus, although the videotaped segments presented the same amount of smiles, vocalizations, and gestures performed by the mothers as in the live interactions, they were not in response to the infants' social and emotional behaviors. The authors reported that whereas the infants during the live interaction produced high levels of positive affect, they produced high levels of negative affect during the replay condition. Thus, infants discriminated between live and replay conditions. Some researchers proposed that because contingent responding was the only difference between replay and live conditions, infants' distress was related to a lack of social contingency. They suggested that the expectancy for social contingency was a precursor to the understanding of intentions (Gergely & Watson, 1999; Muir & Hains, 1999; Nadel et al., 1999; Rochat & Striano, 1999).

Because of its theoretical significance, many researchers tried to replicate this phenomenon; however, they obtained mixed results. For instance, Bigelow et al. (1996) studied 4-, 6-, and 8-month-old infants in conditions in which interactions with mothers via video were replaced with replays of the mothers' actions. The authors found a decrease in attention over time and a change in facial expressions across the live/replay/live conditions. The infants in the Bigelow et al. study, however, were older than those studied by Murray and Trevarthen (1985). The peak of social interest and responsiveness in infants occurs

around 3 months of age. Legerstee et al. (1987) have provided detailed information on the evolution of infants' responses to interactive and passive people and dolls during the first 10 months of life. They reported that infants' responsiveness to people increased from approximately 5 to 15 weeks. By 17 weeks, when infants became capable of grasping a doll, their displays of affectivity and attention to their mothers decreased. Similar developmental changes have been reported by others studying young infants in this age range (Bruner, 1975; Kaye & Fogel, 1980; Newson & Newson, 1976; Trevarthen & Hubley, 1978). Hains and Muir (1996) also failed to replicate the phenomenon in infants aged 22 to 26 weeks ($M = 23.4$ weeks, $SD = .9$ weeks) when they interacted with their mothers, although the authors replicated the results with infants ranging between 14 and 26 weeks ($M = 20.6$ weeks, $SD = 3.8$ weeks) when they interacted with a stranger. Hains and Muir suggested that infants were not perturbed by the lack of contingent responding during a brief replay condition because, by that age, infants have developed stable expectancies about the interactive styles of their mothers. They further reported that the infants quickly lost interest (a decline in attention), which may have been due to familiarity with the mother. In contrast, when 5-month-old infants interacted with a novel person, the impact of noncontingent stimulation on infant behavior was immediate: "When they received a stranger's noncontingent dynamic facial-vocal display during the first period, infants lost interest and looked away within the first 20 s and displayed little positive affect" (Hains & Muir, 1996, p. 58). The authors proposed that because younger (2- to 3-month-old) infants may not have well-established social relationships with their mothers, lack of contingency would constitute a major violation for these infants.

In a recent study, Rochat et al. (1998) pointed out that the research by Hains and Muir (1996) and Bigelow et al. (1996) used video arrangements that differed from those used by Murray and Trevarthen (1985). Their video arrangements did not allow for eye contact between mothers and infants, nor were the sessions counterbalanced in all studies. This may have suppressed the communicative responses (gazes and happy, negative, and neutral facial expressions) of the infants. Rochat et al. (1998) corrected for these shortcomings by calibrating for infant focal vision. They also matched infants on age and added an additional group to control for order. The infants were presented with 1-min live interactions over video and 1-min replays of different live interactions. Five infants, ranging from 2 months 12 days to 3 months 0 days, failed to discriminate between the replay

and live conditions. The authors then repeated the study with 2- and 4-month-old infants, but also presented these infants with a still-face condition. At both ages, infants discriminated between the still-face and live conditions, but not between the live and replay conditions.

The inconclusive results of these social contingency studies cast doubt on the idea that the perception of contingency is important for prosocial behavior and intersubjectivity. One possible explanation for the inconsistent results might be that infants had different interactional histories. All infants in the preceding studies were exposed to natural interactions, of the social partners. It is possible that some infants may have had histories of more gratifying social interactions, during which social agents responded empathetically as well as contingently to the affective expressions of their infants.

Only one study replicated Murray and Trevarthen's (1985) findings with infants less than 3 months of age. This study showed that when the quality of maternal interaction was controlled, infants demonstrated differential responsiveness to live and replay conditions (Nadel et al., 1999). The authors adopted a three-condition design (live/replay/live) by inserting a seamless shift from the initially live interaction period to a replay period of "good" maternal behavior. This was followed by a seamless shift back to a subsequent live interaction. The authors found that ten 9-week-old infants discriminated between the live and replay conditions: they reacted more negatively to the replay condition than to the two live conditions. The live period varied from 1 to 3 min, depending on the "quality of the first contact" (Nadel et al., 1999, p. 168). Thus, for mothers who provided optimal interactions in this paradigm, infants discriminated between the live and replay conditions. Rochat et al. (1998) did not control for the quality of the social interactions. Thus, it is possible that infants in that study received a noncontingent interaction in the live episode rather than a contingent interaction, and consequently did not differentiate between the live and replay conditions.

The findings of Murray and Trevarthen (1985) and Nadel et al. (1999) showed that infants who experienced positive interactions discriminated between live and replay conditions. This suggests that affect mirroring plays an important role in the development of these abilities. It is proposed that those infants with mothers who rank high on affect mirroring get upset doing the replay condition because there is a lack of affect sharing with their mothers. Conversely, infants of mothers who rank low on affect mirroring do not get upset because they have not become accustomed

to maternal affect mirroring. To assess this hypothesis, studies need to control for affect mirroring as well as contingency. The purpose of the present study was to identify high- and low-affect-mirroring dyads during live interactions, and to investigate the effects of maternal affect mirroring on infants' prosocial behavior and social expectancies. Consequently, maternal behaviors were manipulated using the double TV paradigm (Bigelow et al., 1996; Hains & Muir, 1996; Murray & Trevarthen, 1985; Nadel et al., 1999; Rochat et al., 1998). The different interactive styles of mothers were assessed by measuring the amount of time they spent in affect mirroring of their infants during a 3-min preliminary visit and monitoring infants in another 3-min live interaction with their mothers a week later. If mothers showed similar types of behaviors during Visits 1 and 2, they would be valid indicators of the way mothers usually interact with their infants. It was predicted that high-affect-mirroring (HAM) mothers would have infants who scored high on prosocial behaviors as measured by positive expressions (either vocal or facial) and gazes at their mothers during the social interactions. Conversely, it was predicted that low-affect-mirroring (LAM) mothers would have infants who scored lower on prosocial behaviors during these sessions. In addition, it was proposed that infants with HAM mothers have developed stable expectancies about sharing affective states in face-to-face situations. Consequently, these infants should reduce their positive behaviors when presented with the replay condition, because they notice a lack of affect sharing with their mothers, which violates their expectations. Infants with LAM mothers, on the other hand, may not show a significant change in behavior to the replay conditions because their social interactional history with their mothers has not prepared them to be sensitive to these dimensions. The infants were presented with only one live and one replay condition, because it has been indicated that presenting infants with too many different types of stimulations may interfere with their information-processing abilities (Ellsworth et al., 1993). To control for order, the presentation of the live and replay conditions was counterbalanced.

METHOD

Participants

Sixty infants ranging in age from 82 days to 117 days ($M = 89.6$ days, $SD = 8.1$) and their mothers participated in this study, which was conducted at the Infancy Research Center at York University, Toronto, Ontario, Canada. Each mother-infant pair came in

twice; the two visits were separated by approximately 1 week. All mothers were recruited from a local hospital shortly after the birth of their infant. Of this initial sample, 19 infants were excluded from the study due to excessive crying, sleepiness, or inability to complete the second visit. Thus, a total of 41 infants (18 girls, 23 boys; $M = 93$ days, $SD = 9.05$ days at Visit 1, and $M = 100$ days, $SD = 8.84$ days at Visit 2) were included in the analyses. All infants were healthy and born at term (Apgar ratings of 8–10), and came from lower to upper middle-class families. Socioeconomic status was based on parental occupation. Forty-one percent of the infants had at least one sibling.

Apparatus and Setting

A double closed-circuit television system was used. Infants were seated in an infant seat, approximately 50 cm in front of one of the monitors. In an adjoining room, mothers sat in front of a television monitor tilted at a 90° angle, which projected the image of the infant onto an upright, transparent screen behind which a camera was positioned. The mother sat facing the upright screen and was filmed as she looked at her infant on the screen. Her image was then projected to her infant. Because the lens of the camera filming the mother was positioned directly behind the image of the infant's eyes and the mother was looking at the image of her infant's eyes while she interacted, the infant had full eye contact during the interaction. This setup allowed mothers to watch their infants during the interaction and the infants were able to see a video image of their mother that was full faced and life sized, with full eye contact. The images of each mother or infant were relayed to the opposite monitor via video cameras placed on the top and center of the infant's monitor and behind the mother's transparent screen. Video cameras were focused on both mother and infant and were connected to a video recorder with a special-effects generator to yield a split-screen image of mother and infant. Figure 1 depicts the apparatus and setting.

Procedure

Visit 1. The purpose of the first visit was to acquire a sample of the mothers' interactions for use as stimulus for the replay conditions. Mothers and infants took their respective seats in separate rooms and interacted over the TV monitors. To gain more information about the infants' background, mothers were asked to fill out a form concerning demographic information. Because we were interested in the variation of affect mirroring of nondepressed mothers on

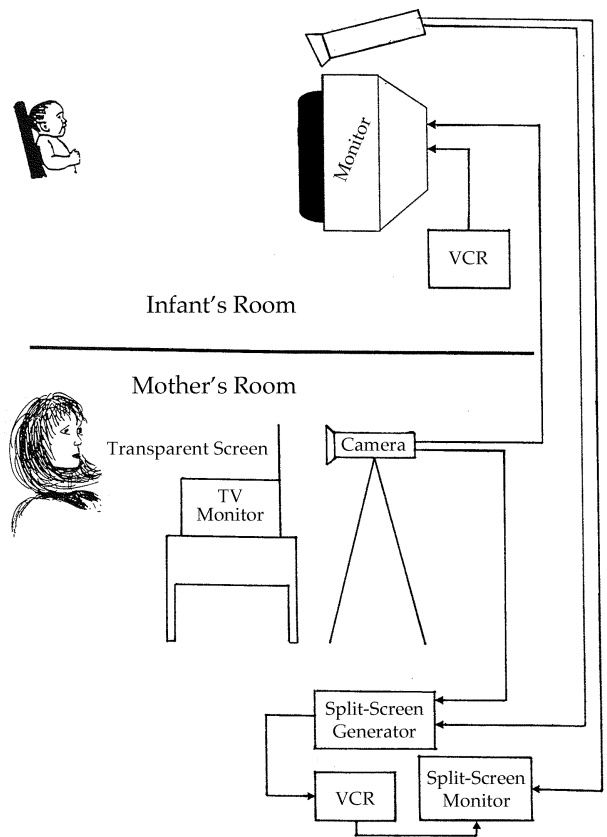


Figure 1 Apparatus and setting.

the behavior of their infants, mothers were screened for possible mood disorders or postpartum depression. Consequently, maternal depression was assessed through the administration of the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mach, & Erbaugh, 1961) and the Edinburgh Postnatal Depression Scale (EPDS; Cox, Holden, & Sagovsky, 1987). The BDI and EPDS were administered 15 min before the interaction of the first visit. Both questionnaires were administered in a waiting room by the experimenter and an assistant.

The 21 BDI items are scored on a 4-point Likert-type scale, which gives an indication of the absence/presence and severity of depressed feelings and behaviors. The BDI is one of the most commonly used instruments in research on nonclinically depressed samples. Further, it has been reported (Cohn, Campbell, Matias, & Hopkins, 1990) that interaction behaviors of depressed mothers are more highly correlated with self-report scores than with diagnostic interview measures. Mothers with a score of 0 through 9 are said to be experiencing no or minimal depression, mothers with scores of 10 through 16 are said to be experiencing

mild depression. It was assumed that mothers who scored between 17 and 29 were experiencing moderate depression. The BDI is not intended as a diagnostic instrument, but rather is best regarded as a screening tool to indicate possible depression (Conoley, 1992).

The EPDS is a 10-item, self-report scale designed to screen for postnatal depression. The EPDS has been found to have satisfactory sensitivity and specificity and is also sensitive to changes in the severity of depression over time (Cox et al., 1987). The scale can be completed in approximately 5 min and is simple to score. Women who score above a threshold of 12 or 13 are most likely to be suffering from a depressive illness of varying severity.

An instant photograph of the mother also was taken during Visit 1 for mothers to take home to remind them to keep their appearances the same for the second visit.

Visit 2. The purpose of the second visit was to determine whether infants could discriminate between the live and the replay conditions. Mother–infant pairs were randomly assigned to receive either the live or the replay condition first. During the live condition, infants and mothers interacted while viewing each other on separate TV monitors in separate rooms for 3 min. In the replay condition, the infants viewed the tapes of their mothers from Visit 1 for 3 min. There was a 5-s break between the two episodes that allowed the experimenter to push the button on the video recorder to either stop the recorder (when replay was first) or start the recorder (when replay was second). To obtain information about maternal interactive styles, their behaviors were recorded during two 3-min, live interactions. We reasoned that this amount of time would enable the partners to become familiar with the situation. In addition, this time span was sufficient to obtain a good sample of the usual interactions that both HAM and LAM mothers have with their children and that both high and low prosocial infants have with their mothers (see Landry, Smith, Miller-Loncar, & Swank, 1998).

Bigelow et al. (1996), Murray and Trevarthen (1985), and Nadel et al. (1999) replaced interactions with mothers via video with replays of the mothers' actions and then presented infants with a live interaction over video again. This procedure allowed the researchers to compare the same maternal sequence in the two conditions: live and replay. Thus, the difference in the behavior of the infants to the live and replay conditions must be a result of the difference in contingency rather than a difference in other behaviors, such as the amount of smiles and vocalizations. To ensure that the possible reduced responsiveness of the infants during the replay condition could not be

attributed to fatigue, researchers in all three studies controlled for order by presenting the infants with another live session (live/replay/live). In the present study, we controlled for order by presenting the infants with a 3-min replay condition of the live video interaction that had been taped the week before, and by counterbalancing the order of presentation of the two episodes. To ascertain that the behaviors of mothers were similar in the two live conditions, smiles, verbalizations, and gazes at their infants were coded in the two conditions.

Behavioral Categories

Table 1 presents the definitions for maternal and infant behaviors.

Maternal behaviors. To obtain information about maternal interactive styles, mothers' maternal affect mirroring was coded during the live conditions. Affect mirroring was composed of three maternal behavioral categories: (1) maintaining attention, (2) warm sensitivity, and (3) social responsiveness. *Maintaining attention* was defined as a maternal request, question, or comment that related to or elaborated on the activity the infant was currently visually engaged with, physically engaged with, or both. Maintaining could also be a maternal request, question, or comment that was in direct response to the infant's attempt to attract the mother's attention to an object or activity, for example, "Are you looking at your socks? Those are very pretty socks!" *Warm sensitivity* was a composite assessment of the degree of sensitivity that mothers displayed to their infants' affective cues, including promptness and appropriateness of reactions, acceptance of the infants' interests, amount of physical affection, positive affect, and tone of voice. Five-point rating scales were used to make global ratings for three separate behaviors: (1) positive affect, (2) warm concern/acceptance, and (3) maternal social responsiveness (Landry et al., 1998). Three ratings were made for each of the behaviors, once every minute of each 3-min live interaction, and an average was calculated for each category. *Social responsiveness* was defined as imitative responses to infants' smiles and vocalizations, and as modulations of infants' negative affect.

Maternal responses during the first (Visit 1) and second (Visit 2) live episodes. To ensure that infants' discrimination between the live and replay conditions was a function of a lack of contingency rather than of smiles, vocalizations, and gazes, the total amount of time mothers produced these behaviors to their infants was coded.

Infant prosocial measures. To assess infants' level of prosocial behavior, three measures were coded during

Table 1 Behavioral Categories

| Category | Definition |
|-----------------------|--|
| Maternal behaviors | |
| Maintaining attention | Maternal directive, question, or comment that was related to the activity or object that the infant was currently visually engaged with, physically engaged with, or both, just prior to the mother's request, or was in direct response to the infant's attempt to attract her attention to an object or activity |
| Warm sensitivity | Degree of sensitivity mothers displayed to infants' cues, including promptness and appropriateness of reactions, acceptance of infants' interests, amount of positive affect, and tone of voice |
| Social responsiveness | Mothers' imitative responses to infants' smiles and vocalizations, and as modulation of infants' negative affect |
| Gazes | All gazes mothers directed at their infants' faces lasting longer than 2 s |
| Smiles | Happy facial expression of mothers consisting of a smile and further creasing of the nasolabial fold (Ekman & Friesen, 1975), lasting longer than 2 s |
| Vocalizations | All verbalizations and utterances of mothers (e.g., matching of infants' vocal sounds, etc.) |
| Infant behaviors | |
| Gazes at mother | Looks at mother for more than 2 s |
| Smiles | Raised eyebrows and raised corners of the mouth, with the mouth either open or closed |
| Negative expression | Furrowed brow, pouting (i.e., corners of the mouth turned down), or both |
| Melodic vocalization | Relatively long vocal sounds with varied pitch contours and oral resonance |

the live interaction condition: (1) gazes at mother, (2) smiles, and (3) melodic vocalizations.

Infant social competency measures. To determine whether infants would discriminate between the replay and live conditions, four measures were coded independently and in real time: (1) gazes at mother, (2) smiles, (3) negative facial expressions, and (4) melodic vocalizations. Direction of gaze was coded as "gazes at mother" when infants looked at their mothers for at least 2 s. Smiles were defined as raised eyebrows and raised corners of the mouth, with the mouth either open or closed. Negative facial expressions consisted of a furrowed brow, pouting (i.e., corners of the mouth turned down), or both. Melodic vocalizations were defined as relatively long vocal sounds with varied pitch contours and oral resonance—discrete, voiced sounds occurring within one aspiration. Wheezes, sneezes, coughs, and cries were not included in the vocalization count.

Interrater Reliability

Two coders coded the frequency and duration of infants' and mothers' behaviors. Coding began when infants and mothers looked at each other and discontinued after 3 min. Coding was performed separately for each behavior and in real time. On- and offset times of the variables were indicated using a video recorder with an internal time generator. The time gener-

ator imposed a clock directly onto the tapes to aid in determining the length (in seconds and minutes) of conditions and behaviors. One observer coded all the sessions, whereas the second observer coded 30% of the sessions to assess reliability. Kappas were .82 for gazes, .88 for smiles, .80 for negative expressions, and .85 for melodic vocalizations. Kappas for maternal behaviors were .83 for maintaining attention, .80 for warm sensitivity, and .80 for social responsiveness. In comparing maternal behaviors between the live and replay conditions, κ s were .80 for smiles, .85 for vocalizations, and .93 for gazes at infant. The second observer was trained to 90% reliability with an experienced trainer and was unaware of the hypotheses and the mothers' affective state.

RESULTS

Mood Disorder Scales

All mothers scored between 0 and 12 on the BDI, with a mean score of 3.79 ($SD = 2.95$). In a normal population, scores greater than 15 indicate possible depression. All mothers scored between 0 and 14 on this scale, with a mean score of 3.56 ($SD = 2.80$). In a normal population, scores of 14 or greater indicate possible depression. Performance on the BDI scores and the EPDS scores correlated significantly, $r(39) = .67, p < .001$.

High- and Low-Maintaining Mothers

To divide mothers into high-maintaining and low-maintaining groups, their scores on maintaining were rank ordered. A natural split was observed in these scores such that 58% of mothers were in the high-maintaining group and 42% were in the low-maintaining group. Score percentages for the high-maintaining group ranged from 90.56% to 100%. Score percentages for the low-maintaining group ranged from 39.44% to 87.22%.

Relation between Maintaining and Warm Sensitivity

To determine whether there was a relation between maternal maintaining attention and maternal warm sensitivity, a correlational analysis was performed between scores on maintaining and scores on warm sensitivity. Results of this analysis showed a significant correlation between maintaining attention and warm sensitivity, $r(39) = .62, p = .01$.

Relation between Maintaining and Social Responsiveness

To find out whether maintaining correlated with social responsiveness, a correlational analysis was conducted on the scores of maintaining and those of social responsiveness. Again, the correlation was significant, $r(41) = .34, p = .03$.

High and Low-Affect-Mirroring Mothers

As the data indicate, mothers who ranked high on maintaining attention also ranked high on warm sensitivity and social responsiveness. Those mothers who ranked high on maintaining, warm sensitivity, and social responsiveness were labeled the HAM group and those that ranked low on these variables were labeled the LAM group.

Relation between Maintaining and Mood Disorder Scales

To determine whether there was a relation between maternal mood state and maternal interactive styles, a correlational analysis was performed between (1) maternal scores on the BDI and maternal scores on maintaining attention, and (2) maternal scores on the EPDS and maternal scores on maintaining attention. The results of these analyses were not significant.

Maternal Responses during Live and Replay Episodes

The maternal behaviors in the live and replay episodes (gazes, smiles, and vocalizations) were correlated. There was a significant correlation between gazes in the live ($M = 97.56\%$, $SD = 4.04\%$) and replay ($M = 97.34\%$, $SD = 3.61\%$) episodes, $r(39) = .50, p = .002$. There also was a significant correlation between smiles in the live ($M = 62.26\%$, $SD = 30.63\%$) and replay ($M = 63.51\%$, $SD = 31.74\%$) episodes, $r(39) = .74, p < .001$. Finally, there was a significant correlation between vocalizations in the live ($M = 90.98\%$, $SD = 8.81\%$) and replay ($M = 88.18\%$, $SD = 11.93\%$) episodes, $r(39) = .64, p < .001$.

Subgroups of Infants

The two groups of infants were randomly assigned to receive either the live or the replay condition first. Ages of the four subgroups of infants at Visit 2 were as follows: Group 1A: HAM-live/replay ($n = 14, M = 101.7$ days, $SD = 8.96$ days, $range = 82$ – 117 days); Group 1B: HAM-replay/live ($n = 9, M = 97.4$ days, $SD = 6.8$ days, $range = 88$ – 108 days); Group 2A: LAM-live/replay ($n = 9, M = 97.7$ days, $SD = 7.01$ days, $range = 88$ – 113 days); Group 2B: LAM-replay/live ($n = 9, M = 102.8$ days, $SD = 9.64$ days, $range = 90$ – 116 days).

All scores for both maternal and infant behaviors were converted to percentages because two infants had sessions that were 15 and 20 s shorter than the rest of the group, respectively. Table 2 presents the mean proportional durations and standard deviations of infant behaviors in response to HAM and LAM mothers as a function of condition.

Prosocial Behavior

To determine whether infants of HAM mothers scored higher on prosocial behavior than infants of LAM mothers, three t tests were performed between maternal interactive styles and each of the following infant behaviors: (1) gazes at mother, (2) smiles, and (3) melodic vocalizations. The first test showed that infants whose mothers ranked higher on affect mirroring gazed longer at their mothers than infants whose mothers ranked lower on affect mirroring, $t(39) = 5.203, p = .05$. The second test revealed that infants whose mothers ranked higher on affect mirroring smiled significantly more than infants whose mothers ranked lower on affect mirroring, $t(39) = 2.564, p = .016$. The third test showed that infants of HAM mothers produced more melodic

Table 2 Mean Proportional Durations and Standard Deviations of Infant Gazes, Smiles, Negative Expressions, and Melodic Vocalizations by Condition to HAM and LAM Mothers

| Condition | HAM Mothers | LAM Mothers |
|-----------------------|-------------|-------------|
| Gazes | | |
| Order 1 ^a | | |
| Live | | |
| M | 52.90 | 40.00 |
| SD | 7.23 | 19.83 |
| Replay | | |
| M | 43.80 | 26.17 |
| SD | 14.41 | 16.10 |
| Order 2 ^a | | |
| Replay | | |
| M | 50.87 | 45.37 |
| SD | 11.53 | 12.13 |
| Live | | |
| M | 54.25 | 28.87 |
| SD | 6.71 | 17.31 |
| Smiles | | |
| Live | | |
| M | 14.43 | 4.83 |
| SD | 16.92 | 5.31 |
| Replay | | |
| M | 7.26 | 7.78 |
| SD | 12.13 | 11.35 |
| Negative expressions | | |
| Live | | |
| M | 1.35 | 4.27 |
| SD | 3.52 | 11.42 |
| Replay | | |
| M | 1.82 | 2.18 |
| SD | 2.68 | 3.48 |
| Melodic vocalizations | | |
| Live | | |
| M | 4.20 | .55 |
| SD | 5.36 | .91 |
| Replay | | |
| M | .79 | .33 |
| SD | 1.40 | .59 |

Note: HAM = high-affect-mirroring; LAM = low-affect-mirroring.

^aThe effect for order was not significant for smiles, negative expression, or melodic vocalizations.

vocalizations than infants of LAM mothers $t(39) = 3.206, p = .004$.

Infants' Ability to Discriminate between Live and Replay Conditions

To evaluate the effects of maternal interactive styles on infants' ability to discriminate between the live and replay video conditions, infants' gazes at mother, smiles, negative faces, and melodic vocalizations were submitted to a repeated-measures three-way ANOVA. In this analysis, group (HAM, LAM) and order of conditions were the between-subjects

factors and condition (live and replay) was the within-subjects factor. A significant Order \times Group \times Condition interaction for gazes $F(1, 37) = 5.822, p = .02$, and subsequent post hoc analyses indicated that infants of the HAM mothers gazed at their mothers significantly longer during the live condition than during the replay condition $F(1, 21) = 6.06, p = .02$, regardless of the order of presentation of the conditions (see Figure 2). Infants of the LAM mothers gazed at their mothers significantly longer during the live condition than during the replay condition when the live condition was presented first, $F(1, 16) = 5.32, p = .031$. When the replay condition was presented first, however, infants gazed at their mothers for a significantly less period of time during the live condition than during the replay condition, $F(1, 16) = 16.89, p = .001$.

The effect for order was not significant for smiles, melodic vocalizations, or negative expressions. Consequently, these infant behaviors were submitted to a repeated-measures two-way ANOVA, in which group was the between-subjects factor and condition was the within-subjects factor. A significant Group \times Condition interaction for smiles, $F(1, 39) = 7.118, p = .011$, revealed that infants of HAM mothers smiled significantly more during the live condition than during the replay condition, whereas infants of LAM mothers did not show significant differences in smiling during the live and replay conditions (see Figure 3). This result was confirmed by a simple effects analysis $F(1, 39) = 8.150, p = .007$. A second significant Group \times Condition interaction for melodic vocalizations, $F(1, 39) = 6.624, p = .014$, revealed that infants of HAM mothers produced significantly more melodic vocalizations during the live condition than during the re-

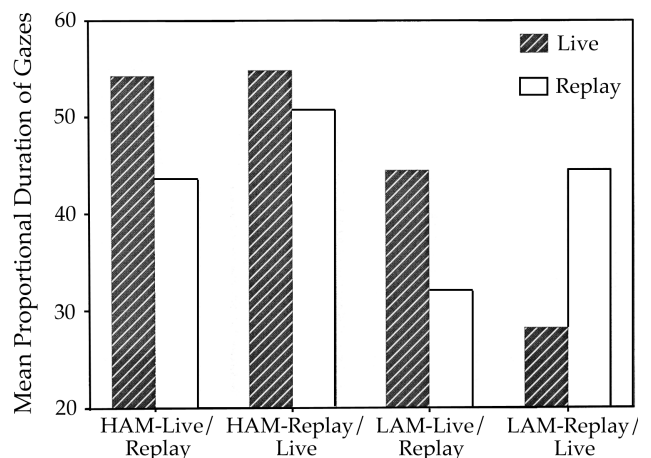


Figure 2 Mean proportional duration of infant gazes to high-affect-mirroring (HAM) and low-affect-mirroring (LAM) mothers during live and replay conditions by order of presentation.

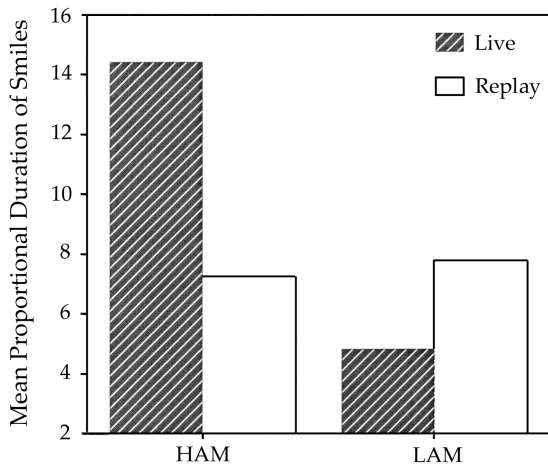


Figure 3 Mean proportional duration of infant smiles to high-affect-mirroring (HAM) and low-affect-mirroring (LAM) mothers during live and replay conditions.

play condition, whereas infants of LAM mothers did not show significant differences in melodic vocalizations during live and replay conditions (see Figure 4). This result also was confirmed by a simple effects analysis, $F(1, 39) = 17.209, p = .001$. No significant differences were found for negative expressions. This result, however, may be explained by previous research that has shown positive affect to be a primary index of social/emotional competence and a stronger indicator of discrimination between reciprocal and nonreciprocal social contexts than the expression of negative affect (Hains & Muir, 1996).

In summary, although there appeared to be no de-

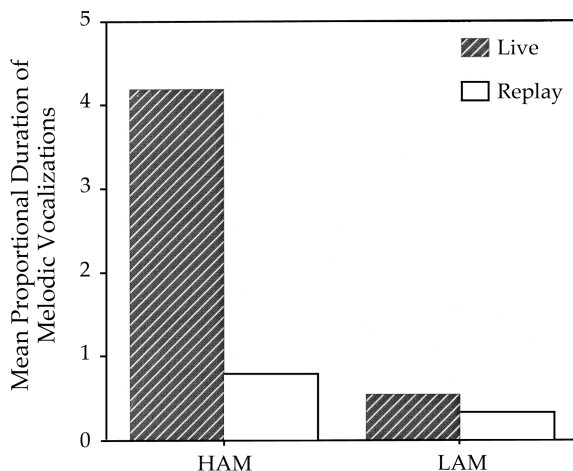


Figure 4 Mean proportional duration of infant melodic vocalizations to high-affect-mirroring (HAM) and low-affect-mirroring (LAM) mothers during live and replay conditions.

pressed mothers in this study, mothers could be divided into two groups in terms of their interactive styles. HAM mothers maintained the attention of their infants, and ranked high on warm sensitivity and social responsiveness, whereas LAM mothers scored low on maintaining the attention of their infants and scored low on warm sensitivity and social responsiveness. Infants of the HAM mothers displayed more positive behaviors and gazed longer at their mothers than did infants of the LAM mothers, and they scored higher on social competence because they discriminated between the live and replay conditions. When the live condition was presented first to the HAM group, 10 out of the 14 infants (71.43%) gazed at their mothers longer and smiled more, and 7 out of 14 (50%) produced more melodic vocalizations during the live than during the replay condition. When the live condition was presented second, the trend remained the same. Five out of 9 infants (55.56%) gazed at and vocalized more to their mothers during the live than during the replay condition, and 6 out of 9 infants (66.67%) smiled more.

Infants in the LAM group scored lower on social competence because they looked consistently longer during the first episode (either live or replay), and they did not differentiate with their smiles and melodic vocalizations between the live and replay episodes. When the live condition was presented first, 5 out of 9 (55.56%) infants gazed at their mothers longer and smiled more, and 2 out of 9 (22.22%) infants produced more melodic vocalizations during the live than during the replay condition. When the live condition was presented second, however, a completely different pattern was noted. None of the infants increased the amount of time they gazed at their mothers during the live condition after having been presented with the replay condition, and only 3 out of 9 (33.33%) infants smiled more, and only 1 out of 9 (11.11%) produced more melodic vocalizations.

DISCUSSION

This study was conducted to assess the effects of differences in maternal affect mirroring on levels of prosocial behaviors and on social expectancies in 3-month-old infants. Prosocial behavior was characterized as infants' high levels of positive affect (smiles and vocalizations) and increased attention toward their mothers during live interactions. Social expectancy was defined as the ability to discriminate between the live and replay conditions of their mothers. We predicted that mothers who exhibited high levels of affect mirroring would have infants who would join or participate in this interpersonal communion

(Stern, 1985) and would rank high on prosocial behaviors (smiles, melodic vocalizations, and gazes directed at mother). On the other hand, we predicted that, mothers who displayed low levels of affect mirroring would have infants who ranked low on prosocial behaviors. These hypotheses were confirmed. The results showed that 3-month-old infants are highly sensitive to maternal affect mirroring. Infants who had mothers who ranked high on maintaining attention, warm sensitivity, and social responsiveness, appeared to reflect back this maternal affect because they smiled, cooed, and gazed more at their mothers than infants whose mothers ranked low on these behaviors. It was further argued that infants who ranked high on prosocial behaviors would rank high on social expectancies. These infants have been exposed to more empathetic interactions during which affective states are shared, and therefore should discriminate between the live and replay conditions. This hypothesis was also confirmed. Infants who ranked high on prosocial behaviors also ranked high on social expectancy because they discriminated with their responses (smiles, melodic vocalizations, and gazes) between the live and replay conditions. Interestingly, the infants of HAM mothers reduced their levels of smiles, melodic vocalizations, and gazes in the replay condition, regardless of the presentation order. This supports the idea that during the live episode, infants were sharing affective states with their mothers rather than matching their mothers behavior because during the replay condition, even when mothers displayed the same amount of smiles and vocalizations, infants reduced their positive affect. The responses of the infants of LAM mothers revealed a completely different pattern. These infants did not distinguish between the live and replay conditions with their levels of smiles and melodic vocalizations. This does not mean, however, that these infants were not able to discriminate contingencies, because when presented with a live interaction first, infants of LAM mothers detected a change in the replay condition and reduced the amount of time they gazed at their mothers. Additionally, when these infants were presented with the replay condition first, they reduced the amount of time they gazed at their mothers in the subsequent live condition and appeared to avoid further interaction. This suggests that certain social contexts (such as interactions with HAM mothers), allow infants to form stable expectancies for a sharing of affect, whereas other contexts, such as interactions with LAM mothers, do not, because these mothers are not consistent in their affect sharing. Field (1995) proposed the unresponsive-mother model, which allows for an interpretation of these results. In this model, in-

fants of responsive and sensitive mothers develop a sense of control or efficacy, whereas infants of insensitive mothers experience behavioral disorganization and lack of control and efficacy. This model would predict that if infants in the HAM group are presented with a change in the behavior of their mothers (such as a replay condition first), they would reduce positive affect, but they would not give up trying to interact with their mothers in the subsequent live episode because these infants have developed stable affective relationships with their mother that results in efficacy. If infants in the LAM group receive the replay condition first, however, they would withdraw and show a kind of learned helplessness (Seligman, 1975) in the subsequent live interaction because they have not consistently experienced a synchrony of affect and attention of their mothers, and consequently would lack efficacy.

It should not be surprising that prosocial infants discriminate between the live and replay conditions, because the live condition mirrors the history of affective sharing to which infants of HAM mothers have become accustomed. Our results support the findings of other laboratory studies examining the effect of maternal social responsiveness on very young infants' development (Murray & Trevarthen, 1985; Nadel et al., 1999), and also of studies conducted in more natural play situations (Bornstein & Tamis-LeMonda, 1989; Brazelton, Koslowski, & Main, 1974; Hobson, 1993; Landry et al., 1998; Stern, 1985). These researchers have shown that a parenting style that is responsive and sensitive to children's signals results in infants that rank high on social and cognitive competence.

Many studies investigating the effects of the quality of mother-child interactions have examined the impact of maternal depression on infant behavior (Campbell, Cohn, & Myers, 1995; Cohn et al., 1990; Field, 1984; Murray, Fior-Cowley, Hooper, & Cooper, 1996). As the present study shows, however, mothers who are not diagnosed as depressed may show maladaptive patterns while interacting with their infants. These nondepressed mothers were divided into HAM and LAM mothers who ranked either high or low on their attentional and affective behavior and social responsiveness. The results indicated that even the microdysfunctions of nondepressed mothers, such as their lack of mirroring of the affective states of their infants, have an effect on the social and cognitive behaviors of their infants.

The present findings seem to suggest that infants are highly sensitive to social contingencies. Other research (Bigelow, 1998; Hains & Muir, 1996; Legerstee, 1997; Watson, 1985) has supported the fact that very young infants have this ability. Those studies, how-

ever, did not clarify whether infants responded to contingency or to affect mirroring, because the two were confounded in those studies' design. Maternal responsiveness can be contingent and can be demonstrated by mirroring affect. In contingent responding, people react to one another. During affect mirroring, however, infants are sharing affective states with their mothers. Recall that infants in both the HAM and LAM groups looked longer at their mother during the live condition than during the replay condition when the live condition was presented first, but that only the HAM children produced significantly more smiles and vocalizations during the live condition. This suggests different bases for the responses; looking may indicate attention (presence of a contingency), whereas smiles and vocalizations have a potential social significance (affect sharing; Legerstee, Anderson, & Schaffer, 1998). The findings that infants in both groups reduced the amount of time they gazed at their mothers from live to replay conditions but that only infants in the HAM group reduced their levels of positive affect suggest that both groups reacted to a change in contingencies, but that infants of HAM mothers reacted to a lack of affect sharing by reducing their own affective behaviors.

What are the implications of the detection of social contingencies for an understanding of the intentions of people? It may be that the perception of contingencies is important for the development of certain aspects of social cognition, but this does not seem sufficient to explain an understanding of intentions. Primates are very skillful at analyzing social contingencies, but they do not develop an understanding of their conspecifics as intentional, whose affective states can be shared (Tomasello, 1999). The infants of HAM mothers in the present study, however, were not only reacting to contingencies but were also sharing affective states with their mothers. This finding has important implications for the origins of intentions because affect sharing requires infants to be aware of their own affective states as separate from those of others (Bruner, 1983; Hobson, 1993; Karmiloff-Smith, 1993; Stern, 1995; Tomasello, 1999; Trevarthen, 1979). Empirical findings support the idea that infants make independent contributions to interpersonal social exchanges. It appears that even before infants are 3 months old, they match the affective states and behaviors of caregivers, engage in dialogues, and expect others to engage in mutual turn-taking with them (Brazelton et al., 1974; Hobson, 1993; Legerstee, 1991; Trevarthen, 1979; Tronick, 1989). Affective states (smiles, vocalizations, gestures, etc.) are social signals that provide information about another person's intentions as well as a direction for one's own actions

(Walker-Andrews, Montague, & Kahana-Kalman, 2000). It would follow that mothers who provide more information about their own intentions have infants who may begin to act intentionally themselves and understand intentions in others sooner than infants of mothers who do not provide such information.

In summary, the present results suggest that by 3 months, infants are social creatures who, in addition to perceptually discriminating between contingent and noncontingent interactions, understand something about the social message parents deliver, because they reflect this message back to them. Mothers who display positive affect to their infants have infants who display positive affect in return. It has been argued that these findings are evidence of primary intersubjectivity, an awareness of shareable feelings rather than the result of imitation or contingency. Sharing of affect is presumed to be the consequence of (1) an understanding infants have that they are similar to others, and (2) the subsequent affective interactions they engage in with their caregivers.

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