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Maternal Depressive Symptoms and 6-Month-Old Infants' Sensitivity to Facial Expressions

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We examined 6-month-old infants' abilities to discriminate smiling and frowning from neutral stimuli. In addition, we assessed the relationship between infants' preferences for varying intensities of smiling and frowning facial expressions and their mothers' history of depressive symptoms. Forty-six infants were presented pairs of facial expressions, and their preferential looking time was recorded. They also participated in a 3-min interaction with their mothers for which duration of both mother and infant gazing and smiling were coded. Analyses revealed that the infants reliably discriminated between varying intensities of smiling and frowning facial expressions and a paired neutral expression. In addition, infants' preferences for smiling and frowning expressions were related to self-reports of maternal depressive symptoms experienced since the birth of the infant. Potential implications for social cognitive development are discussed.

The ability to discriminate facial expressions is essential in interacting with and understanding the intentions of others. Research shows that as young as 2 to 3

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months of age, infants reliably discriminate a range of static facial expressions such as happiness, sadness, anger, fear, and surprise (e.g., Barrera & Maurer, 1981; Caron, Caron, & Myers, 1985; LaBarbera, Izard, Vietze, & Parisi, 1976; Ludemann, 1991; Serrano, Iglesias, & Loeches, 1995; Young-Browne, Rosenfield, & Horowitz, 1977). Sensitivity to variations in facial expressions is a necessary precursor to recognizing the meaning behind others' emotions and in predicting how people will behave in the future (Walker-Andrews, 1997). Substantial evidence suggests that discrimination and meaningful recognition of facial expressions occurs during early infancy (e.g., Camras & Sachs, 1991; Ludemann & Nelson, 1988; Serrano, Iglesias, & Loeches, 1992; Sorce, Emde, Campos, & Klinnert, 1985). What is not known, however, is what factors may underlie individual differences in infants' sensitivity to these affective stimuli.

In one of the few studies to consider such individual difference factors, Kuchuk, Vibbert, and Bornstein (1986) examined the experiential correlates of 3-month-old infants' sensitivity to varying intensities of static smiling faces. In that study, infants viewed a graduated series of smiling facial expressions that varied in intensity. The infants were found to discriminate between different levels of smiles. In addition, duration of looking time at smiling facial expressions was related to mothers' interactive style. Specifically, infants whose mothers more often encouraged attention to their face while they were smiling showed a stronger preference for higher intensities of smiles. Interestingly, the relationship between an infant's preferential looking and the mother's encouraging the infant's attention to her face was most pronounced for those mothers who displayed relatively low amounts of smiling during a home observation. This study suggests that the ability to discriminate between facial expressions is evident for infants by the age of 3 months, but also that infants' preferences for affective facial expressions may be influenced by mothers' interaction styles.

Kuchuk et al. (1986) speculated that infants might be more likely to display a stronger preference for emotional expressions when their attention is directed toward expressions that they do not frequently encounter. This interpretation is particularly intriguing with respect to the affective styles of depressed mothers. Compared to nondepressed controls, depressed mothers display more flat affect, more negative facial expressions, and fewer positive facial expressions toward their infants during interactions (e.g., Cohn, Matias, Tronick, Connell, & Lyons-Ruth, 1986; Field, 1992; Field et al., 1985). Given that infants of depressed mothers are less likely to be exposed to smiling facial expressions, in cases in which the attention of these infants is directed toward smiles we would expect that they would display a greater preference for these affective stimuli. Given the propensity for depressed mothers to display both more flat affect and more negative facial expressions, it is not clear whether infants of these mothers would have a greater or lesser preference for frowning stimuli.

Mother and infant interaction behaviors have been examined in relation to maternal depressive symptoms. Studies focused on this topic have noted that both

depressed mothers and their infants evidence less positive facial expressions and a more depressed mood style (Field, 1984, 1992). No studies to date have specifically examined whether infants of depressed mothers are more likely to attend to their mothers when they are smiling.

The goal of this study was to extend the findings reported by Kuchuk et al. (1986) and, in particular, to assess the potential role of maternal affective style in young infants' early preferences for smiling and frowning facial expressions. Specifically, our hypotheses were that, during a preferential looking task, (a) all infants would discriminate smiling and frowning from neutral expressions and (b) infants whose mothers reported a history of depressive symptoms would show a greater preference for smiling facial expressions than for paired neutral expressions. In addition, during a mother–infant interaction task, (c) mothers reporting more depressive symptoms would smile and gaze less at their infants and their infants would (d) smile and gaze less at their mothers and (e) look more at their mothers when their mothers were smiling. Finally, we explored preferences for frowning stimuli in relation to maternal depressive symptoms.

METHOD

Participants

Forty-six infants were included in the final sample (23 males and 23 females; *M* age of 180 days; range = 90–210 days). An additional 12 infants were tested but excluded from the analyses because of technical problems ($n = 3$), or because (due to fussiness or distractibility) they did not look at both monitors either during all four levels of frowns or all four levels of smiles that were presented ($n = 9$). Mothers and infants, who were mostly non-Hispanic Whites, were recruited from a database containing names of mothers who had expressed interest in participating in research with their infants. The mothers had responded to a mailed solicitation sent to neighborhoods in proximity to the Emory University Early Development Laboratory in Atlanta, Georgia, or to advertisements in a local newspaper, shortly after the birth of their infant. All infants were full term (>38 weeks gestation). Families were given a T-shirt for participating in the study.

General Procedure

There were three phases of the study that took place in the following order: a preferential looking phase, a face-to-face interaction phase, and a questionnaire phase. We present the methodology of these phases separately.

Phase 1: Preferential Looking Phase

Apparatus and set-up. As shown in Figure 1, infants were seated on their mother's lap on a chair facing two 14-in. color monitors, approximately 3 ft in front of them. The stimuli were simultaneously displayed on each monitor via a Macintosh computer. Mothers wore opaque sunglasses and were requested to remain still to ensure that they did not bias their infant's visual attention in any way. The lights were dimmed to capture the infant's attention toward the computer monitors and to avoid other visual distractions. Between the television monitors, a zoom-lens video camera recorded the infant's gaze toward the monitors. A second camera was positioned behind the infant and recorded the stimulus output from the monitors. The two images were synchronized with a digital video mixer and simultaneously recorded on a videocassette recorder. This image was also fed to third monitor (Monitor C) that was not visible to the infants. Two experimenters were present for testing. They sat behind the two monitors facing the infant. Occluders made of Styrofoam were positioned behind the two monitors so that the infant was not visually distracted by the experimenters. One experimenter (E1) presented the stimuli to infants by activating the computer. The second experimenter (E2) observed the infant on Monitor C and indicated to the other experimenter when to present the stimulus trials.

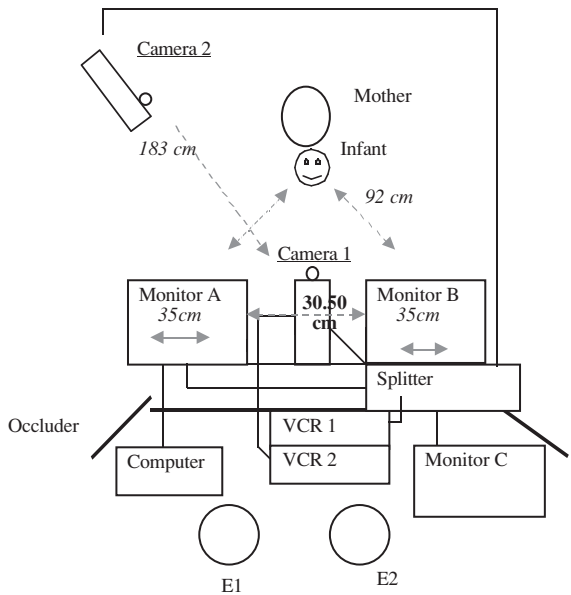

FIGURE 1 The experimental setup.

FIGURE 2 The neutral and four intensities of smiling and frowning expressions.

Stimuli. Two series of slightly smaller than life-size photographs taken of a female's face were used in the study. The "Smiling" series of photographs included a neutral expression and four smiles ranging from a slight smile with slightly upturned corners of the mouth and wide open eyes to a toothy smile with crinkled eyes. The "Frowning" series of photographs included a neutral expression and four frowns ranging from a slight frown with downward corners of the mouth and wide open eyes to an extreme frown with downward corners of the mouth and eyes crinkled. Following Kuchuk et al. (1986), in pilot testing we asked 10 adult participants to arrange the two series of photographs in order of intensity of expression. Adults systematically ranked the intensity of these expressions in the order shown in Figure 2.

Procedure and design. Infants were presented with a total of 18 preferential looking trials. Trials were presented in two separate blocks, one for the Smiling series and one for the Frowning series. Each pair of expression pictures within a block was presented twice to infants. In addition, to assess any side preference, a neutral–neutral trial was presented in each block of trials. A one-sample t test revealed no difference in the tendency for the infants to look to the right or the left monitors on these neutral–neutral trials, $t(45) = 1.12$, $p = .27$. There were four orders of presentation, with each intensity appearing once on each side. The blocks and presentation of particular intensities within a block were also randomized.

At the start of each trial presentation, E2 reorientated the infant by shaking a rattle attached to a rod between the two monitors. Once the infant's attention was oriented to the center of the monitors the experimenter removed the object and signaled to E1 to present the trials by pressing a key on the computer. The trial began

immediately and lasted for 10 sec, which was calculated by the computer program. When the trial ended the monitors were dark, and the same procedure was repeated again for each trial. The time between test trials was 2 to 4 sec on average.

Coding and reliability. Based on video records, the percentage of total time that infants gazed at each monitor was recorded. Videotapes were coded by an observer, blind to the hypotheses, using a computerized event recorder. While viewing the online video recording of the infant and pressing a particular key of a computer, the observer activated the channels of the event recorder. The coders were able to see a trial's onset and offset when the monitors lit up with the stimulus presentation, but they could not determine which expressions were presented to the infant on any given trial, given the resolution of the stimulus on the video image (the stimuli appeared as two solid white spots that could not be discriminated on any basis).

For reliability, a second independent observer coded a random 20% of all infants. The Cohen's kappa coefficient, based on 1-sec intervals, was .84.

Phase 2: Mother–Infant Interaction

Following the preferential looking phase, mothers and infants engaged in a 3-min face-to-face interaction. In this phase, mothers were instructed to interact as they normally would, without touching their infant. Infants were seated in a standard car seat that was secured on a chair. Infants were placed approximately 0.3 m away from their mother, who was seated in a chair facing the infant at eye level. One camera filmed the infant's face and entire body, and a second camera filmed the mother's face and torso. These two images were fed into the split-screen generator and video recorder used in the preferential looking phase.

Coding and reliability. Video recordings of the view of the infant and mother were coded by two naive observers using a computerized event recorder (see previous section). Watching the interaction tape together, one observer coded mother behaviors while the other simultaneously coded infant behaviors during a single coding pass. The coding program generated percentage time duration for all coded behaviors and also calculated percentage duration of one behavior within the occurrence of another behavior. The coding pertained to the occurrence of the following behaviors, operationally defined as: Gazing: look toward social partner's face; Smiling: cheeks raise and sides of the mouth turn up. The percentage of time duration for each measure was calculated and used in the analyses. In addition, from the coding of gazing and smiling, we included another measure, infant gazing while mother smiling: the percentage of time that infants gazed at mother during the times that she smiled.

Interobserver reliability. Reliability between the two independent coders was assessed for 20% of dyads by having them switch who they were observing (mother vs. infant) and recode the interaction. For all measures Cohen's kappa coefficient, based on 1-sec intervals, was above .81.

Phase 3: Maternal Depressive Symptomatology

Mothers completed a modified version of the Inventory to Diagnose Depression (IDD), a 22-item questionnaire that assesses for symptoms of depression according to *Diagnostic and Statistical Manual of Mental Disorders* criteria (Zimmerman, Coryell, Corenthal, & Wilson, 1986). The IDD has been found to have excellent concurrent validity, with significant correlations noted between the IDD and other self-report depression scales, such as the Beck Depression Inventory ($r = .87$; Zimmerman et al., 1986). It has also been found to have high internal consistency and good test–retest reliability (Zimmerman et al., 1986). Instead of reporting symptoms in the past 2 weeks, mothers were instructed to report symptoms experienced (for a duration of 2 weeks or more) since the birth of their infant. The internal reliability of this modified IDD was high for our sample (Cronbach's $\alpha = .91$).

Coding. The number of symptoms endorsed on the IDD ranged from 0 to 16, with a mean of 4.37 and a standard deviation of 4.43. Inspection of our sample's scores on this measure revealed a non-normal distribution in terms of positive and significant skewness (34.8% of the participants had a score of 0 or 1; skewness = .99, $z = 2.82$, $p < .05$). This non-normal distribution necessitated a transformation of the IDD measure for its use in parametric data analyses. We transformed the IDD scores in the following manner: 0 = 0 ($n = 13$), 1 to 3 = 1 ($n = 12$), 4 to 6 = 2 ($n = 9$), 7 to 10 = 3 ($n = 7$), 11 to 16 = 4 ($n = 5$). The result of this transformation was an ordinal measure of maternal depressive symptoms, with less extreme skewness (skewness = .45, $z = 1.28$, $p > .05$) that could be analyzed without violating the assumptions of linear regression techniques.

RESULTS

All statistical tests were evaluated using an alpha level of .05, and two-tailed tests, when applicable. Our ordinal measure of maternal depressive symptoms was examined using linear regression techniques. We included in our sample ($n = 46$) all of the infants who had either looked at both monitors for all four levels of frowns ($n = 41$) or who looked at both monitors for all four levels of smiles ($n = 40$). Preferential looking analyses were examined for these two overlapping but distinct groups. One mother–infant pair did not have mother–infant interaction data (due

to a technical malfunction), and so analyses of interaction data were performed for the remaining 45 participants in the sample.

Maternal Depressive Symptoms and Infant Age and Gender

Maternal depressive symptoms were not significantly correlated with infant age ($r = .02$, $p = .89$) or infant gender ($r = –.05$, $p = .75$). Despite the small effect size of these relationships, all analyses concerning maternal depressive symptoms included statistical controls for infant age and gender.

Preferential Looking

For each trial pair, we created a difference score between percentage of time looking at the smiling or frowning expression and the percentage of time looking at the paired neutral expression. Thus, positive difference scores indicated longer time looking at the smiling or frowning expression. Because each pair of stimuli was presented twice across the 18 trials, mean difference scores were calculated for the two presentations of each level of smiling and frowning and its paired neutral expression.

One sample *t* tests comparing mean expression difference scores to zero for each stimulus pair indicated that infants reliably discriminated each expression from its neutral counterpart (see Table 1).

Face-to-Face Interaction and Maternal Depressive Symptoms

Multiple regression analyses controlling for age and gender found that our ordinal measure of maternal depressive symptoms was not significantly related to mother

TABLE 1
Mean Difference Scores as a Function of Smiling and Frowning Expressions

Expression	*Intensity*	*Mean Difference Score (SD)*	*t*	*p*
Smile ($n = 40$)	1	8.01 (22.25)	2.27	.02
	2	9.01 (22.23)	2.56	.01
	3	7.07 (21.50)	2.07	.04
	4	10.85 (25.70)	2.67	.01
Frown ($n = 41$)	1	20.07 (25.43)	5.05	.0001
	2	11.64 (32.91)	2.26	.029
	3	14.05 (24.41)	3.68	.001
	4	9.02 (27.57)	2.09	.04

gazing, $\Delta F(1, 41) = .00$, $p = .92$, $\Delta R^2 = .00$, or mother smiling, $\Delta F(1, 41) = 1.77$, $p = .19$, $\Delta R^2 = .04$, during the mother–infant interaction. Our ordinal measure of maternal depressive symptoms was also not significantly related to either infant gazing, $\Delta F(1, 41) = .59$, $p = .45$, $\Delta R^2 = .01$, or infant smiling, $\Delta F(1, 41) = .00$, $p = .99$, $\Delta R^2 = .00$, during the mother–infant interaction.

A final analysis of mother–child interaction examined the relationship between maternal depressive symptom level and the infant's tendency to look at the mother when she was smiling. Multiple regression analyses controlling for age, gender, mother smiling time, and infant gazing time found that maternal depressive symptoms were positively and significantly related to an infant's duration of looking at his or her mother while she was smiling, $\Delta F(1, 39) = 7.25$, $p = .01$, $\Delta R^2 = .04$. Specifically, each increase in a (recoded) category of depressive symptoms was associated with an increase of 3.92% in the percentage of time infants looked at their mothers while they were smiling.

Relation Between Maternal Depressive Symptoms and Preference for Affective Facial Expressions

Multiple regression analyses (controlling for age and gender) were used to assess the relationship between our ordinal measure of multiple depressive symptoms and infants' preference for facial expressions. Separate multiple regression analyses were performed for each distinct level of smiling stimuli and each distinct level of frowning stimuli. In addition, two additional multiple regressions were performed—one examining the relationship between maternal depressive symptoms and average difference scores for the four smiling stimuli, and the other examining the relationship between maternal depressive symptoms and average difference scores for the four frowning stimuli (Table 2). Maternal depressive symptoms were significantly related to the average difference score for the four levels of smiles, but not the average difference score for the four levels of frowns. Maternal depressive symptoms were also positively and significantly related to infants' preferential looking at the highest level but not the other levels of frowns, and marginally related to the highest level but not the other levels of smiles.

DISCUSSION

In accordance with our hypotheses, 6-month-old infants reliably discriminated between various intensities of smiling and frowning facial expressions and a paired neutral expression, looking proportionally longer at the affective expressions compared to the neutral faces. This result is not surprising given evidence that infants are able

TABLE 2
Maternal Depressive Symptoms and Preferential Looking at Affective Facial Expressions.

Expression	*Intensity*	*(df)*	ΔF	*p*	ΔR^2
Smile ($n = 40$)	All (mean)	(1, 36)	6.82	.01	.15
	1	(1, 36)	0.31	.58	.01
	2	(1, 36)	1.65	.21	.04
	3	(1, 36)	0.08	.79	.00
	4	(1, 36)	3.78	.06	.09
Frown ($n = 41$)	All (mean)	(1, 37)	2.28	.14	.06
	1	(1, 37)	0.23	.64	.01
	2	(1, 37)	0.44	.51	.01
	3	(1, 37)	0.05	.82	.00
	4	(1, 37)	6.41	.02	.15

Note: In all analyses, the first block included the entry of age and gender as statistical controls and ΔF and ΔR^2 refer to the second block of analyses in which the maternal depressive symptoms variable was entered.

to discriminate varying levels of smiling intensities by the age of 3 months (Kuchuk et al., 1986). Our article extends this general finding to 6-month-old infants' discrimination of varying intensities of frowning stimuli.

We also hypothesized that maternal depressive symptomatology would be negatively related to maternal and infant smiling and gazing during a mother–infant interaction task. These hypotheses were not supported in our study. Our results run counter to previous findings that depressed mothers and their infants display less positive facial expressions and a depressed mood style in face-to-face interactions (Field, 1984, 1992). One likely explanation for our nonsignificant findings is that our particular measure of maternal depression was not specifically a measure of current symptoms. We used a modified version of the IDD, where higher scores represented more maternal depressive symptoms since the birth of the child. Mothers with high scores on this measure may or may not have been experiencing depressive symptoms at the time that they participated in our study. Current maternal depression rather than a history of maternal depression might be more likely to be related to infant and mother behaviors observed during mother–infant interactions.

The primary aim of our study was to examine whether maternal depressive symptom history was related to young infants' preference for smiling facial expressions. We found that a history of maternal depressive symptoms was positively correlated with longer duration of infants gazing at mothers while they smiled. Furthermore, mothers' depressive symptoms experienced since the birth of the infant were related to infants' preference for static pictures of smiling facial expressions. Infants whose mothers experienced higher levels of depressive symptoms manifested greater looking preference for the smiling stimuli in general, and a trend for

a preference for the most extreme smiling stimuli in particular. These findings are consistent with those of Kuchuk et al. (1986) and extend their results to the area of maternal depressive symptom history. It appears that history of maternal depressive symptomatology is related to an infant's preference for smiling stimuli. One possible explanation for this result is the salience of smiling expressions to these infants. It is conceivable that due to the flatter affect of their more depressed mothers, these infants would not have been exposed as much to high-intensity facial expressions and might be more likely to look longer at presumably more novel, smiling faces.

The salience hypothesis may also explain why infants of mothers reporting more depressive symptoms would also show a visual preference toward the most extreme frown stimuli. That is, a preponderance of flat affect displayed by their mothers might make any type of affective stimuli more novel or salient to them. Given the fact that exposure to frowns would also be expected to be greater for infants of mothers with a history of depressive symptoms, this result could also be seen as nonintuitive. Future studies are needed to determine whether this finding is replicable and, if so, what its meaning might be.

Our study was hampered by two important methodological and sampling weaknesses. First, our measure of maternal depressive symptomatology was modified from its original format. We modified the IDD to better reflect an infant's complete experiential history with maternal depressive symptoms. Our results suggest that this modified measure may have some predictive utility in relation to infants' preference for affective stimuli. Nevertheless, our measure did not differentiate between current and past symptoms and is not buttressed by validity and reliability testing.

A second weakness of our study is that it was focused on a convenience sample, that is, a sample that lived close to our testing laboratory. Although we did not measure the socioeconomic status levels of our participants, general community characteristics suggest that our sample may be skewed toward the higher end of the socioeconomic status stratum. It is not clear how socioeconomic status might moderate our findings or whether our findings would generalize to other samples of lower socioeconomic status levels.

This research shows that infants' preference for facial expressions is moderated by their mothers' depressive symptom history, although the meaning and ontogeny of such preferences remains to be established.

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