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Facial Expressivity at 4 Months: A Context by Expression Analysis

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Abstract

The specificity predicted by differential emotions theory (DET) for early facial expressions in response to 5 different eliciting situations was studied in a sample of 4-month-old infants (n = 150). Infants were videotaped during tickle, sour taste, jack-in-the-box, arm restraint, and masked-stranger situations and their expressions were coded second by second. Infants showed a variety of facial expressions in each situation; however, more infants exhibited positive (joy and surprise) than negative expressions (anger, disgust, fear, and sadness) across all situations except sour taste. Consistent with DET-predicted specificity, joy expressions were the most common in response to tickling, and were less common in response to other situations. Surprise expressions were the most common in response to the jack-in-the-box, as predicted, but also were the most common in response to the arm restraint and masked-stranger situations, indicating a lack of specificity. No evidence of predicted specificity was found for anger, disgust, fear, and sadness expressions. Evidence of individual differences in expressivity within situations, as well as stability in the pattern across situations, underscores the need to examine both child and contextual factors in studying emotional development. The results provide little support for the DET postulate of situational specificity and suggest that a synthesis of differential emotions and dynamic systems theories of emotional expression should be considered.

Researchers use many tasks to elicit facial expressions in infants, including tickling, arm restraint, aversive-tasting substances, and presentation of a jack-in-the-box or a masked stranger (Bendersky, Alessandri, & Lewis, 1996; Braungart-Rieker & Stifter, 1996; Fox & Davidson, 1986; Ganchrow, Steiner, & Daher, 1983; Kochanska, Coy, Tjebkes, & Husarek, 1998; Rosenstein & Oster, 1988; Scarr & Salapatek, 1970; Skarin, 1977; Sroufe & Wunsch, 1972; Steiner, 1979). Infants' responses to these distinct contexts serve as a critical source of evidence for the presence of emotions during the first few months of life. Little research, however, has systematically documented the variety of facial expressions young infants exhibit in response to such a diverse set of situations.

Studying facial expressivity in response to varied stimuli may have important implications for emotion theory. Are there relatively unique sets of facial expressions for a given context or situation, or are the same expressions present across situations but perhaps serving different functions (e.g., smiling can be exhibited in the service of pleasure, embarrassment, or fear and submission; Lewis & Michalson, 1983)? To strengthen inferences about the meaning of particular facial expressions at early ages, it is crucial to observe the full range of contexts in which infants produce the expressions (Camras, Malatesta, & Izard, 1991). In

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addition, the study of emotional expressions without attention to context may result in misinterpreting the meaning or function of such expressions (Fernandez-Dols & Carroll, 1997; Lewis, 1978, 1997; Lewis & Michalson, 1983; Zivin, 1989). Most important, the examination of infants' facial expressions across contexts permits researchers to test assumptions of emotion theory, including a key assumption of differential emotions theory (DET; Izard, 1977; Izard & Malatesta, 1987).

DET proposes that situations produce in a biologically fixed fashion a set of discrete facial expressions (e.g., joy, surprise, anger, disgust, fear, and sadness), each with unique adaptive functions and each representing discrete emotional states in young infants. Differential emotions theorists state that specificity exists between situations and emotional responses, and that such specificity is present from a very early age (Izard & Malatesta, 1987). A predominant, prototypic expression (e.g., anger) is hypothesized to be the most common response to a distinct elicitor (e.g., arm restraint). In addition to demonstrating such intrasituational specificity (i.e., that a particular expression is most prevalent in response to a particular elicitor), intersituational specificity also must be demonstrated (i.e., the predicted expression should be more prevalent in response to the predicted elicitor than to other elicitors; e.g., anger expressions should be more prevalent in response to arm restraint than in response to a jack-in-the-box). Infants' specific emotional responses, including facial expressions, to sets of such eliciting situations are believed to have functional significance for self-regulation and recruitment of motivation in others.

Although several studies have examined infants' facial expressions in response to situations, only limited evidence of situational specificity exists. For example, in a review of the extant literature, Camras et al. (1991) found that anger expressions appeared to be the most prevalent expression in response to many negative elicitors that had been studied among infants, whereas sadness expressions were not a common response to any elicitor. However, Camras (1992) did report more sadness and disgust-related expressions (e.g., upper-lip lifting) than anger expressions when her infant daughter consumed sour-tasting vitamins. Yet facial distress and lip pursing, rather than the DET-specified disgust expressions per se, are generally reported in response to sour substances (Kochanska et al., 1998; Rosenstein & Oster, 1988; Steiner, 1979). Furthermore, several facial expressions are not typically seen in situations expected to elicit them (e.g., surprise in response to an object permanence task; Camras, 1992) or may be seen in nonpredicted situations (Camras, Lambrecht, & Michel, 1996). Similarly, the same expressions may be present across multiple, diverse situations, counter to the DET specificity hypothesis (Hiatt, Campos, & Emde, 1979).

There are several limitations to these studies that need to be addressed before we can reject the DET specificity hypothesis. First, many studies have not used codes that assess emotional configurations at the level of anger, sadness, and disgust, making it difficult to infer the degree to which such expressions were present (Kochanska et al., 1998; Rosenstein & Oster, 1988; Sroufe, Waters, & Matas, 1974; Steiner, 1979). Second, relatively few studies have assessed multiple facial expressions in multiple contexts. Third, those that have assessed multiple expressions in multiple contexts are limited by their use of older infants (e.g., Hiatt et al., 1979, and Kochanska et al., 1998, observed 8- to 12-month-old infants) or small samples (e.g., Camras, 1992; Hiatt et al., 1979, observed fewer than 30 infants), the assessment of contexts that primarily included mother–infant interaction (Camras, 1992; Izard et al., 1995), or the assessment of only those expressions that were most expected in a given context (Kochanska et al., 1998; Steiner, 1979). Similarly, often only a single facial expression has been assessed across multiple contexts, producing an incomplete description of an infant's facial expressiveness (e.g., Provost & Gouin-Decarie, 1979; Scarr & Salapatek, 1970; Stenberg, Campos, & Emde, 1983).

Implicit in the study of a single, perhaps predominant expression is the assumption that there is little variability of emotional expressions present within each context. This is problematic, as the approach of a stranger, for example, is often used to elicit fear but may actually elicit a wide variety of expressions, including joy, surprise, and interest (Bretherton & Ainsworth, 1974; Langlois, Roggman, & Rieser-Danner, 1990; Lewis & Michalson, 1983; Skarin, 1977). Studies assessing both expected and unexpected expressions allow for more comprehensive model building, as hypotheses regarding the presence of unexpected expressions can be addressed (e.g., Lewis, Sullivan, Ramsay, & Alessandri, 1992). Collectively, these limitations make it difficult to conclude that DET-predicted situational specificity for facial expressions is lacking during early infancy. Hence, the primary goal of this study is to examine the predicted specificity of multiple facial expressions across a diverse set of contexts. Four months is an important age at which to examine specificity, as DET posits that specific, discrete emotional expressions are present during early infancy (Malatesta-Magai & Izard, 1991).

To support DET's hypothesis of situational specificity, we would expect to observe (a) joy expressions to be most prevalent in response to tickling, (b) surprise expressions to be most prevalent in response to a jack-in-the-box, (c) anger expressions to be most prevalent in response to arm restraint, and (d) fear expressions to be most prevalent in response to a masked stranger. Given the mixed results of prior studies using sour-tasting substances, we did not have a clear hypothesis regarding which expression would be most prevalent, although we did hypothesize that it would be an expression of negative valence (e.g., anger or disgust). To test for predicted specificity, we sought evidence for both intrasituational and intersituational specificity.

Female infants have been shown to exhibit greater negative affect and interest expressions in interactions with their mothers (Malatesta, Culver, Rich-Tesman, & Shepard, 1989; Malatesta & Haviland, 1982; Matias & Cohn, 1993; Mayes & Carter, 1990; Stoller & Field, 1982; Weinberg, Tronick, Cohn, & Olson, 1999). However, some studies have failed to find sex differences (Cohn & Tronick, 1983; Izard et al., 1995; Matias & Cohn, 1993; Mayes, Bornstein, Chawarska, Haynes, & Granger, 1996), whereas others have found sex differences to be mediated by parental affect during relational interactions (Carter, Mayes, & Pajer, 1990; Weinberg et al., 1999). Sex differences in infants' facial expressivity have been examined less frequently in response to emotion-eliciting situations outside of mother–infant interaction. An exception found male infants to show more pain, and female infants more anger, in response to inoculation at 4 months (Izard, Hembree, & Huebner, 1987). Other studies using negative situations such as inoculation and arm restraint, however, have failed to find sex differences during infancy, challenging the presence of sex differences in facial expressivity during early infancy (Braungart-Rieker & Stifter, 1996; Worobey & Lewis, 1989). Given the inconsistent presence of sex differences, we did not have a specific hypothesis regarding sex differences in response to the five situations used in this study.

The purpose of this study was threefold. First, we wanted to examine the predicted specificity of facial expressions across each of five situations among a sample of 4-month-old infants. Given the generally modest number of infants participating in prior studies, we used a large sample to increase the likelihood of detecting even modest differences in expressivity across and within situations. Second, we wanted to examine whether male and female infants exhibit different patterns of facial expressivity in response to a diverse set of situations. Finally, we wanted to explore the degree of stability in facial expressions across situations.

METHOD

Participants

The sample of 150 infants (80 boys, 70 girls) and their biological mothers were recruited for a longitudinal study of emotional development. Participants for this study were unexposed control subjects from a study on the developmental effects of prenatal cocaine exposure (see Bendersky & Lewis, 1998). Pregnant women attending participating hospital-based prenatal clinics, or newly delivered women in the three hospitals in Trenton, New Jersey, or at the Medical College of Pennsylvania in northwest Philadelphia were approached. Of these, 82% agreed to participate in the study. Informed consent was obtained at this time. Infants were excluded from the study if they were born prior to 30 weeks of gestation (only 3 infants were born prior to 37 weeks), required special care or oxygen therapy for more than 24 hr, exhibited congenital anomalies, were prenatally exposed to cocaine, opiates, or phencyclidine in utero, or if their mothers were infected with HIV. Mothers were predominantly African American (87%), with 9% White and 3% Hispanic. Mothers' median education level was 11th grade (*SD* = 1.5), and 57% of families received Aid for Dependent Children. Mothers ranged in age from 13.7 to 42.1 years (*M* = 23.5, *SD* = 5.7). Participation was voluntary, and incentives were provided in the form of vouchers for use at local stores. Scheduling of appointments at 4 months was done using ages corrected for prematurity. Infants were a mean age of 19.1 weeks, corrected age, at the time of the study (range: 15.9–36.0 weeks; *SD* = 2.6). Mean gestational age was 39.7 weeks (range: 30–43 weeks; *SD* = 1.7). All infants lived with their biological mothers.

Procedure

For each situation, infants were placed in an infant seat situated at eye level across from the examiner. Mothers were seated in the room but outside of their infants' field of sight and were thus unavailable for referencing. Mothers were instructed to talk to and to calm their infants between each situation; the next situation was not initiated until the infant appeared calm and recovered from the previous stimulus (approximately 1 min on average). During each situation, the examiner maintained a neutral facial expression (except where otherwise indicated; see later) and refrained from comforting the infant. Although rare, the situation was discontinued if the infant became highly upset. The next situation was initiated only after the infant was calm. The entire session was recorded on videotape. Infant's face and upper body were filmed in close-up, at an angle such that a full face to three-fourths profile was recorded throughout the episode. Situations were administered in the same order for each infant, as described next.

Tickle—The examiner smiled and talked pleasantly for 6 sec and then gently tickled the infant's sides and abdomen for 9 sec. The examiner stopped tickling but continued smiling and talking to the infant for another 6 sec before getting up. Infants' expressions were coded during the 9 sec of tickling plus 1 additional sec after the examiner ceased tickling. The mean number of scorable seconds was 9.3 (range: 2–10; *SD* = 1.6).

Sour taste—The examiner, sitting across from the infant, gently placed a cotton swab soaked with lemon juice into the infant's mouth and removed it after 3 sec. After 15 sec, the examiner got up. Coding was done for the 10 sec following removal of the cotton swab. The mean number of scorable seconds was 9.6 (range: 4–10; *SD* = 1.1).

Jack-in-the-box—The examiner sat across from the infant with the jack-in-the-box at the infant's eye level. After the jack popped up, the examiner waited 9 sec, then, once the infant was calm and looking at the box again, rewound the toy and repeated the procedure. A third trial of the same procedure was then administered. Coding was conducted for each of the

three 9-sec periods that immediately followed the Jack popping up. The mean number of scorable seconds was 25.6 (range: 8–27; *SD* = 3.9).

Arm restraint—The examiner, silent and not looking at the infant, gently held the infant's forearms down, close to the infant's body. After 30 sec of holding or the infant's becoming very distressed, the examiner released the infant's arms. The mean number of scorable seconds was 25.0 (range: 2–30; *SD* = 6.7).

Masked stranger approach—A female adult, wearing a white hockey mask, slowly entered the room for 3 sec, stopped 4 m away from the infant, and paused for 5 sec. The stranger then walked slowly toward the infant for 2 sec, stopped 1 m away, and paused for 5 sec. The stranger then sat in a chair across from the infant and gently touched the infant for 15 sec. The stranger then got up, turned, and left the room. Coding was conducted for the complete 30-sec procedure, starting when the examiner entered the room and concluding when she stopped touching the infant. The mean number of scorable seconds was 25.6 (range: 5–30; *SD* = 5.9).

Dependent Measures

Facial expressions—Facial expressions were coded for joy, surprise, anger, disgust, fear, sadness, interest,1 neutral, not codeable (i.e., facial expression components that were not consistent with any emotion code), and not scorable codes (e.g., infant moved head to side or camera out of focus) using the Maximally Discriminative Facial Movement Coding System (MAX; Izard, 1983,1995). With the volume off, positions of the brows, eyes, and mouth were coded for 1-sec intervals from videotape. Facial expressions were then identified using MAX coding rules and some combinatorial rules that we added:

1. If two of the three facial regions were consistent with an expression, then that expression was assigned.
2. Any blend of interest with another emotional expression was coded as the other expression (see Haviland & Lelwica, 1987).
3. For other blends (e.g., anger/sadness), we used the code for the upper region of the face as the code for the expression.
4. To control for the position of the head and eye, which may inflate the prevalence of certain expressions (e.g., interest and surprise) when infants gaze upwards (Camras et al., 1996; Michel, Camras, & Sullivan, 1992), any second during which infants gazed upwards was coded as not scorable.

Coders were trained to achieve an intercoder agreement correlation coefficient within 1 sec of at least .85. Duplicate coding of 10% of the sample indicated the following reliability coefficients for the presence of each expression (Cohen's κ; Cohen, 1960): joy = .70, surprise = .47, anger = .80, disgust = .19, fear = −.09, and sadness = .33. These values indicate substantial interrater agreement for joy and anger expressions, moderate agreement for surprise expressions, fair agreement for sadness expressions, and slight or poor agreement for disgust and fear expressions (Landis & Koch, 1977). Reliability coefficients for the proportion of seconds that each expression was present are as follows (intraclass correlation coefficients; Shrout & Fleiss, 1979): joy = .66, surprise = .83, anger = .97, disgust = .16, fear = −.08, and sadness = .14.

[1]Because interest expressions are ubiquitous in novel situations (Camras et al., 1991; Izard et al., 1995; Sullivan, Lewis, & Alessandri, 1992), we expected (and found) high rates of interest expressions across all situations and hence did not include interest expressions in the specificity analyses.

RESULTS

Facial Expressions Across Stimulus Situations

Table 1 presents, by situation, the number of infants exhibiting each of the six facial expressions. As expected, each facial expression was present in each situation; however, the number of infants exhibiting each individual facial expression differed significantly ($p < .001$) across situations (see Cochran *Q* values, Table 1). Joy expressions were most common during tickle and least common during the sour taste, arm restraint, and jack-in-the-box situations. Surprise expressions were most common in response to the jack-in-the-box, arm restraint, and masked-stranger situations. Anger expressions were most common during arm restraint and sour taste, and least common during the tickle and jack-in-the-box situations. Disgust expressions were rare, but were most common during the sour taste situation. Although only 22 infants exhibited a disgust expression in response to the sour taste, it was not uncommon to observe a grimace, or fleeting nose wrinkling and compressed lip movements (i.e., MAX codes 42 and 62) in this situation. However, these movements were often very mild and did not reach MAX criteria for a disgust expression. Fear and sadness expressions were most common during the relatively negative situations (i.e., sour taste, arm restraint, and masked stranger).

Facial Expressions by Situations

Table 2 presents the rank order for the number of infants exhibiting each facial expression for each situation. The *Q* values indicate that the frequency of expressions within each situation differed significantly for each of the five situations. Also, the pattern of facial expressions differed somewhat by situation. Joy and surprise expressions were most common, and the four negative expressions least common, in response to tickling. Sour taste elicited more sadness expressions among infants than any other expression. In contrast, prior research has generally found anger expressions to be the most common response to an aversive situation. Given this unexpected finding, we examined the hypothesis that anger expressions may evolve into sadness expressions as the intensity of the distress dissipates (Camras, 1992). We found little support for this hypothesis, however, as only 7 of the 25 infants who exhibited an anger expression later exhibited a sadness expression during the sour taste condition.

Surprise and joy expressions were most common, and negative expressions least common, in response to the jack-in-the-box, arm restraint, and masked-stranger situations, indicating a relative preponderance of positive expressions during these situations.

Sex Differences

No sex differences were found, as boys and girls were similarly apt to exhibit each expression in response to each situation.

Individual Stability of Facial Expressions Across Situations

Individual infants' tendency to display the same facial expressions across situations was examined next. Some stability was observed, as infants who displayed, for example, joy expressions in response to one situation were more likely to display joy expressions in response to other situations (Kendall's coefficient of concordance, based on the proportion of time each expression was present; $W = .21$, $p < .001$). Similarly, infants who displayed surprise ($W = .18$, $p < .001$), anger ($W = .06$, $p < .001$), disgust ($W = .09$, $p < .001$), fear ($W = .04$, $p < .001$), and sadness ($W = .18$, $p < .001$) expressions in response to one situation were more likely to display these expressions in response to other situations.

DISCUSSION

This study indicates that young infants exhibit a variety of facial expressions in response to a given situation. We hypothesized that infants would exhibit high rates of joy expressions during tickle. This was confirmed, as more infants exhibited joy expressions than any other expression. Furthermore, joy expressions were not the most common response to any other situation, indicating that the predicted specificity was found for joy expressions. Second, we hypothesized that a negative expression such as anger or disgust would be the most common response to sour taste, but we did not anticipate that the most common expression would be sadness. Third, we hypothesized that surprise expressions would be the most common response to a jack-in-the-box. Whereas surprise expressions were the most common response to the jack-in-the-box, they were also the most common expression in response to the arm restraint and masked stranger situations, indicating a lack of intersituational specificity. Fourth, we hypothesized that anger expressions would be a common response to arm restraint. This was not confirmed, as more infants exhibited surprise expressions and essentially the same number exhibited joy expressions. Finally, we hypothesized that fear expressions would be a common response to the masked stranger. This also was not confirmed, as more infants exhibited surprise and joy expressions. Thus, little support was found for the predicted situational specificity of facial expressions, with only joy expressions demonstrating the predicted intra- and intersituational specificity.

Several explanations for this lack of specificity need to be considered. Differential emotions theorists have maintained that most significant situations elicit multiple emotional responses (Blumberg & Izard, 1991), although there are limits in the type and frequency of emotional expressions in response to eliciting situations (Izard et al., 1987). Hence, specificity may be relative, not absolute. Second, perhaps facial expressions, particularly negative ones, are not well differentiated in early infancy (Camras, 1992; Matias & Cohn, 1993). For example, although Sullivan and Lewis (1989) found 4-month-old infants to exhibit fear expressions, such expressions have not been commonly documented at 4 months, leading differential emotions theorists to state that fear expressions may not emerge until about 7 months (Ackerman, Abe, & Izard, 1998). The possible lack of well-differentiated fear expressions at age 4 months may explain the poor interrater reliability for fear expressions in this study.

Third, it is possible that eliciting contexts may trigger the display of a variety of facial movements, some of which may have emotional meaning. One or more expressions may emerge as the dominant expression, or the “attractor” in dynamic systems terminology, in response to a given perturbation or elicitor. The data reported here suggest at least a very modest degree of situational specificity at 4 months, consistent with other research indicating some differentiation in expressions at age 3 months (Izard et al., 1995). Dynamic systems theory suggests that the dominant expression becomes more accessible and hence frequent in similar contexts over time. Consistent with such an interpretation, specific facial expressions become more discernible by adult raters with increased age during infancy (Galati & Lavelli, 1997). Hence, although this study should not be construed as a test of dynamic systems theory, our findings are not opposed to a synthesis of dynamic systems and differential emotions theories. Research examining the sequence of facial expressions over multiple presentations of particular elicitors during the first months of life is needed.

A fourth potential explanation for the lack of predicted specificity concerns the possibility that facial expressions do not necessarily represent emotional responses. For example, it has been shown that the facial action of opening the mouth in a non-surprise-inducing context is accompanied by brow raising, a component of surprise expression codes, in infants (Camras et al., 1996). We also found surprise expressions to occur in unexpected situations (arm

restraint and masked stranger), raising the possibility that these expressions may not be indicative of surprise per se.

Finally, the presence of a variety of facial expressions across diverse situations is consistent with prior research (Campos, Campos, & Barrett, 1989; Lewis & Michalson, 1983). Such variable responses to common elicitors (e.g., arm restraint elicited positive expressions for some infants, and negative expressions for others) suggests the existence of individual differences in young infants' facial expressivity. Further support for the presence of individual differences is found in the intraindividual stability data, as infants exhibited a tendency to exhibit particular expressions across situations, somewhat diminishing the importance of context. This finding, in conjunction with prior research showing stability in infants' facial expressivity across age (e.g., Izard et al., 1995), is consistent with temperament research indicating the existence of individual stability in emotional dimensions from an early age (Bates, 1989; Kagan, 1997; Rothbart, 1986). The presence of both individual stability in facial expressivity across situations, and the existence of somewhat unique patterns of expressions within a particular situation, suggests that both child and contextual factors need to be examined in studying emotional development (Lewis & Michalson, 1983).

Considering specific facial expressions, this study found more infants to exhibit sadness than anger expressions in response to tasting a sour substance. In contrast, prior research has found anger to be the most common facial expression across most negative elicitors for young infants (Camras, 1992; Camras et al., 1991), perhaps because prior studies using sour-tasting substances with infants did not specifically assess sadness expressions (Kochanska et al., 1998; Rosenstein & Oster, 1988; Steiner, 1979). This finding, although in need of replication, might be explained by the time frame of the situation. Sadness is distinguished from fear by being a response to an event that has already occurred, whereas fear anticipates an event to come (Stearns, 1993). Likewise, anger is probably exhibited most often during, as opposed to after, an aversive event. In the sour taste situation, coding began after the aversive stimulus was removed from the mouth, as accurate facial coding could not have been conducted while the cotton swab was in the infant's mouth. Consistent with this interpretation, anger was exhibited by the highest number of infants (n = 36) during the arm restraint situation, in which the aversive stimulus is ongoing, and from a functionalist perspective might be considered an attempt by the infant to signal the experimenter to stop the aversive event.

To the extent that joy and surprise may both be conceptualized as expressions of discrete, positive emotion systems (Izard, 1977), some situational specificity should exist between these expressions. As predicted, we found that more infants exhibited joy than surprise expressions in response to tickling. Although we also found that more infants exhibited surprise than joy expressions in response to the jack-in-the-box, as hypothesized, surprise expressions were also the most common response to the arm restraint and masked stranger situations. Researchers have previously questioned the ability of hypothesized surprise-eliciting situations to induce surprise expressions reliably (Camras et al., 1996; Oster, Hegley, & Nagel, 1992) or with specificity (Hiatt et al., 1979). These findings, suggesting that a jack-in-the-box may induce surprise expressions for 4-month-old infants, also indicate a lack of intersituational specificity for surprise expressions.

Further support for the predicted situational specificity of joy expressions during early infancy has been found in the contingency learning and emotion literature. For example, 4- to 6-month-old infants exhibited joy expressions most frequently at the point when arm pull responses indicate the infant has learned the contingency (Lewis, Sullivan, & Michalson, 1985; Sullivan & Lewis, 1989). Surprise expressions, in contrast, were found to be most

common just prior to peak responding (i.e., learning of a contingency), suggesting that surprise expressions coincided with the infants' discovery of the contingency.

The lack of sex differences in this study adds to an inconsistent literature. Martin, Wisenbaker, Baker, and Huttunen (1997) found girls to exhibit more negative affect in response to novel stimuli at age 6 months and speculated that girls may be more neurologically mature and thus more aware of the novelty of particular situations at this age. The findings reported here appear to argue against this interpretation, at least for 4-month-old infants, as similar numbers of boys and girls exhibited each expression in each situation.

The generalizability of these findings for more diverse socioeconomic status, ethnic, and age groups, as well as for other situations, is unknown. Infants' responsiveness to particular types of stimuli may vary with age (Camras, Oster, Campos, Miyake, & Bradshaw, 1992; Izard et al., 1987; Malatesta & Haviland, 1982; Sroufe & Wunsch, 1972). Skarin (1977), for example, found more positive affect among 6- versus 11-month-old infants in response to situations predicted to produce fear. Generalizability of these findings also may be limited to the particular contexts studied, as even slight alterations in situations may change the frequency with which particular facial expressions are elicited (Langlois et al., 1990; Skarin, 1977). Furthermore, situations were administered in a constant order, which may have produced carryover effects, even though the time interval between situations was, on average, 1 min apart.

Regarding expression coding, blends that did not involve interest were collapsed into the code for the expression observed in the upper facial region. Only 14% of our blends involved expressions other than interest, precluding a systematic examination of blends. Finally, this study focused solely on facial expressions, which are not isomorphic to infants' bodily or vocal behaviors (Lewis & Michalson, 1983) or the presence of emotions (Michel et al., 1992). Future research examining the coherence of facial, vocal, gestural, and behavioral indexes of emotions across contexts is warranted (Weinberg & Tronick, 1994).

In conclusion, these findings provide little support for the DET hypothesis of situational specificity during early infancy. Nonetheless, these findings do challenge the traditional view that the emotions of sadness and surprise, at least as measured by facial expression, are either not in the infant repertoire before 6 months or, if behaviorally present, are functionally irrelevant (see Malatesta-Magai & Izard, 1991). Both sadness and surprise expressions exhibited intrasituational specificity, although sadness expressions were not predicted to be a common response to sour taste, and surprise expressions lacked intersituational specificity. Predicted specificity was clearly found for joy expressions. These findings suggest that there is some organization to the type of expressions that occur in response to certain contexts, and that the pattern and relatedness of expressions within contexts is not just noise in a poorly differentiated system. Rather, such context by expression analyses may inform us about how early emotion and motivation systems are becoming expressed in the face.

Although tasks are often designed to elicit a specific emotion or expression, many studies have examined only the target emotion, neglecting the potential presence of other emotions (e.g., Grolnick, Cosgrove, & Bridges, 1996; Kochanska et al., 1998; Scarr & Salapatek, 1970; Steiner, 1979). It is important to recognize that a variety of facial expressions are actually elicited by each situation. Accordingly, we suggest that broadening the assessment of facial expressivity to include nontargeted expressions will provide a more comprehensive and meaningful approach to the study of individual differences in emotional responsivity. Such assessment could provide a better understanding of the complex role that contexts, temperament, parent–child interaction history, and other factors have in producing individual differences in emotional expressivity. Future research is needed to more fully

document the nomological network of phenomena linked to differential responses in the five contexts examined in this study, and to evaluate their ability to predict other meaningful phenomena.

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TABLE 1

Number of Infants Exhibiting Each Facial Expression During Situations

Expression	*Tickle*	*Sour Taste*	*Jack-in-the-Box*	*Arm Restraint*	*Masked Stranger*	$Q_{(4\ df)}$
Joy	83[a]	28[c]	38[c]	37[c]	56[b]	70.45*
	4.59 (2.75)	1.67 (1.30)	0.81 (0.52)	3.95 (3.30)	5.12 (4.09)	
Surprise	29[b]	22[b]	78[a]	80[a]	90[a]	122.08*
	2.43 (1.48)	1.32 (0.72)	1.80 (1.54)	3.46 (2.80)	4.82 (4.25)	
Anger	7[c]	25[ab]	9[c]	36[a]	23[b]	39.73*
	3.00 (1.73)	3.00 (1.74)	0.83 (0.68)	6.31 (4.98)	6.17 (5.97)	
Disgust	1[b]	22[a]	6[b]	3[b]	4[b]	45.52*
	2.00 (—)	2.45 (1.65)	1.31 (2.30)	1.67 (1.15)	1.75 (0.96)	
Fear	6[b]	20[a]	18[a]	29[a]	20[a]	18.70*
	3.67 (2.42)	2.00 (1.29)	0.92 (0.71)	3.03 (3.09)	3.40 (3.50)	
Sadness	5[d]	60[a]	12[cd]	28[b]	19[bc]	94.30*
	2.80 (2.49)	2.22 (1.49)	0.64 (0.32)	2.04 (155)	3.47 (3.91)	
No. possible seconds	10	10	27	30	30	

Note. Means for jack-in-the-box are averages across three trials. Facial expressions with different superscripts *across* situations indicate significant differences ($p < .05$) in the frequency that the facial expression was exhibited in pairwise comparisons. The mean number of seconds the expression was exhibited for those infants who exhibited the expression, and standard deviations, are below the frequencies. $n = 150$.

*$p < .001$.

TABLE 2

Rank Orders of Number of Infants Exhibiting Each Facial Expression Within Each Situation

Rank	*Tickle*	*Sour Taste*	*Jack-in-the-Box*	*Arm Restraint*	*Masked Stranger*
1	Joy[a]	Sadness[a]	Surprise[a]	Surprise[a]	Surprise[a]
2	Surprise[b]	Joy[b]	Joy[b]	Joy[b]	Joy[b]
3	Fear[c]	Anger[b]	Fear[c]	Anger[b]	Anger[c]
4	Anger[c]	Disgust[b]	Sadness[c]	Fear[b]	Fear[c]
5	Sadness[c]	Surprise[b]	Anger[c]	Sadness[b]	Sadness[c]
6	Disgust[c]	Fear[b]	Disgust[d]	Disgust[c]	Disgust[d]
Q value$_{(5\ df)}$	249.46*	47.55*	173.19*	117.22*	175.80*

Note. Facial expressions with different superscripts within situations indicate significant differences ($p < .05$) in expression within situations, based on the McNemar test. $n = 150$.

* $p < .001$.