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Does the Organization of Emotional Expression Change Over Time? Facial Expressivity From 4 to 12 Months

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Abstract

Differentiation models contend that the organization of facial expressivity increases during infancy. Accordingly, infants are believed to exhibit increasingly specific facial expressions in response to stimuli as a function of development. This study tested this hypothesis in a sample of 151 infants (83 boys and 68 girls) observed in 4 situations (tickle, sour taste, arm restraint, and masked stranger) at 4 and 12 months of age. Three of the 4 situations showed evidence of increasing specificity over time. In response to tickle, the number of infants exhibiting joy expressions increased and the number exhibiting interest, surprise, and surprise blends decreased from 4 to 12 months. In tasting a sour substance, more infants exhibited disgust and fewer exhibited joy and interest expressions, and fear and surprise blends over time. For arm restraint, more infants exhibited anger expressions and anger blends and fewer exhibited interest and surprise expressions and surprise blends over time. In response to a masked stranger, however, no evidence of increased specificity was found. Overall, these findings suggest that infants increasingly exhibit particular expressions in response to specific stimuli during the 1st year of life. These data provide partial support for the hypothesis that facial expressivity becomes increasingly organized over time.

Organized emotional reactions emerge over time in humans (Balaban, Snidman, & Kagan, 1997; M. Lewis, 1998; Sroufe, 1996). Facial expressions, although not considered isomorphic with emotional state (M. Lewis & Michalson, 1983; Weinberg & Tronick, 1994), are frequently used in both research and everyday life to assess the preverbal infants' emotional state. In examining infant facial expressivity, considerable debate exists as to when, and if, facial expressions begin to represent an organized emotional system.

From an early age, infants exhibit a variety of expressions representative of the primary emotions. Expressions of joy, interest, anger, and sadness emerge by 4 months of age (Izard, Hembree, & Huebner, 1987; Izard & Malatesta, 1987; Langsdorf, Izard, Rayias, & Hembree, 1983; M. Lewis, Alessandri, & Sullivan, 1990), and surprise expressions by 6 months (M. Lewis, Sullivan, & Michalson, 1984; Reissland, Shepherd, & Cowie, 2002). It has been argued that disgust expressions are present at birth (Izard & Malatesta, 1987), although perhaps only particular components are present this early (e.g., mouth gaping; Rosenstein & Oster, 1988). Fear expressions appear to emerge in the second half of the first

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year (Ackerman, Abe, & Izard, 1998; Sroufe, 1996), although such expressions have been observed at 4 months (Sullivan & Lewis, 1989). Hence, a variety of facial expressions are present during the first 6 months or so of life, but whether these early expressions represent meaningful emotional states or are more indicative of the infant's general arousal level has been questioned (Camras, 1992; Sroufe, 1996).

Differentiation models (e.g., Bridges, 1932; Camras, 1992; Matias & Cohn, 1993; Oster, Hegley, & Nagel, 1992) propose that infants have two basic states or one bipolar state at birth: a negative or distress state and a positive state. Subsequent states emerge through the differentiation of this basic bipolar state. According to differentiation models, a wide range of stimuli will initially elicit similar behaviors in young organisms. Over time, however, infants will exhibit responses that are more differentiated and specific (Emde, Gaensbauer, & Harmon, 1976; Sroufe, 1979; Weiss & Nurcombe, 1992; Werner, 1948; Witherington, Campos, & Hertenstein, 2001). Such differentiation is hypothesized to emerge due to the maturation of neurological inhibitory systems, cognitive development, and socialization (Cicchetti, Ganiban, & Barnett, 1991). Differentiation models thus suggest that early in development a negative stimulus situation might produce a relatively undifferentiated negative expression (e.g., distress) or perhaps a variety of emerging but not yet stable negative expressions (e.g., anger, fear, sadness, or disgust). Over time, the emergence of increasing specificity toward a particular facial expression in response to a given situation is likely to occur, for example, anger in response to arm restraint or disgust in response to a sour-tasting substance. Expressions are expected to show an increasing degree of situational specificity during infancy.

Several studies have assessed changes in the frequency of expressions over time, providing data relevant to the question of whether specificity increases during infancy. Camras (1991), for example, reported that anger expressions are the most prevalent response to many negative stimuli among infants until age 12 months or so, when sadness expressions appear to become a common response to some stimuli. Anger expressions have been found to increase between 7 and 19 months, and distress expressions to decrease from 2 to 19 months in response to inoculation (Izard, Hembree, Dougherty, & Spizzirri, 1983; Izard et al., 1987). Examining positive expressions, Duchenne smiles have been found to increase during the first 6 months of life (Messinger, 1994), while smiling in response to faces increases during the second 6 months (M. Lewis, 1969). Examining both positive and negative expressions in response to mother–child interaction, joy and interest expressions increased from 2 to 7 months, whereas the frequency of anger and sadness expressions decreased (Malatesta, Culver, Rich-Tesman, & Shepard, 1989). Collectively, these studies indicate that changes occur in the frequency of expressions in response to a variety of stimulus situations during the first year of life. However, changes are not always observed (e.g., Izard et al., 1995; M. Lewis et al., 1990), and whether they are observed may depend on the particular stimulus situations examined.

Most studies focus on full-face expressions, and not blends (i.e., expressions containing signals of two or more discrete emotions; e.g., eyebrows that signal sadness in the presence of a mouth that signals anger). Blends, however, are present from early infancy (Matias & Cohn, 1993) and also need to be considered when examining changes in specificity. Just as full-face expressions might change over infancy, so too might blends. Although it is unclear whether differentiation models would predict an increase (i.e., as might occur if blends reflect newly emerging, mixed, or complex emotion states) or a decrease (i.e., if blends reflect motoric “error” in facial expressivity, and dissipate with maturation) in blends overall during infancy, any change in the prevalence of blends needs to be explained by differentiation models. It has been suggested that blends become more frequent with changes in neural and cognitive development (Izard et al., 1995), although research supporting this hypothesis is mixed (Demos, 1982; Izard et al., 1995; Izard et al., 1987; Lauesen, 1994; Matias & Cohn, 1993).

Existing studies have not directly examined whether a situationally specific, increasingly predominant expression tends to emerge during infancy in response to particular stimulus situations. Most of the studies already cited have focused on only one particular stimulus situation or facial expression. Furthermore, several cross-sectional studies have examined a variety of stimulus situations and expressions (Bennett, Bendersky, & Lewis, 2002; Camras, Oster, Campos, & Bakeman, 2003; Hiatt, Campos, & Emde, 1979; Kochanska, Coy, Tjebkes, & Husarek, 1998) but because of their cross-sectional design do not allow us to conclude if increasingly specific expressions emerge over time.

A more comprehensive method for examining situational specificity is to examine frequency changes in a variety of expressions across a number of controlled stimulus situations at multiple time points. If differentiation occurs, we would expect to observe both increasing intrasituational specificity (i.e., that a particular expression becomes most prevalent in response to a particular situation) and increasing intersituational specificity (i.e., that the predicted expression is not as prevalent in response to other situations).

The degree to which facial expressions exhibit stability in response to particular stimuli from 4 to 12 months also is an important question in understanding the organization of facial expressivity. Whether infants exhibit stable patterns of facial expressions addresses whether individual differences in expressivity are related to some traitlike or dispositional characteristic. Do infants who exhibit more anger expressions in response to arm restraint at 4 months also exhibit more anger in response to arm restraint at 12 months? This study examines stability across several distinct stimulus situations.

The primary purpose of this study was to examine whether facial expressivity shows increased situational specificity from 4 to 12 months in response to a series of stimulus situations. An earlier report on the 4-month data from this longitudinal study found some specificity between situations and expressions (Bennett et al., 2002) but did not examine whether increasingly specific expressions emerge over the first year of life. We hypothesized that the specificity of expressions would be greater at 12 months than at 4 months in response to four different stimulus situations. Specifically, we hypothesized that at 12 months, in comparison to 4 months, infants would be more likely to exhibit (a) joy expressions in response to being tickled, (b) disgust expressions in response to tasting a sour substance, (c) anger expressions in response to arm restraint, and (d) fear expressions in response to being approached by a masked stranger.

The study of facial expressivity in the period from 4 to 12 months is of particular interest as cognitive and neurological changes permit infants to have a greater understanding of causality and intentionality, and to have more control over their emotions and behavior by the end of this period (Chugani & Phelps, 1986; Dawson, 1994; Fox, 1994; Kopp, 1982; M. Lewis, 1990; M. Lewis et al., 1990; M. Lewis & Ramsay, 1999; Sroufe, 1996; Thompson, 1990).

METHOD

Participants

The sample of 151 infants (83 boys and 68 girls) and their biological mothers were recruited for a longitudinal study of emotional and cognitive development among at-risk children (Bendersky & Lewis, 1998; Bennett et al., 2002). Five additional infants (2 boys and 3 girls) were assessed but were omitted from data analyses because they became mildly distressed and were unable to complete all four stimulus situations at either the 4- or 12-month visit. Pregnant women attending participating hospital-based prenatal clinics and newly delivered women in the three hospitals in Trenton, New Jersey, or at Woman's Medical Hospital in Philadelphia, Pennsylvania, 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 6 infants were born prior to 36 weeks; gestational age M = 39.1 weeks, SD = 2.1), required special care or oxygen therapy for more than 24 hr, exhibited congenital anomalies, were exposed to opiates or phencyclidine in utero, or if their mothers were infected with HIV. Mothers, who ranged in age from 13.7 to 43.6 years (M = 25.6, SD = 6.1), were predominantly African American (87%), with 10% European American and 3% Hispanic. Mothers' median education level was 11th grade (SD = 1.6), and 62% of families received Aid for Dependent Children. Forty-three percent of mothers reported smoking cigarettes at least once during their pregnancy, 38% drank alcoholic beverages, 33% used cocaine, and 12% used marijuana.[1] Participation was voluntary, and incentives were provided in the form of vouchers for use at local stores. Scheduling of appointments at 4 and 12 months was done using ages corrected for prematurity. Infants were a mean age of 19.7 weeks at Time 1 (range = 15.6–36.0 weeks, SD = 3.6) and 53.8 weeks at Time 2 (range = 49.4–65.3 weeks, SD = 3.2). All participants lived with their biological mothers.

Procedures

For each situation, infants were placed in an infant seat (4 months) or in their mother's lap (12 months), situated at eye level across from the examiner. Mothers were outside of their infant's field of sight. Mothers were instructed to talk to and calm their infants between each situation. During each situation, the examiner maintained a neutral facial expression (except when tickling the infant) and refrained from comforting the infant. Although rare, the situation was discontinued if infants became highly upset. The next situation was initiated only after infants appeared calm. Situations were administered in the same order (tickle, sour taste, arm restraint, and masked stranger) for each participant at both ages.

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.

Sour taste—The examiner, sitting across from the infant, gently placed a cotton swab soaked with lemon juice into the infant's mouth, removing it after 3 sec. Coding was done for the 10 sec following removal of the swab.

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. Coding was done for all 30 sec of arm restraint.

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[1]Prenatal substance exposure (maternal report of the mean number of alcoholic beverages, cigarettes, marijuana joints, and grams of cocaine used during pregnancy) was examined as a correlate of facial expressions (including blends) for each situation (tickle, sour taste, arm restraint, and masked stranger) at both 4 months and 12 months. The results indicated that the number of significant correlations were within the range of those expected by chance ($p < .05$): For cocaine exposure, 9 of 144 (6%) correlations were significant; for alcohol, 8 of 144 (6%); for marijuana, 7 of 144 (5%); and for cigarettes, 5 of 144 (3%). Thus, prenatal substance exposure generally did not affect facial expressivity in response to the stimulus situations in this study. This is consistent with research finding that prenatal cocaine exposure, for example, is related to infants' emotional regulation abilities (i.e., ability to recover from a stress situation), but not to emotional reactivity (i.e., response to the initial situation itself; Bendersky & Lewis, 1998).

Masked stranger—

A female adult, wearing a white hockey mask, slowly entered the room, stopped 4 m away from the infant and paused for 5 sec. The stranger then walked slowly toward the infant and stopped for 5 sec, 1 m away. 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.

Measures

Facial expressions—

Facial expressions were coded for joy, surprise, anger, disgust, fear, sadness, interest, neutral, not codeable (i.e., facial expression components were not consistent with any emotion code), and not scoreable (i.e., the infant moved head to side or the camera was 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 every second from videotape. Following Max combinatorial rules, if at least two of the three facial regions were consistent with a given expression and the third area was neutral, then that expression was coded. (For example, codes 25 [eyebrows lowered and drawn together] + 33 [eyes squinted or narrowed] in the upper facial regions, and 0 [no coded movement] in the lower face was coded as anger. Likewise, 25 + 0 in the upper face and 54 [squarish mouth] or 55 [mouth open wide, with lips stretched tense] in the lower face was coded as anger.) Thus, this rule included partial expressions on an otherwise neutral face. However, single movements on an otherwise neutral face (e.g., 0 + 0 + 54) were coded as neutral expressions. To control for an upward gaze that may inflate the coding of certain expressions (e.g., interest and surprise), any second in which infants gazed upward was coded as not scoreable (Camras, Lambrecht, & Michel, 1996; Michel, Camras, & Sullivan, 1992). In addition to the coding of full-face expressions, blends of anger, fear, sadness, and surprise were coded (e.g., 25 + 33 in the upper face and 51 [opened, relaxed mouth] or 65 [pursed lips] in the lower face was coded as an anger–interest blend; 25 + 33 in the upper face and 56 [mouth corners are downward and outward] in the lower face was coded as an anger–sadness blend). Blends of two or more expressions (e.g., anger–sadness) were coded as present for both expressions (e.g., anger and sadness), with the exception of interest. Any blend of interest with another emotional expression was coded as the other expression (see Haviland & Lelwica, 1987). Anger blends consisted of anger–other, anger–pain, anger–sadness, interest–anger, and sadness–anger. Fear blends consisted of fear–interest, fear–other, fear–sadness, and interest–fear. Sadness blends consisted of anger–sadness, fear–sadness, interest–sadness, sadness–anger, and sadness–other. Surprise blends consisted of surprise–interest.

Coders were trained to achieve an intercoder agreement correlation coefficient within 1 sec of at least .85. Reliability coefficients (intraclass correlation coefficients [ICC]) for the presence of each expression were as follows: joy = .97, surprise = .55, anger = .96, disgust = .63, sadness = .89, and interest = .88. Fear expressions were not observed during reliability coding, and subsequently an ICC for fear was not computed. The proportion of seconds that a particular expression was present were used for the initial multivariate analysis of variance (MANOVA) and for computing stability coefficients; all other analyses were based on whether a particular expression was present or absent for each participant in response to a given stimulus situation.

RESULTS

Due to the frequency of zero data points in the expression data, nonparametric statistical analyses of dichotomous data were used rather than proportion data to examine changes in the number of infants exhibiting each expression in response to each situation at 4 and 12 months. Sex differences were explored by conducting chi-square analyses for each expression (including blends) within each situation at both 4 and 12 months. No sex differences were found. Boys' and girls' data were aggregated in subsequent analyses to increase power.

Table 1 presents the number of infants exhibiting each expression and blend in response to each stimulus situation. Cochran *Q* values were computed using nonasymptotic probability values given the high prevalence of zero data points for some expressions and blends (see Berry & Mielke, 1996; Mielke & Berry, 1995). *Q* values indicate that the number of infants exhibiting particular expressions and blends varied within most situations (see *Q* values running horizontally across Table 1). For example, the number of infants exhibiting joy, surprise, anger, disgust, fear, sadness, and interest expressions differed in response to being tickled at 4 months ($Q = 394.8$, $p < .01$). The number of infants exhibiting most expressions and blends also varied across situations at both 4 and 12 months (see *Q* values in the far right column of Table 1). For example, the number of infants exhibiting joy differed in response to the tickle, sour taste, arm restraint, and masked stranger situations at 4 months ($Q = 41.8$, $p < .01$). However, fear expressions and sadness blends, which represented the two least observed categories, did not vary across stimulus situations.

Figure 1 presents these relations for expressions by displaying the change in the number of infants from 4 to 12 months who exhibited each expression in each situation. McNemar change tests with Yates's correction for continuity are reported for each situation to examine the change in the absolute number of infants exhibiting an expression from 4 to 12 months.2 Findings for each stimulus situation are described next.

Tickle

The number of infants exhibiting joy expressions increased from 4 to 12 months during the tickle situation (from 79 to 93), $\chi^2(1, N = 151) = 2.73$, $p < .10$. There also was a decrease in the number of infants exhibiting interest expressions (from 87 to 53), $\chi^2(1, N = 151) = 14.33$, $p < .01$; full-face surprise expressions (from 9 to 2), binomial distribution, $p < .10$; and surprise blends (from 21 to 7), $\chi^2(1, N = 151) = 6.50$, $p = .01$, from 4 to 12 months. Thus, from 4 to 12 months there is evidence of an increasingly predominant joy expression and decreases in the number of infants exhibiting interest, surprise, and surprise blends in response to the tickle situation. Furthermore, joy expressions appeared to be increasingly specific to tickle, as the number of infants exhibiting joy during other stimulus situations decreased, and significantly so during the sour taste situation.

Sour Taste

The number of infants exhibiting disgust expressions in response to the sour taste situation increased from 4 to 12 months (from 11 to 26), $\chi^2(1, N = 151) = 6.76$, $p < .01$. In contrast, the number of infants exhibiting joy expressions (from 31 to 16), $\chi^2(1, N = 151) = 4.78$, $p < .05$, and interest expressions (from 125 to 102), $\chi^2(1, N = 151) = 8.20$, $p = .01$, as well as fear blends (from 17 to 1), binomial distribution, $p < .01$, and surprise blends (from 21 to 7), $\chi^2(1, N = 151) = 6.50$, $p = .01$, decreased. Aside from interest expressions, which were prevalent across all situations, disgust expressions were the most frequently exhibited full-face negative expression in response to sour taste at 12 months. The number of infants exhibiting disgust increased, although it was still not a common response. Thus, although still relatively uncommon at 12 months, disgust exhibited increased intrasituational specificity. Furthermore, the number of infants exhibiting disgust did not increase

[2]For small expected frequencies, chi-square distributions can be unstable for the McNemar change test. In such cases, binomial distributions were used (see Siegel & Castellan, 1988).

significantly in response to any other situation, indicating limited intersituational specificity for disgust expressions.

Arm Restraint

The number of infants exhibiting full-face anger expressions (from 14 to 33), $\chi^2(1, N = 151) = 8.3l$, $p < .01$, and angerblends (from 15 to 25), $\chi^2(1, N = 151) = 2.89$, $p < .10$, increased from 4 to 12 months. In contrast, the number exhibiting full-face surprise expressions (from 22 to 4), $\chi^2(1, N = 151) = 11.12$, $p < .01$, and interest expressions (from 136 to 122), $\chi^2(1, N = 151) = 4.45$, $p < .05$, and surprise blends (from 69 to 27), $\chi^2(1, N = 151) = 24.01$, $p < .01$, decreased. Collectively, the increase in the number of infants exhibiting anger and decrease in those exhibiting surprise and interest expressions suggests a transition toward greater intrasituational specificity for anger in response to arm restraint. Furthermore, anger expressions appear to be increasingly specific across situations at 12 months as anger was an infrequent response to each of the other stimulus situations, and actually decreased from 4 to 12 months in response to the masked stranger.

Masked Stranger

The number of infants exhibiting full-face surprise expressions (from 31 to 10), $\chi^2(1, N = 151) = 11.43$, $p < .01$; anger expressions (from 10 to 2), binomial distribution, $p < .05$; interest expressions (from 136 to 121), $\chi^2(1, N = 151) = 5.94$, $p < .05$; and surprise blends (from 74 to 53), $\chi^2(1, N = 151) = 6.56$, $p = .01$, all decreased from 4 to 12 months. Thus, the masked stranger situation did not show evidence of an increasingly specific expression from 4 to 12 months.

Specificity Across Situations

To examine whether the overall specificity of expressions increased from 4 to 12 months, the number of situations during which each infant exhibited the target expression (i.e., joy in response to tickle, disgust in response to lemon, anger or anger blends in response to arm restraint, and fear or fear blends in response to the masked stranger) was summed at both ages. Scores could range from 0 to 4 at each age. Infants' mean overall specificity scores were significantly higher at 12 months ($M = 1.1$, $SD = 0.9$) than at 4 months ($M = 0.8$, $SD = 0.7$), $t(150) = 3.39$, $p = .001$, although the relatively low scores indicate that hypothesized expressions were observed a minority of the time.

Stability of Facial Expressions Across Age

To examine stability from 4 to 12 months, correlations of the proportion of seconds that each expression was shown in each situation were examined. The only significant stability was found for joy expressions in response to the tickle situation ($r = .25$, $p < .01$). Stability also was examined using dichotomous data (i.e., presence vs. absence of an expression) within each situation. McNemar change tests indicated significant stability for interest expressions in response to each situation: tickle, $\chi^2(1, N = 151) = 16.00$, $p < .001$; sour taste, $\chi^2(1, N = 151) = 6.35$, $p = .01$; arm restraint, $\chi^2(1, N = 151) = 5.93$, $p < .05$; and masked stranger, $\chi^2(1, N = 151) = 8.03$, $p < .01$. In addition, stability was found for anger in response to arm restraint, $\chi^2(1, N = 151) = 9.76$, $p < .01$; disgust, $\chi^2(1, N = 151) = 7.50$, $p < .01$, and joy, $\chi^2(1, N = 151) = 5.95$, $p < .05$, in response to sour taste; and surprise in response to arm restraint, $\chi^2(1, N = 151) = 11.12$, $p = .001$, and the masked stranger, $\chi^2(1, N = 151) = 11.43$, $p = .001$. Fear blends exhibited stability across sour taste (binomial distribution, $p < .001$), whereas surprise blends exhibited stability across each situation: tickle, $\chi^2(1, N = 151) = 7.26$, $p < .01$; sour taste, $\chi^2(1, N = 151) = 6.50$, $p = .01$; arm restraint, $\chi^2(1, N = 151) = 24.85$, $p < .001$; and masked stranger, $\chi^2(1, N = 151) = 7.11$, $p < .01$. Again, no stability was found for fear expressions, sadness expressions, anger blends, or sadness blends.

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DISCUSSION

The main purpose of this study was to test the hypothesis that infants exhibit increasing specificity in facial expressions from 4 to 12 months. This hypothesis was partially supported in the tickle, arm restraint, and sour taste situations, but not in the masked stranger situation. Modest stability was found in facial expressions from 4 to 12 months, as there was evidence of stability in hypothesized expressions across three of the four situations (i.e., joy in response to tickle, disgust in response to sour taste, and anger in response to arm restraint), as well as interest across all situations. The sex of the child failed to predict facial expressivity.

Examining the organization of expressions, we hypothesized that joy expressions would show increased situational specificity at 12 months in response to tickling. The majority of infants had already exhibited joy expressions when tickled at 4 months. Nonetheless, this number increased slightly, albeit not significantly, at 12 months, whereas the number of infants exhibiting the next most common expressions, interest and surprise, decreased from 4 to 12 months. Furthermore, the number of infants exhibiting joy expressions in response to the other situations decreased (although significantly so only in the sour taste situation), providing support for increasing intersituational specificity. Collectively, these findings suggest that joy expressions become increasingly predominant and situationally specific from age 4 to 12 months. Sroufe (1996) reported a similar change in smiling behavior, as infants shift from indiscriminate smiling in response to any pleasing social stimulus in the first few months of life to increased selectivity in the situations that elicit smiles during later infancy. Similarly, infants have been found to increasingly exhibit Duchenne smiles during the first 6 months of life in response to maternal smiling, but to decrease such smiles in response to less positive stimuli, including interaction with a nonsmiling mother (Messinger, Fogel, & Dickson, 2001).

Second, we hypothesized that disgust expressions would show increased situational specificity at 12 months in response to tasting a sour substance. We found the number of infants who exhibited disgust expressions increased, whereas the number who exhibited joy and interest expressions as well as fear and surprise blends decreased. Partial support for intersituational specificity was found in that disgust expressions did not increase in response to the tickle and masked stranger situations, although disgust did show a nonsignificant increase in response to arm restraint. However, disgust expressions occurred among only a minority (17%) of infants at 12 months, indicating that disgust expressions are not a prevalent response to a sour-tasting substance at this age. Given that disgust may be particularly sensitive to enculturation (Rozin, Haidt, & McCauley, 2000), it is possible that disgust expressions become a more predominant response to sour substances when the child is older.

Third, we hypothesized that anger expressions would show increased situational specificity at 12 months in response to arm restraint. We found the number of infants exhibiting anger expressions and blends did increase, whereas the number exhibiting surprise expressions, surprise blends, and interest expressions decreased. Examining intersituational specificity, the increase in anger expressions was specific to arm restraint as the number of infants exhibiting anger decreased or did not change in the other situations. Thus, this hypothesis was partially supported. The increased anger expressions observed at 12 months are consistent with findings of Camras, Oster, Campos, Miyake, and Bradshaw (1992), who found that infants exhibited a higher proportion of negative facial expressions at 12 months than at 5 months in response to arm restraint.

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Fourth, we hypothesized that fear expressions would show increased situational specificity at 12 months in response to a masked stranger. In contrast to the first three situations, the masked stranger situation failed to provide any support for the emergence of a situationally specific, increasingly predominant expression. The number of infants exhibiting fear increased only from 4 to 5 participants. These findings are inconsistent with earlier research finding that infants exhibit more fear in response to masks and strangers at around 12 months than before 7 months (Scarr & Salapatek, 1970). However, Scarr and Salaptek assessed fear using observer ratings of cautiousness, fretting, and the cessation of ongoing activity rather than facial coding, which might explain the discrepant findings. Several other factors may have contributed to this lack of increase in fear. First, it has been shown that few infants will exhibit distress to a stranger when the mother is present (Rheingold & Eckerman, 1973). Although the mother was outside the child's field of vision during the masked stranger situation, the child was in her lap at 12 months, perhaps providing a sense of security that may have decreased the likelihood of infants exhibiting fear. Other contextual factors, including whether the stranger gradually or swiftly approaches the infant, whether the stranger picks up the infant, the order of preceding events, and the degree to which the mask is unattractive also may affect infants' reactions to the masked stranger (Langlois, Roggman, & Rieser-Danner, 1990; Sroufe, 1996). Finally, it is possible that improved ability to self-regulate during distressing situations led to infants exhibiting fewer negative expressions at 12 months than at 4 months. This interpretation, however, is unlikely given research indicating that negative reactions are as common as or more common around 12 months than they are earlier during infancy (Axia & Bonichini, 1998; Buss & Goldsmith, 1998; Cossette, 1998; Lilley, Craig, & Grunau, 1997; Scarr & Salapatek, 1970).

Overall, our findings demonstrate some significant changes in the number of infants exhibiting specific expressions in specific stimulus situations and are distinct from those of Izard et al. (1995), who observed similar rates of joy, anger, and sadness expressions from 2½ to 9 months. Consideration of the different contexts in the two studies may explain these differences (M. Lewis & Michalson, 1983). In the Izard et al. study, the context was one of mother–infant interaction. First, it is possible that infants' prior experiences with their mothers may have affected their expressivity in the mother–infant interactions. For example, infants of depressed mothers have been found to exhibit higher rates of anger and sadness expressions in interactions with their mothers than those of mothers who are not depressed (Pickens & Field, 1993). Thus, it is unclear what effect, if any, individual differences in mother–child interaction may have had on infants' facial expressivity during mother–infant interaction in the study by Izard et al. Although examination of mother–infant interactions is important in the study of emotional development, the use of relatively novel stimulus situations that do not involve caregivers may minimize the historical effects of mother–infant interaction paradigms. Second, the study reported here examined expressions when infants were age 12 months rather than 9 months, as in the Izard et al. study. Considerable maturation of the prefrontal cortex, associated with emotional regulation, may occur during this 3-month period (Diamond & Doar, 1989; Schore, 1996) and might be related to the changes in facial expressivity found in this study.

Consistent with some (Izard et al., 1987; M. Lewis & Ramsay, 1995a; Malatesta et al., 1989; Sullivan, Lewis, & Alessandri, 1992) but not all prior studies (e.g., Cossette, Pomerleau, Malcuit, & Kaczorowski, 1996; Field, Vega-Lahr, Goldstein, & Scafidi, 1987; M. Lewis & Ramsay, 1995b; Kaye & Fogel, 1980), evidence of stability was found for several expressions, in particular those that showed increased specificity from 4 to 12 months. Further increases in the stability of expressions across time might be observed with shorter time intervals between assessments. Haynie and Lamb (1995), for example, found stability in expressivity from 7 to 10 months, and from 10 to 13 months, but not from 7 to 13 months. In addition, the use of aggregated data might have increased reliability and hence stability

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(Epstein, 1983; Seifer, Sameroff, Barrett, & Krafchuk, 1994). We did not aggregate across multiple testing days, which may be important as infants exhibit a significant degree of day-to-day intraindividual variability in emotionality during the first year (de Weerth, van Geert, & Hoijtink, 1999). Finally, parenting factors were not assessed in this study but have been found to predict discontinuity in infants' emotionality and should be considered in future research on the stability of facial expressivity (Belsky, Fish, & Isabella, 1991; Matheny, 1986; Washington, Minde, & Goldberg, 1986).

Individual differences also need to be considered when examining expressivity. At both 4 and 12 months, the majority of infants showed the hypothesized expression only in response to the tickle situation. Prior research with participants ranging from infants to adults (Hiatt et al., 1979; M. Lewis & Michalson, 1983) has demonstrated that specific events may elicit a variety of different emotions. Although sex did not explain such individual differences in this sample, other characteristics of the infant (e.g., temperament and experience; Izard, 2004) may help to explain such differences in facial expressivity.

Individual variability in the expression of blends also was observed, although generally fewer infants displayed blends at 12 months than at 4 months, with the notable exception of an increase in anger blends in response to arm restraint. This decrease adds to an inconsistent literature. Some studies have found evidence of an increase in blends with age during infancy (Demos, 1982; Izard et al., 1987), but others find evidence for no change (Izard & Abe, 2004; Izard et al., 1995; Matias & Cohn, 1993) or a decrease (Lauesen, 1994). These studies used different stimulus situations (e.g., mother–child interaction or inoculation) and a different population (i.e., middle-class, White infants) than this study, making comparisons difficult.

This study has several implications for developmental theory. The findings provide limited support for the differentiation model prediction of increased situational specificity during infancy. This finding is consistent with that of dynamic systems theorists who also have found increased organization in emotional behavior with age during infancy (M. D. Lewis, Lamey, & Douglas, 1999). The existence of some increasing situational specificity does support the view that infants evaluate events in their context and that infants' reactions must likewise be interpreted in terms of organization within context by the end of the first year (M. Lewis & Michalson, 1983; Sroufe, 1996). Differential emotions theory emphasizes the meaningfulness of early facial expressions in response to specific classes of eliciting events (Izard, 2004) and proposes that certain emotions may become more prominent as the child gets older to facilitate progress in the developmental tasks of that period (Abe & Izard, 1999). It appears that such a shift is already occurring between 4 and 12 months of age for at least some expressions.

Interest expressions were by far the most prevalent expression in response to all situations other than tickle at both ages. Still, as the hypothesized target expressions generally increased from 4 to 12 months, the number of infants exhibiting interest expressions decreased. This is consistent with prior research finding the duration of interest expressions to decrease from age 5 months to 10 months in response to mother and stranger approach (Stifter, Fox, & Porges, 1989), but contrasts research finding interest expressions to increase from 2 months to 8 months in response to viewing a motionless face and objects (Langsdorf et al., 1983). However, it is notable that the stimuli used in the Langsdorf et al. study were intended to elicit interest, whereas the stimuli used in the study here and in the Stifter et al. study were intended to elicit expressions other than interest. More research is needed to better understand the contextual significance of interest expressions, including whether early displays of interest are precursors to other expressions (e.g., joy, surprise) elicited in similar contexts later during infancy and toddlerhood.

As noted, this study found only partial support for shifts toward increasingly specific expressions in three of the four situations examined. Although such descriptive changes do not establish the existence of underlying communicative functions, it is plausible that the observed changes may facilitate interaction with others in the infants' environment (Frijda & Mesquita, 1998). Joy expressions, present during tickling, may foster social interaction and the formation of social bonds (Huebner & Izard, 1988). Disgust expressions, increasingly present during the sour taste situation, may communicate an avoidance of an ingested substance (Fridlund, 1994). Anger expressions, increasingly present during arm restraint, may serve as a protest against discomfort and communicate a desire for someone to change what is happening (Emde et al., 1976; Izard et al., 1987).

Future research examining the situational specificity of emotional responses should ideally use multiple stimulus situations assessed over multiple occasions in an effort to elicit each target emotion (Bennett, Bendersky, & Lewis, 2004; Izard, 2004). In addition, the individual variability present in emotional responses to particular stimuli highlights the need to use different approaches for different research questions. For example, studies designed to examine the prevalence, development, or variability of fear in response to particular stimuli (e.g., strangers) may elect to focus narrowly on a rather limited range of fear stimuli (i.e., a variety of strangers under a variety of circumstances). In contrast, studies interested in examining the emotional regulation abilities of young children in response to fear may need to use a more ideographic approach, assessing multiple potential fear-inducing stimuli to identify a particular fear stimulus for each child.

This study focused solely on facial expressions, which, as noted previously, may not be isomorphic to emotional state (M. Lewis & Michalson, 1983; Michel et al., 1992). Future research examining the coherence of facial, vocal, gestural, and behavioral indexes of emotions is warranted (Weinberg & Tronick, 1994). In addition, component facial expressions (i.e., an emotion expression in only one region of the face, with the other regions neutral) appear to increase from infrequent to common during the second year of life (Izard & Abe, 2004) and should be examined in addressing questions of specificity in late infancy. Examination of component expressions may be of particular importance when using relatively mild stimulus situations, as component expressions are believed to indicate a milder, more regulated emotional response than are full-faced expressions (Izard & Abe, 2004).

The generalizability of these findings to more diverse socioeconomic status, ethnic, and age groups, as well as to other situations, is unknown. Prior research, for example, has found cross-cultural expressivity differences in response to a series of laboratory situations (Camras et al., 1998; M. Lewis, 1989; M. Lewis, Ramsay, & Kawakami, 1993). In addition, the relatively small number of infants exhibiting some expressions limits the ability of statistical tests (e.g., the McNemar) to detect changes in these expressions over time. Finally, the modest reliability found for some expressions (e.g., disgust) may have limited the degree to which they could be seen to emerge as situationally specific expressions and may have lowered their stability coefficients.

In summary, we found limited support for the emergence of predominant, situationally specific facial expressions in response to a series of stimulus situations. Future research examining facial expressions across multiple time points and stimulus situations during infancy and toddlerhood is needed to identify whether the limited specificity found in this study continues to emerge. Furthermore, it would not be surprising to eventually observe a decrease in the frequency of predominant expressions in some situations as young children gradually become more adept at masking their expressions, resulting in incoherence between expressions and emotional states (Saarni & von Salisch, 1993). Although this study focused on normative development in facial expressivity, considerable individual differences were observed. Many infants, for example, did not exhibit joy expressions in response to tickling. Although a growing literature exists examining correlates of such individual differences in expressivity, future research should examine whether the early display of particular expressions in response to various stimulus situations is related to broader temperamental characteristics, and is a predictor of emotion regulation, emotion knowledge, or adjustment in later childhood.

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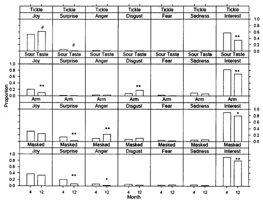

FIGURE 1.
Proportion of infants exhibiting full-face expressions by situation as a function of age. *$p \leq .10$. *$p \leq .05$. **$p \leq .01$ (representing significant changes from 4–12 months on the McNemar test).

TABLE 1

Number of Infants Exhibiting Each Facial Expression During Each Situation

Expression	Tickle		Sour Taste		Arm Restraint		Masked Stranger		Total Number of Infants Exhibiting		Cochran's Q (df=3)	
	4 mos.	12 mos.	4 mos.	12 mos.	4 mos.	12 mos.	4 mos.	12 mos.	4 mos.	12 mos.	4 mos.	12 mos.
Full-face expressions												
Joy	79	93	31	16	44	38	58	51	118	109	41.8**	107.7**
Surprise	9	2	3	2	22	4	31	10	52	15	34.4**	10.8*
Anger	3	1	5	4	14	33	10	2	25	38	11.1*	73.5**
Disgust	2	1	11	26	10	15	9	4	16	35	12.5*	40.2**
Fear	1	1	4	1	5	2	4	5	14	8	2.6	5.2
Sadness	1	0	14	9	7	7	5	1	25	16	13.8**	14.4**
Interest	87	53	125	102	136	122	136	121	150	149	68.6**	94.6**
Cochran's *Q*(*df*=6)	394.8**	405.6**	472.5**	371.4**	471.2**	404.7**	468.5**	493.6**	471.2**	482.5**		
Blends												
Anger	5	5	19	13	15	25	5	4	38	34	15.2**	31.7**
Fear	4	1	17	1	5	8	7	2	23	12	17.1**	11.3*
Sadness	2	2	8	6	5	8	4	3	16	15	4.6	5.6
Surprise	21	7	21	7	69	27	74	53	107	64	85.7**	82.3**
Cochran's *Q*(*df*=3)	28.8**	6.1	6.5#	10.8#	131.5**	20.8**	167.3**	126.5**	146.9**	67.9**		

Note. Anger blends consisted of anger–other, anger–pain, anger–sadness, interest–anger, and sadness–anger. Fear blends consisted of fear–interest, fear–other, fear–sadness, and interest–fear. Sadness blends consisted of anger–sadness, fear–sadness, interest–sadness, sadness–anger, and sadness–other. Surprise blends consisted of surprise–interest.

$p \leq .10$.

* $p \leq .05$.

** $p \leq .01$.