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Adult Judgments and Fine-Grained Analysis of Infant Facial Expressions: Testing the Validity of A Priori Coding Formulas

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Three studies tested whether infant facial expressions selected to fit Max formulas (Izard, 1983) for discrete emotions are recognizable signals of those emotions. Forced-choice emotion judgments (Study 1) and emotion ratings (Study 2) by naive Ss fit Max predictions for slides of infant joy, interest, surprise, and distress. But Max fear, anger, sadness, and disgust expressions in infants were judged as distress or as emotion blends in both studies. Ratings of adult facial expressions (Study 2 only) fit a priori classifications. In Study 3, we coded the facial muscle components of faces shown in Studies 1 and 2 with the Facial Action Coding System (FACS; Ekman & Friesen, 1978) and Baby FACS (Oster & Rosenstein, in press). Only 3 of 19 Max-specified expressions of discrete negative emotions in infants fit adult prototypes. Results indicate that negative affect expressions are not fully differentiated in infants and that empirical studies of infant facial expressions are needed.

Research during the past 10 years has led to a growing appreciation for the crucial role of emotions and emotional expressions in early development. Despite differing theoretical perspectives, most contemporary developmental psychologists recognize that emotions and their facial, vocal, and bodily expressions serve important adaptive functions, mediating the infant's transactions with the physical and social environment as well as serving intrapsychic signaling and motivational functions (Campos & Barrett, 1984; Cicchetti & Schneider-Rosen, 1984; Izard & Malatesta, 1987; Sroufe, 1979). However, fundamental questions about the ontogenesis of the basic human emotions and their expressions remain unanswered. In particular, there has been continuing disagreement about whether young infants show the full range of facial expressions identified in adults (cf. Cicchetti & Schneider-Rosen, 1984; Fridlund, Ekman, & Oster, 1987; Izard & Malatesta, 1987) and about the extent to which facial expressions in young infants reflect discrete emotional feeling states (cf. Camras, Malatesta, & Izard, 1991; Cicchetti & Schneider-Rosen, 1984; Izard & Malatesta, 1987; Lewis, Brooks, & Haviland, 1978; Oster, 1978; Sroufe, 1979). The three studies reported here addressed the first issue, particularly the question of whether infants show recognizable, differentiated facial expressions of discrete negative emotions.

The pioneering cross-cultural research of Darwin (1872/1965), Ekman (1973; Ekman et al., 1987), Izard (1971, 1977), and others has provided conclusive evidence that certain basic human emotions have universally recognizable facial expressions, suggesting that these expressions have a biological basis. However, it does not necessarily follow that facial expressions of all of the basic emotions should be present in their adultlike form from early infancy or that facial expressions in infants should have the same affective meaning and signal value as adult expressions (see Oster, 1992; Oster & Ekman, 1978, for discussion of this issue). According to traditional views of emotional development, the basic human emotions and the facial expressions signaling those emotions develop through a gradual process of differentiation from relatively nonspecific arousal and distress in the newborn period (e.g., Bridges, 1932; Charlesworth & Kreutzer, 1973; Sroufe, 1979; Werner, 1948). Most earlier investigators agreed that the hedonically positive emotion of delight or pleasure emerges by 2 to 3 months but that discrete negative emotions such as anger, fear, and sadness are not present until 6 to 10 months of age (Sroufe, 1979). Even in the latter part of the first year, when the presence of these specific negative emotions can be inferred from nonfacial behavior, early investigators reported only nonspecific reactions such as crying in fear- or anger-eliciting situations, indicating that differentiated *facial expressions* of these emotions were still absent (see reviews by Camras et al., 1991; Fridlund et al., 1987; Oster, 1992).

In sharp contrast, according to differential emotions theory

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(DET) the morphological appearance of universal facial expressions and the subjective feeling state accompanying them are invariant throughout life (Izard, 1977, 1990; Izard & Dougherty, 1982; Izard & Malatesta, 1987, pp. 516–519, 529–532). Moreover, in this view, facial expressions and emotions are innately linked. According to Izard (1990, p. 492; also Izard & Malatesta, 1987), because young infants are not capable of masking or feigning their feelings, the infant's facial expressions are reliable indexes of their emotional feeling states (see also Izard & Malatesta, 1987). These assumptions of DET represent the theoretical basis for two measurement systems, Max (Izard, 1983) and Affex (Izard, Dougherty, & Hembree, 1983), which use a priori formulas derived from prototypical adult facial expressions to identify each of the basic emotions in infants. Max coders have identified discrete sadness and anger by 2 to 3 months and fear by 7 months, which was earlier than these emotions were previously believed to be present (Izard & Malatesta, 1987). The classic, open-mouth cry face (Darwin, 1872/1965), traditionally viewed as an expression of global negative affect or distress, is classified by Max as an expression specific to physical discomfort or pain. Max has no nonspecific distress category. Thus, DET explicitly rejects the long-held view that the facial expressions and experience of the basic emotions gradually develop from less finely differentiated precursors.

These assumptions of DET can be questioned on purely theoretical grounds, because, as noted earlier, universality does not necessarily imply developmental fixity (Darwin, 1872/1965; Oster, Daily, & Goldenthal, 1989; Oster & Ekman, 1978).[1] But ultimately, the question of whether infants of a particular age show differentiated facial expressions of negative emotions can be resolved only by empirical research. Unfortunately, existing studies have either failed to address this question or have failed to produce conclusive answers.

Studies of Infants' Facial Expressions in Emotion-Eliciting Situations

There is strong evidence that certain facial configurations shown in early infancy communicate reliable information about the infant's "state of mind": for example, cry and precry faces; disgustlike expressions in response to bitter tastes (Rosenstein & Oster, 1988; Steiner, 1973); smiling (Sroufe, 1979); and a variety of expressions accompanying focused, alert attention and active information processing (e.g., Langsdorf, Izard, Rayias, & Hembree, 1983; Oster, 1978). However, surprise expressions have not been reliably observed in surprise-eliciting situations (Camras, 1988; Charlesworth & Kreutzer, 1973). And although different negative emotions can be reliably coded using Max formulas, it has not been shown that Max-specified facial expressions of emotions such as anger, fear, and sadness do, in fact, represent those specific emotions in infants who display them. Rather, investigators have simply applied adult emotion labels to infant facial configurations that fit Max formulas, without explicitly testing the validity of the assumptions underlying the coding scheme.

To date, no studies have demonstrated that infants show different facial expressions in situations thought to elicit different negative emotions or that different negative facial expressions have different behavioral correlates (e.g., Camras, 1988; Parisi, 1977; Schwartz, Izard, & Ansul, 1985; Young & Décarie, 1977; and reviews by Camras et al., 1991; Fridlund et al., 1987; Oster, 1992). Studies frequently cited as showing facial expressions of fear (Hiatt, Campos, & Emde, 1979) and anger (Stenberg & Campos, 1990; Stenberg, Campos, & Emde, 1983) in infants were inconclusive, because only one kind of negative elicitor (fear or anger) was used in each study, and because the facial configurations shown in the fear and anger studies overlapped considerably. Significant differences have been found in newborn infants' facial responses to sweet versus nonsweet and to bitter versus sour and salty tastes (Rosenstein & Oster, 1988), but disgustlike expressions have also been reported in other contexts (Camras, 1988).

We should not expect to find a fixed, one-to-one correspondence between antecedent events and emotional expressions (cf. Izard & Malatesta, 1987, p. 505). However, if infants do have differentiated expressions of emotions such as anger, sadness, and fear, we would not expect these expressions to occur interchangeably, and we should be able to find some independent evidence that they do, in fact, reflect these specific emotions. Such evidence is lacking to date.

Observer Judgment Studies

As evidence for the construct and external or criterion-related validity of Max coding formulas, Izard (1983, pp. 41–43) cites studies indicating that untrained adults accurately identify the emotions shown in slides of infant facial expressions. Such findings are seen as demonstrating (a) that infants produce "the same pattern of facial movements" as adults, and (b) that these expressions have social signal value for adults (Izard, Huebner, Risser, McGinnes, & Dougherty, 1980, p. 138). Because these findings have been given so much weight, we examine the evidence in some detail.

In the four studies reported by Izard et al. (1980), adults judged slides of infant facial expressions selected to fit prototypical adult expressions. Pre- and posttraining measures were obtained on three tasks: matching infant and adult expressions, free labeling of infant emotions, and recognition (selecting one of eight emotions for each expression). Because the infant expressions were selected to resemble the adult prototypes used in training and in the matching task, only the pretraining labeling and recognition measures provided unbiased tests of the recognizability of the infant expressions. In general, joy, interest, and surprise expressions were judged highly accurately. But the results for the five negative emotions varied widely from sample to sample, across tasks, and among slides within emotion categories. For many of the negative affect expressions, the predicted emotion was selected by only a slight majority or even a small minority of judges—even when the percentage correct was significantly greater than the chance level of 12.5% (one in eight emotion categories). Because the pattern of judgment errors was not reported, we do not know whether the predicted emotion for a given slide was selected significantly more often

[1] For this reason, the debate about the existence of "basic" or discrete human emotions (cf. Camras, 1991; Fogel & Reimers, 1989; Ortony & Turner, 1990; Scherer, in press) does not hinge on evidence of whether emotions and their expressions are invariant throughout life.

than any other emotion or even, in many cases, if the predicted emotion was the most frequent choice. Thus, it is impossible to rule out systematic "errors" or close ties among the negative affect expressions.[2]

A related problem in the Izard et al. (1980) studies is that the judgment tasks allowed only for discrete negative emotions. A term suggesting more global negative affect (e.g., *distress*) was not among the possible choices in the forced-choice recognition task; and in the free labeling task, responses such as *distress, crying,* and *suffering* would have been categorized as discrete *sadness* (Izard, 1971, p. 271), thus inflating the percentage of correct responses for the sad expressions. Given these methodological flaws and the inconsistency of the results, the reported data do not support the claim that untrained adults perceive discrete and differentiated expressions of specific negative emotions in infants' faces. In a subsequent observer judgment study, Emde, Izard, Huebner, Sorce, and Klinnert (1985) reported high interobserver agreement within and between two laboratories in labeling infant facial expressions. However, neither the distribution of responses nor the percentage of judges who selected the predicted emotion for each slide was reported. Thus, the validity of a priori Max formulas for discrete negative emotions could not be assessed.

In a study by Huebner and Izard (1988), subjects rated their imagined behavioral and affective reactions to slides of infant facial expressions and then rated the intensity of each of eight emotions shown in each slide. The stimuli were Max-classified infant expressions of physical distress, anger, sadness, and interest. Fear and disgust expressions were not shown, and the slides of negative expressions all showed infants over 5 months of age. Therefore, the claim that these expressions are all present in early infancy (Izard & Malatesta, 1987) could not be tested. In addition, subjects' ratings could have been confounded by age differences, because the two infants showing Max anger expressions were older (8.9 and 14.9 months) than those showing physical distress (both 6.9 months) and sadness (5.4 and 7.4 months).[3]

Huebner and Izard (1988) reported significant differences in subjects' ratings of the three negative affect expressions. However, the pattern of behavioral ratings was not predicted in advance and was in many cases counterintuitive. For example, ratings on the item "give love, affection, and cuddling" were as high for Max anger as for Max sadness expressions; and sad expressions were rated significantly higher than anger expressions on the tendency to "keep a distance" from the baby. These results and ratings of imagined affective reactions suggest that judges may have interpreted Max-specified anger expressions as intense distress and sadness as mild or moderate distress. On the emotion rating task, the predicted emotion received the highest mean rating for the three negative expressions. However, the mean rating of the predicted choice was within one scale point of the next-highest choice. Thus, judges may have perceived more global distress or blends of two or more negative emotions in the infants' faces.

In a series of studies by Daily and Goldenthal (1987a, 1987b), subjects sorted 21 photographs of Max-specified infant expressions. A multidimensional scaling (MDS) of the similarity scores for all pairs of expressions yielded two-dimensional configurations similar in form to Russell's (1980) circumplex model of emotions. However, unlike the results for adult facial expressions, infant expressions of physical distress and anger were closely interspersed within the same quadrant, and exemplars of fear and sadness were dispersed over two or more different quadrants. These findings suggest that the Max-specified infant expressions of negative emotions were not perceived as members of discrete and differentiated categories.

In summary, the observer judgment studies conducted to date have failed to establish the external or criterion-related validity of Max formulas for identifying facial expressions of discrete negative emotions in infants. Equally important, there has been no direct, independent test of the claim that Max-specified infant facial expressions of negative emotions involve the same patterning of facial muscle actions as adult universals. The three studies reported here were designed to provide more stringent tests of these assumptions of DET.

Overview of the Present Investigation

Three studies are reported here: In Studies 1 and 2, we asked whether slides of infant facial expressions fitting Max formulas for seven discrete emotions and *distress/pain* could be accurately identified by untrained adult observers. In Study 1, subjects made forced-choice emotion judgments; in Study 2, they rated infant and adult expressions on eight emotion scales. In both studies, we analyzed the pattern of judgment errors to determine whether the predicted emotion was selected significantly more often or rated significantly higher in intensity than nonpredicted emotions. The two studies thus tested the explicit claim of DET that Max-specified infant facial expressions of discrete negative emotions signal those specific emotions, rather than relatively nonspecific distress or blends of two or more negative emotions. Because subjects in observer judgment studies may miss or misinterpret reliable emotion cues that are actually present in the stimuli (Scherer, 1982), in Study 3 we used Baby FACS (Facial Action Coding System for infants; Oster & Rosenstein, in press) to code the facial configurations shown in each stimulus slide. This study tested the claim that Max-specified infant facial expressions are the same, in terms of their facial muscle components, as universal adult prototypes.

The term *distress* was among the choices listed in both observer judgment studies. We used this general term rather than the restricted term *in pain* or *physical distress* for three reasons:

1. The term distress has conventionally been defined as a state encompassing mental as well as physical pain or suffering (e.g., Darwin, 1872/1965; Ekman & Friesen, 1975; Izard, 1971; Mandler, 1975; Merriam-Webster, 1971; Sroufe, 1979; Tomkins, 1963, 1982). Most psychologists view physical pain as only one of many potential causes of distress. Moreover, the purely physi-

[2] An examination of Tables 1 and 2 in Izard et al. (1980, pp. 135 and 137) shows that on the unbiased pretraining labeling and recognition tasks, fewer than 40% of the judges—and in some cases, 0%–20%—selected the predicted emotion for slides designated as anger, disgust, and contempt. The results for fear were better on average but were very variable.

[3] The ages of the infants were supplied by Izard, personal communication, October 3, 1989.

cal sensation of pain is not generally regarded as an emotion (Ekman, 1984).

2. The Max distress/pain face is the classic cry-face configuration first described by Darwin (1872/1965). The existing evidence (e.g., Camras, 1988; Sroufe, 1979; Wolff, 1969; Young & Décarie, 1977) indicates that this expression is not specific to physical pain.

3. Our use of the general term distress allowed subjects to interpret it broadly or narrowly as they saw fit in decoding the infants' expressions. Thus, although judges were not precluded from selecting discrete negative emotion terms, the task also allowed them to select a more general term if they perceived physical or mental distress in the infants' faces.

Study 1: Forced-Choice Observers' Judgments

Method

Subjects

Thirty-six graduate education students (33 women and 3 men, *M* age = 32.3 years) served as voluntary, unpaid subjects. They had no training in identifying adult or infant facial expressions and no knowledge of the issues under investigation. They were tested in two groups of equal size.

Materials

The stimuli were 22 monochromatic slides of infants' faces, each showing one of eight facial configurations identified by Max and Affex coding formulas as discrete emotion expressions (Izard, 1983; Izard et al., 1983). As in the studies reviewed earlier, the slides of infant facial expressions were taken from still frames of videotapes and were carefully selected to represent prototypical exemplars of the designated expressions. Fifteen of the slides (prefixed by X in Tables 1 and 2) were selected from a set of 21 slides from Izard's laboratory. The facial expressions shown in 11 of these 15 slides are also shown on the Max and/or Affex training tapes and are identified by slide number in the master key of the coding manuals as prototypical illustrations of a particular discrete emotion expression (8 slides), a particular facial movement code (6 slides), or both.[4] The expressions shown in some of the slides have been reproduced in publications as illustrations of prototypical infant expressions, for example, Slides X-119 and X-034, shown in Izard and Dougherty (1982), and Slides X-076 and X-003, shown in Izard (1991). Thus, the slides selected can be considered representative exemplars of each emotion expression.

Several slides from Izard's set were not usable because of poor slide quality, because the expression shown was a blend, or because there were visible cues to the eliciting situation, which could have influenced subjects' judgments. Therefore, we substituted seven slides (prefixed by O in Tables 1 and 2) from H. Oster's slide file. These slides were selected to conform to Max formulas for discrete emotion expressions. As a check on the selection criteria, the O slides used in Studies 1 and 2 were independently coded by two trained Max coders, one from a different laboratory who was unaware of the purposes of our study. Agreement on Max appearance changes or movement codes was perfect except for the brow component of one slide; there was complete agreement on the emotion classification of each slide.

The ages of the infants shown in the slides ranged from 2 hr to 21.1 months (*M* age = 5.3 months, *SD* = 5.3). The mean ages of babies did not differ significantly across slide categories, $F(7, 14) = 0.70$. Altogether, there were two slides each of joy, interest, surprise, and disgust; three each of fear, anger, and distress; and five of sadness. We used more slides of negative than positive expressions because judgments of negative facial expressions were our primary interest. Sadness expressions were overrepresented because Max classifies several visibly different facial configurations as sadness, including the "kidney-mouth" faces described by Young and Décarie (1977) and the "pouts" and "horseshoe-mouth" configurations identified by Oster (1982; Oster & Ekman, 1978). Therefore, we were interested in whether different variants of this heterogeneous category would be perceived as being similar.

Procedure

The slides were projected one at a time on a screen at the front of a dimly lit classroom. The two groups saw the slides in the same order, which was random, except that the same emotion category could not be presented consecutively. Each slide was shown for 15 s, with an interstimulus interval of 1 s. Subjects were instructed to circle on their answer sheets the single emotion term out of the eight listed that best described the feeling expressed in the infant's face. We emphasized that we were interested in their own personal judgment of the expression shown in each slide.

Results

The percentage of subjects selecting each emotion category (nonpredicted as well as predicted) for each slide is shown in Table 1. Accuracy (i.e., percentage of subjects choosing the label predicted by Max) was not significantly correlated with age of the stimulus infant ($r = .05$).

The binomial test (Siegel, 1956) showed that with eight emotion categories, nine (25%) or more of the judges had to select a given emotion term to significantly exceed the 12.5% expected by chance, $p(x \geq 9) = .03$. An emotion category was selected significantly less often than expected by chance only if none of the judges chose it, $p(x = 0) = .01$. Among the six slides representing nonnegative facial expressions (joy, interest, and surprise), five were judged highly accurately and discretely according to the Max predictions: 72%–89% correct and no other emotion selected significantly more often than chance. One interest slide (X-092, showing a baby with prominent brow ridges) was seen as distress by a majority of judges.

However, most of the facial expressions classified by Max as discrete negative emotions were not accurately judged. Whereas the predicted emotion was selected significantly more often than chance for 10 of the 16 negative affect slides, *nonpredicted* emotions were also selected more often than chance for 10 negative affect slides. In four cases (AR X-030, DP X-097, SD X-082, and SD O-337), two different nonpredicted choices were greater than chance. The predicted Max category was the most frequent choice for only 8 of the 16 negative affect slides. And for only 2 of these 8 slides was the predicted emotion selected significantly more often than the next-highest choice:

[4] Izard's slides of Infant Affect Expressions and the Max and Affex training tapes are available from the University of Delaware Instructional Resources Center. A key accompanying the slide set identifies the Max/Affex emotion classification for each slide. The Max and Affex manuals provide frame-by-frame "master codes" with the Max/Affex emotion classification for each facial expression shown on the tapes.

Table 1
Forced-Choice Classification of Infants' Facial Expressions

Slide class	Age (months)	ID	% subjects selecting each emotion							
			Joy	Interest	Surprise	Fear	Anger	Distress	Sadness	Disgust
Joy	7.0	X-119	**89**[a,b]	11	0	0	0	0	0	0
	4.5	X-091	**78**[a,b]	14	6	3	0	0	0	0
M	5.8 (1.8)									
Interest	1.9	X-092	0	**28**[a]	3	3	0	56[a]	6	6
	4.5	X-034	0	**72**[a,b]	22	3	0	3	0	0
M	3.2 (1.8)									
Surprise	7.0	X-102	0	8	**83**[a,b]	3	0	6	0	0
	4.2	X-003	0	14	**83**[a,b]	3	0	0	0	0
M	5.6 (2.0)									
Fear	20.3	X-251	0	0	0	**22**	3	25[a]	47[a]	3
	5.0	X-132	3	39[a]	0	**44**[a]	0	6	8	0
	2.5	O-312	3	17	22	**19**	6	22	11	0
M	9.3 (9.6)									
Anger	21.1	X-226	0	0	3	6	**44**[a]	17	19	11
	4.8	X-030	0	0	6	3	**25**[a]	31[a]	31[a]	6
	2.2	O-031	6	19	17	3	**6**	36[a]	6	8
M	9.4 (10.2)									
Distress	4.3	X-097	0	0	0	6	31[a]	**33**[a]	25[a]	6
	6.9	X-071	0	0	0	14	22	**33**[a]	22	8
	0.9	O-332	0	0	3	6	11	**39**[a]	28[a]	14
M	4.0 (3.0)									
Sadness	2.2	X-249	3	0	0	6	0	19	**69**[a,b]	3
	5.4	X-082	3	11	3	25[a]	0	25[a]	**25**[a]	8
	2.0	O-B09	0	14	0	3	22	17	**17**	28[a]
	2.5	O-337	0	0	0	3	0	31[a]	**39**[a]	28[a]
	2.5	O-328	6	14	6	8	0	3	**58**[a,b]	6
M	2.9 (1.4)									
Disgust	5.0	X-076	22	6	6	11	14	19	11	**11**
	2 hr	O-369	11	3	8	0	0	53[a]	14	**11**
M	2.6 (3.5)									

Note. $N = 36$. Slide class = a priori classification of stimuli. Values in parentheses after mean ages are standard deviations. Slide ID prefix indicates source: X = C.E. Izard; O = H. Oster. Because of rounding, row totals do not always sum to 100%. For each slide, the emotion category predicted by Max is shown in boldface.
[a] Selected significantly more often than expected by chance, $p = .03$, binomial test. [b] Emotion category predicted by Max was most frequent and was made significantly more often than the second most frequent choice, χ^2 $(1, N = 36)$, $p < .05$.

Slide X-249, $\chi^2(1, N = 32) = 10.12$, $p < .01$; Slide O-328, $\chi^2(1, N = 26) = 9.85$, $p < .01$.

Discussion

The results of Study 1 showed that slides of positive and neutral expressions were judged largely as predicted. However, judges did not agree to a significant extent with the Max classification of negative affect expressions. Moreover, the fact that two or more different negative emotion terms were selected significantly more often than chance for some of the negative affect slides suggests the possibility that judges perceived blended rather than discrete emotions in the infants' facial expressions. Study 2 was designed to test this possibility more directly.

Study 2: Emotion Ratings

Method

Subjects

Thirty-two graduate students in clinical social work and clinical psychology (25 women and 7 men, *M* age = 34.8 years), with no training in identifying facial expressions, served as voluntary, unpaid subjects. They were tested in two groups.

Materials

Thirty slides of infant facial expressions and 7 of adults were used as stimuli. The infant slides included all but 2 (O-031 and O-337) of the 22 slides used in Study 1. To increase the number of exemplars of each expression coded in Izard's laboratory, we added 10 slides taken from still frames of the Affex videotape. These slides, showing close-up views of the infant's face, were made with a Nikon FE camera with a zoom lens on a tripod. Shutter speeds were set for 0.5 s (to avoid sweep lines), and light meter exposures were bracketed. There was no perceptible loss of picture quality from the tapes themselves. The selected frames were identified as discrete emotion expressions in the master key of the Affex manual. Two of the slides were taken from "frozen" stills used on the Affex tape to illustrate the prototypical infant expressions of fear (A-S01) and anger (A-S02). The anger expression (produced by a 6-month-old) shown in the latter slide is reproduced in Izard and Dougherty (1982) and served as the cover illustration of the volume.

Altogether, there were three slides each of joy, interest, surprise, and disgust; four each of fear, anger, and distress; and six of sadness. (Sadness slides were overrepresented for the same reason as in Study 1.) The ages of the infants shown in the slides for Study 2 ranged from 2 hr to 21.1 months (*M* age = 6.55 months, *SD* = 5.04). The mean ages of babies did not differ significantly among slide categories, $F(7, 22) = 1.05$.

The slides of adult facial expressions were included primarily as a check on the viewing conditions, the judges' sensitivity to facial affect cues, and the judges' interpretation of the rating task. Because most cross-cultural research on the recognition of emotion has involved forced-choice paradigms rather than emotion rating paradigms, we wanted to compare judgments of infant and adult facial expressions on the same task. On the other hand, because we did not want to add too many additional slides to an already long task, we used only seven slides of adult faces.

The adult expressions, all posed, included one example of each of the eight basic emotions except surprise, for which a slide was lacking at the time we conducted the study. All of the adult expressions had been used in previous research as prototypical examples of the universal facial expressions identified in cross-cultural observer judgment studies (Ekman, 1973; Izard, 1971, 1977). Four slides (joy, fear, sadness, and distress) were from Ekman and Friesen's (1976) slide set *Pictures of Facial Affect* and were identified as predicted by 90%–96% of the subjects in Ekman and Friesen's reliability studies. The adult disgust slide, also from Ekman and Friesen's laboratory, was used in an observer judgment study by Hager and Ekman (1979). The anger expression, used in Izard's cross-cultural research, was taken from a photograph shown in Izard (1971, p. 330). It shows the open-mouth variant of the anger expression on which the Max anger formula was based. The interest slide (actually inferred interest according to Max) shows a neutral expression with the poser looking directly at the camera.

Because distress and sadness expressions have not been distinguished in research on the recognition of emotion in adults, there are no cross-culturally validated slides of distress. The slide that served as our distress stimulus is designated as a sadness expression in Ekman and Friesen's (1976) slide set. It was identified as sadness by 90% of the subjects in these investigators' reliability studies, but in these studies the term distress was not a possible choice. The expression shown in the slide is actually a blend of sadness in the upper face (oblique brows) and distress (a cry-mouth configuration) in the lower face and was the best available choice for an adult distress stimulus.

Procedure

The slides were projected one at a time on a screen at the front of a classroom. Each slide was shown for 30 s, with an interstimulus interval of approximately 1 s. To avoid biasing the subjects' ratings of the infant expressions, the adult slides followed all of the infant slides. The order of presentation (the same for all subjects) was random except that slides showing the same Max-identified emotion could not be presented consecutively. Subjects were instructed to complete eight separate 9-point rating scales for each slide, indicating how strongly—from 0 = *not at all* to 8 = *strong*—each of the eight emotions was expressed in each face. The instruction sheets informed subjects that "some facial expressions may show many emotions at once, at the same or different strengths, while other facial expressions might show only a single emotion, or even no emotion at all."

Results

A preliminary series of repeated measures multivariate analyses of variance (3, 4, or 6 slides × 8 emotion ratings) for each of the eight slide categories showed that the Slide Exemplar × Emotion Rating interaction was significant ($p < .0005$) for all eight infant slide categories. Because these results demonstrated that subjects' ratings of different slides within the same Max expression category were not homogeneous, we proceeded with a separate, one-way repeated measures analysis of variance (ANOVA) for each slide, with emotion as the independent variable (with up to eight levels, corresponding to the emotions rated) and intensity ratings as the dependent variable (cf. Schwartz & Weinberger, 1980). So as not to violate the assumption of homogeneity of variances underlying the ANOVA, we dropped from the analysis those emotion scales that received a mean rating of zero for a given slide. The three highest mean ratings for each slide were compared by using the Newman-Keuls post hoc procedure ($\alpha = .05$). The complete pattern of results is shown in Table 2.

Ratings of Infant Slides

Positive and neutral expressions. The predicted emotion was rated significantly higher (according to the Newman-Keuls post hoc procedure) than any other emotion for all three interest faces and for two of the three surprise faces. The third surprise face was seen as showing significantly more interest than any other emotion, with fear and surprise next highest. For two of the three joy faces, joy was rated higher than any other emotion, but interest was a close second. The third joy expression (a low-intensity smile) was seen as expressing significantly more interest than joy. Although interest ratings were high for joy and surprise expressions as well as for interest expressions, the mean rating of the predicted emotion was above 5 for all but one joy and one surprise slide. Moreover, only one interest and one surprise expression received mean ratings above 2 on the negative emotion scales. Thus, the positive and neutral expressions were judged largely as predicted.

Negative affect expressions. As expected, the negative expressions obtained low ratings (in all but one case, a mean rating of less than 1) on the joy scale. Only 7 of the 21 negative expressions received mean ratings above 2 on interest or surprise. However, one sadness and one disgust slide were rated significantly higher on interest than on any other emotion.

All four of the distress/pain expressions obtained mean distress ratings above 5. They were also rated significantly higher on distress than on any other emotion. By contrast, only 3 of the 17 Max-specified expressions of discrete negative emotions (fear, anger, sadness, and disgust) received mean ratings above 5 on the predicted emotion. The predicted emotion received the highest mean rating for only 2 of these 17, both of which were sadness slides; and even in these cases, sadness was not rated significantly higher than distress, the next-highest emotion. Distress was rated significantly higher than the predicted emotion for all four anger slides, one fear slide, and two disgust slides.

The pattern of emotion ratings for distress/pain and anger expressions was very similar. For all eight of these slides, distress was rated significantly higher than any other emotion. For all four distress/pain slides and three anger slides, sadness was rated second highest; for the other anger face, anger was second highest. Anger was third highest for the four distress/pain slides and for two anger slides. For the fourth anger expression (A-S02, taken from the still-frame anger prototype on the Affex tape), anger was only the fifth highest emotion. The pattern of ratings was less consistent for the other discrete negative emotions. For three of four fear faces and five of six sadness faces, the two or even three highest emotion ratings were not significantly different from one another. For two sadness slides and two disgust slides, the predicted emotion was not even among the top three highest-rated emotions.

Discrete emotions or blends? The mean emotion ratings presented in Table 2 suggest but do not demonstrate that many of the infants' negative affect expressions were perceived as blends. Alternatively, the results could indicate that individual subjects perceived discrete emotions in the infants' faces but disagreed on which specific emotion was most clearly present. We thus derived a more direct measure of the extent to which individual subjects perceived blended emotions. We classified each subject's ratings on each slide into one of four mutually exclusive and exhaustive categories: A *discrete hit* was scored if the predicted emotion was rated 2 or more points higher than any other emotion; a *discrete miss* was scored if a nonpredicted emotion was so scored. A *correct blend* was scored if the two or three highest-rated emotions were within 1 point of each other and included the predicted emotion; an *incorrect blend* was scored if the highest-rated emotions were within 1 point of each other but did not include the predicted emotion.

As shown in Table 3, only 3 of the 30 infant slides (one surprise and two interest expressions) were rated as discrete hits by a majority of subjects. The third interest face was rated as a discrete hit by 41% of the subjects. Only a small minority of subjects scored discrete hits in rating the infants' negative affect expressions: 16% to 31% of the subjects for distress/pain expressions and 3% to 13% of the subjects for the 17 slides of discrete negative emotions. Among nonnegative slides, only one joy and one surprise expression were rated primarily as discrete misses. But four negative affect expressions were rated as discrete misses by a substantial minority (41%–44%) of the subjects. Fifteen of the infant slides were seen as blends by a majority of subjects, another 5 by a substantial minority (41%–44%). Thus, the percentage of subjects who perceived the infant expressions as blends far exceeded the percentage who perceived them as showing discrete emotions.

A very lenient measure of an observer's accuracy is whether the predicted emotion was rated highest or within 1 point of the highest-rated emotion. By this measure, individual subjects were less accurate in rating discrete negative expressions than positive, neutral, and distress/pain expressions. Seven of the nine positive and neutral expressions were judged as either discrete hits or correct blends by more than 80% of the subjects. All four distress/pain expressions were judged as either discrete distress or distress blends by over 87% of the subjects. But among the 17 discrete negative expressions, only 1 (sadness, X-249) was consistently judged as either a discrete hit or correct blend. Moreover, 6 of the 17 discrete negative expressions were inaccurately judged as either discrete misses or incorrect blends by over 70% of the subjects.

Ratings of Adult Slides

Mean emotion ratings. As shown in Table 2, the mean rating of the predicted emotion was above 5 for all of the adult slides except interest (a neutral expression, as noted earlier). The predicted emotion was rated significantly higher (Newman-Keuls, $\alpha = .05$) than any other emotion for the interest slide but not the joy slide, a relatively low intensity smile that received high ratings on interest as well as joy. The predicted emotion was also rated significantly higher than any other emotion for the anger, sadness, and disgust slides. The fear expression was rated significantly higher on fear than on any other negative emotion, but fear ratings were not significantly higher than surprise ratings —a finding consistent with the results of earlier cross-cultural observer judgment studies (Ekman, 1973). The distress expression, which as we noted earlier was actually a sadness/distress blend, was rated higher on distress than on sadness, but not significantly so. However, both distress and sadness were rated significantly higher than any other emotion for the distress slide.

The ratings of adult slides differed in two important ways from the ratings of infant slides. First, distress was not seen as a significant component of adult fear, anger, disgust, or even sadness expressions, as was the case for the Max-specified infant expressions of these emotions. Thus, subjects did not give indiscriminately high distress ratings to all negative affect expressions; instead, distress ratings were based on the amount of distress subjects perceived in each slide. Second, anger was not seen as a strong secondary emotion in the adult distress face, as it was in the infant distress/pain expressions—suggesting that the Max-specified infant expressions of anger and distress are more similar, in terms of facial muscle patterning and signal value, than adult expressions of these emotions.

Discrete emotions or blends? As shown in the lower part of Table 3, discrete hits were scored by a majority of subjects for four of the seven adult expressions: interest, anger, sadness, and disgust. Discrete misses were scored by only a small minority of subjects for all of the adult slides. Blends (in all cases correct blends) were scored by a majority of the subjects only for joy, fear, and distress. All seven of the adult slides were accurately judged as either discrete hits or correct blends by 81%–100% of the judges. Thus, although some blending of emotions was seen in the ratings of adult slides (consistent with findings by Russell, 1980), these ratings were both more discrete and more accurate than ratings of the infant slides.

Differential Attributions of Emotion Terms to Stimulus Expressions

Another way of looking at whether facial expressions are perceived as communicating discrete and differentiated emotions is to examine the extent to which subjects' ratings on each of the emotion scales varied as a function of the expression. As shown in Figure 1a, ratings of infant facial expressions on the five negative emotion scales do not show clear peaks for the predicted slide categories. Mean distress ratings were higher than ratings on any other emotion for all of the negative affect expressions. Sadness ratings are nearly flat across slides of fear, anger, distress, and sadness. Anger ratings show a double peak for distress and anger slides. Fear ratings show a slight peak for the fear expressions, but fear is still seen as less salient than distress and sadness in the fear slides. Disgust ratings were uniformly low across the five negative slide categories. This

Table 2
Intensity of Eight Emotions Seen in Slides of Facial Expressions

Slide class	Age (months)	ID	Mean ratings of each emotion									
			Joy	Interest	Surprise	Fear	Anger	Distress	Sadness	Disgust	*F*	*df*
						Infant slides						
Joy	4.5	X-091	**6.7**[a] (1.6)	6.6[a] (1.1)	3.7[b] (2.7)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.2)	0.0 (0.2)	182.15*	4, 31
	7.0	X-119	**7.1**[a] (1.0)	6.8[a] (0.8)	2.1[b] (2.5)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	112.65*	2, 31
	8.0	A-019	**3.2**[b] (1.7)	5.9[a] (1.9)	1.7[c] (2.1)	0.2 (0.6)	0.0 (0.2)	0.1 (0.4)	0.1 (0.6)	0.1 (0.6)	112.77*	7, 31
M	6.5 (1.8)		**5.7** (2.1)	6.4 (0.5)	2.5 (1.1)	0.1 (0.1)	0.0 (0.0)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)		
Interest	1.9	X-092	0.5 (1.0)	**6.0**[a] (2.2)	3.3[b] (2.2)	1.9 (1.6)	1.8 (2.2)	2.0[c] (2.0)	0.7 (1.4)	0.6 (1.2)	38.23*	7, 31
	4.5	X-034	0.4 (0.8)	**5.2**[a] (2.3)	3.2[b] (2.5)	2.4[b] (2.0)	1.1 (1.8)	1.7 (2.2)	0.8 (1.4)	0.5 (1.5)	31.78*	7, 31
	7.6	A-015	1.3[c] (1.6)	**6.9**[a] (1.8)	2.5[b] (2.3)	0.9 (1.3)	0.1 (0.3)	0.2 (0.5)	0.2 (0.6)	0.0 (0.0)	121.33*	6, 31
M	4.7 (2.8)		0.7 (0.5)	**6.0** (0.8)	3.0 (0.4)	1.7 (0.8)	1.0 (0.9)	1.3 (1.0)	0.6 (0.3)	0.4 (0.3)		
Surprise	7.0	X-102	0.9 (1.4)	4.8[b] (2.3)	**7.0**[a] (1.4)	1.9[c] (1.8)	0.1 (0.4)	1.2 (1.5)	0.5 (1.0)	0.1 (0.2)	122.34*	7, 31
	4.2	X-003	2.5[c] (2.2)	6.9[b] (1.4)	**7.8**[a] (0.6)	1.3 (1.7)	0.1 (0.4)	0.3 (0.9)	0.1 (0.4)	0.1 (0.2)	245.19*	7, 31
	12.0	A-002	0.2 (0.4)	5.3[a] (2.2)	**3.0**[c] (2.8)	3.9[b] (2.3)	0.1 (0.2)	2.2 (2.2)	1.1 (1.9)	0.1 (0.4)	40.87*	7, 31
M	7.7 (4.0)		1.2 (1.2)	5.7 (1.1)	**5.9** (2.6)	2.4 (1.4)	0.1 (0.0)	1.2 (1.0)	0.6 (0.5)	0.1 (0.0)		
Fear	20.3	X-251	0.0 (0.0)	1.5 (2.1)	1.0 (1.7)	**3.8**[b] (2.9)	3.0 (2.4)	7.2[a] (1.0)	6.5[a] (2.2)	2.1 (2.3)	48.97*	6, 31
	5.0	X-132	0.8 (1.7)	4.4[a] (2.5)	2.6 (2.7)	**4.3**[a] (2.6)	0.4 (0.9)	4.3[a] (2.2)	2.7 (2.6)	0.3 (0.9)	23.95*	7, 31
	7.6	A-S01	0.0 (0.0)	1.5 (2.0)	0.8 (1.4)	**2.5**[b] (2.3)	2.3 (2.3)	5.4[a] (2.0)	4.8[a] (2.8)	2.1 (2.5)	23.81*	6, 31
	2.5	O-312	1.4 (2.6)	1.9 (1.9)	1.8 (2.0)	**3.1**[b] (2.6)	0.8 (1.5)	4.4[a] (2.8)	2.8[b] (2.9)	1.2 (2.0)	9.38*	7, 31
M	8.8 (7.9)		0.6 (0.7)	2.3 (1.4)	1.6 (0.8)	**3.4** (0.8)	1.6 (1.2)	5.3 (1.3)	4.2 (1.8)	1.4 (0.9)		
Anger	21.1	X-226	0.0 (0.0)	0.3 (0.8)	0.7 (1.1)	2.6 (2.3)	**4.2**[b] (2.8)	7.2[a] (1.3)	5.0[b] (1.9)	1.5 (1.9)	63.76*	6, 31
	4.8	X-030	0.0 (0.0)	0.8 (1.6)	1.2 (2.1)	2.7 (2.4)	**5.4**[b] (2.7)	6.7[a] (1.7)	4.4[b] (3.0)	2.2 (2.6)	35.55*	6, 31
	6.0	A-S02	0.2 (0.6)	2.4 (2.4)	1.7 (2.0)	2.8[b] (2.3)	**1.9** (1.9)	4.4[a] (1.9)	3.2[b] (2.6)	1.6 (2.0)	13.82*	7, 31
	13.0	A-023	0.0 (0.0)	0.4 (1.1)	0.5 (1.2)	2.4 (2.5)	**3.8**[c] (2.7)	6.8[a] (1.3)	5.1[b] (2.6)	2.5 (2.7)	47.82*	6, 31
M	11.2 (7.5)		0.0 (0.1)	1.0 (1.0)	1.0 (0.5)	2.6 (0.2)	**3.8** (1.4)	6.3 (1.3)	4.4 (0.9)	2.0 (0.5)		

Table 2 (*continued*)

Slide class	Age (months)	ID	Mean ratings of each emotion: Joy	Interest	Surprise	Fear	Anger	Distress	Sadness	Disgust	F	*df*
Distress	4.3	X-097	0.0 (0.0)	0.3 (1.3)	0.5 (1.5)	2.8 (3.1)	4.6^{c} (2.9)	**7.4^{a}** (1.0)	5.8^{b} (2.4)	3.0 (3.1)	55.64*	6, 31
	6.9	X-071	0.0 (0.0)	0.2 (0.8)	0.3 (0.9)	2.9 (3.0)	5.0^{b} (2.8)	**7.4^{a}** (1.2)	5.4^{b} (2.5)	2.2 (3.0)	58.68*	6, 31
	2.1	A-011	0.8 (2.1)	0.8 (2.2)	0.8 (2.0)	1.6 (2.4)	2.8^{b} (3.0)	**6.1^{a}** (2.4)	3.2^{b} (3.2)	1.0 (2.1)	19.44*	7, 31
	0.9	O-332	0.2 (0.6)	0.1 (0.2)	0.2 (0.5)	2.1 (2.6)	3.5^{b} (2.7)	**5.8^{a}** (2.7)	3.5^{b} (3.0)	1.8 (2.4)	35.54*	7, 31
M	3.6 (2.6)		0.2 (0.4)	0.3 (0.3)	0.4 (0.3)	2.4 (0.6)	4.0 (1.0)	**6.7** (0.9)	4.5 (1.3)	2.0 (0.8)		
Sadness	2.2	X-249	0.0 (0.0)	0.2 (0.6)	0.2 (0.9)	1.9 (1.8)	2.3 (1.2)	6.3^{a} (1.7)	**6.8^{a}** (1.7)	2.4^{b} (2.6)	83.51*	6, 31
	5.4	X-082	0.2 (0.5)	4.0^{a} (2.7)	2.9 (2.7)	4.7^{a} (2.3)	0.9 (1.5)	4.0^{a} (2.2)	**2.8** (2.3)	0.9 (1.5)	24.63*	7, 31
	8.0	A-193	0.5 (1.0)	3.8^{a} (2.1)	1.7 (2.2)	1.8^{b} (2.0)	0.5 (0.9)	1.6 (2.2)	**2.5^{b}** (2.4)	0.8 (1.5)	12.62*	7, 31
	13.1	A-022	0.0 (0.0)	2.4 (2.8)	1.2 (2.0)	2.0 (2.1)	3.0^{b} (2.4)	6.4^{a} (1.6)	**5.5^{a}** (2.5)	2.6 (2.9)	25.75*	6, 31
	2.5	O-328	0.2 (1.0)	2.2^{b} (2.2)	1.1 (1.8)	1.8 (2.3)	2.0 (2.0)	4.0^{a} (2.4)	**4.5^{a}** (2.5)	1.8 (2.4)	15.48*	7, 31
	2.0	O-B09	0.4 (1.2)	2.0 (2.0)	0.8 (1.5)	1.3 (1.9)	3.7^{a} (2.7)	3.7^{a} (2.8)	**3.3** (2.7)	4.0^{a} (2.6)	15.90*	7, 31
M	5.5 (4.4)		0.2 (0.2)	2.4 (1.4)	1.3 (0.9)	2.2 (1.2)	2.1 (1.2)	4.3 (1.8)	**4.2** (1.7)	2.1 (1.2)		
Disgust	5.0	X-076	0.9 (1.6)	1.6 (1.8)	1.5 (1.6)	1.9 (2.3)	2.7^{b} (2.6)	4.6^{a} (2.8)	2.7^{b} (2.7)	**2.0** (2.4)	9.02*	7, 31
	7.0	A-026	0.4 (0.8)	3.1^{a} (2.6)	1.1 (1.6)	1.5 (1.8)	0.6 (1.2)	1.9^{b} (1.8)	1.4^{b} (1.9)	**1.2** (1.9)	8.78*	7, 31
	2 hr	O-369	0.2 (0.6)	0.0 (0.0)	0.1 (0.6)	0.3 (0.9)	0.9 (2.0)	3.1^{a} (3.1)	1.1^{b} (2.1)	**1.4^{b}** (2.5)	12.82*	6, 31
M	4.0 (3.6)		0.5 (0.4)	1.6 (1.6)	0.9 (0.7)	1.2 (0.8)	1.4 (1.1)	3.2 (1.4)	1.7 (0.9)	**1.5** (0.4)		
Adult slides												
Joy		E-PF1-5	**5.3^{a}** (2.0)	4.9^{a} (1.9)	0.7^{b} (1.3)	0.1 (0.3)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	113.62*	3, 31
Interest		O-01	0.7 (1.1)	**3.4^{a}** (2.2)	0.0 (0.0)	0.6 (1.4)	0.9^{b} (1.8)	0.4 (0.9)	0.9^{b} (1.6)	0.3 (1.1)	18.62*	6, 31
Fear		E-JJ5-13	0.1 (0.4)	2.8 (2.7)	6.5^{a} (1.9)	**7.1^{a}** (1.4)	0.9 (2.0)	5.3^{b} (2.7)	1.0 (2.3)	1.7 (2.6)	70.49*	7, 31
Anger		I-02	0.1 (0.2)	1.2 (2.4)	0.1 (0.6)	0.6 (1.3)	**7.8^{a}** (0.6)	2.4^{b} (3.0)	0.3 (1.1)	2.6^{b} (3.2)	72.53*	7, 31
Distress		E-C1-18	0.0 (0.0)	0.4 (1.1)	0.4 (1.2)	2.3^{b} (2.9)	1.2 (2.3)	**7.1^{a}** (1.4)	6.8^{a} (2.1)	0.7 (1.7)	89.22*	6, 31
Sadness		E-JJ5-5	0.1 (0.2)	0.8^{c} (1.8)	0.1 (0.4)	0.4 (1.0)	0.5 (1.3)	3.9^{b} (2.7)	**6.4^{a}** (1.9)	0.6 (1.7)	70.64*	7, 31
Disgust		E-H	0.0 (0.0)	1.3 (2.2)	1.4 (2.3)	0.3 (0.7)	3.2^{b} (2.9)	2.8^{b} (2.5)	0.6 (1.5)	**7.4^{a}** (1.7)	50.98*	6, 31

Note. $N = 32$. Slide class = a priori slide classification. Slide ID prefix indicates source: A, I, X = C.E. Izard; O = H. Oster; E = P. Ekman and W. V. Friesen. Ratings were on a scale from 0 = *not present* to 8 = *strong*. For each slide, the mean rating of the emotion category predicted by Max is shown in boldface. Values in parentheses are standard deviations. Mean ratings for each slide were compared in one-way, repeated measures analyses of variance. The three highest means for each slide were compared by using the Newman-Keuls post hoc procedure ($\alpha = .05$). Within rows, means with different superscripts differed significantly.

* $p < .001$.

Table 3
Percentage of Subjects Whose Ratings Were Scored as Discrete and Blended Emotions

Slide class	Age (months)	ID	Discrete hit[a]	Correct blend[b]	Discrete miss[c]	Incorrect blend[d]
			Infant slides			
Joy	4.5	X-091	13	69	16	3
	7.0	X-119	9	88	3	0
	8.0	A-019	0	25	75	0
Interest	1.9	X-092	53	28	6	13
	4.5	X-034	41	44	9	6
	7.6	A-015	91	9	0	0
Surprise	7.0	X-102	53	44	3	0
	4.2	X-003	25	75	0	0
	12.0	A-002	6	25	53	16
Fear	20.3	X-251	3	22	19	56
	5.0	X-132	6	50	25	19
	7.6	A-S01	3	13	31	53
	2.5	O-312	3	31	31	34
Anger	21.1	X-226	3	31	44	22
	4.8	X-030	6	53	16	25
	6.0	A-S02	0	19	22	59
	13.0	A-023	0	28	31	41
Pain	4.3	X-097	16	84	0	0
	6.9	X-071	25	69	6	0
	2.1	A-011	28	59	9	3
	0.9	O-332	31	56	6	6
Sadness	2.2	X-249	13	81	3	3
	5.4	X-082	6	25	44	25
	8.0	A-193	6	31	38	25
	13.1	A-022	9	56	13	22
	2.5	O-328	9	56	16	19
	2.0	B-09	3	22	41	34
Disgust	5.0	X-076	3	22	28	47
	7.0	A-026	6	28	44	22
	2 hr	O-369	3	59	28	9
			Adult slides			
Joy		E-PF1-5	28	53	19	0
Interest		O-01	53	38	9	0
Fear		E-JJ5-13	13	75	13	0
Anger		I-02	66	34	0	0
Distress		E-C1-18	3	85	13	0
Sadness		E-JJ5-5	56	34	9	0
Disgust		E-H	78	19	3	0

Note. $N = 32$. Slide class = a priori classification. Slide ID prefix indicates source: A, I, X = C. E. Izard; O = H. Oster; E = P. Ekman and W. V. Friesen.
[a] Predicted emotion rated highest by 2 or more points. [b] Highest rated emotions within 1 point of each other, predicted emotion included. [c] Nonpredicted emotion rated highest by 2 or more points. [d] Highest rated emotions within 1 point of each other, predicted emotion not included.

pattern of attributions is not consistent with the claim that Max-specified negative affect expressions communicate discrete and differentiated emotions.

The pattern of emotion attributions was quite different for the adult slides, as shown in Figure 1b. The ratings for fear, anger, and disgust show sharp peaks for the predicted expressions. The distress ratings show a peak for the distress expression with secondary, lesser elevations for the fear faces. Sadness ratings showed peaks for the distress slide (a sadness/distress blend, as noted earlier) as well as for the sadness slide, but sadness ratings were low for all of the other adult slide categories. Thus, the subjects' emotion attributions were consistent with findings from more extensive studies demonstrating that cross-culturally validated adult facial expressions are perceived as communicating relatively discrete and differentiated emotions (Ekman, 1973; and reviews by Fridlund et al., 1987; Oster et al., 1989).

Discussion of Studies 1 and 2

Several generalizations can be drawn from the results of the two observer judgment studies:

1. Max-specified joy, interest, and surprise expressions were judged as communicating positive or hedonically neutral affect; little negative affect was seen in these faces. Interest was seen in joy and surprise expressions, particularly in low-inten-

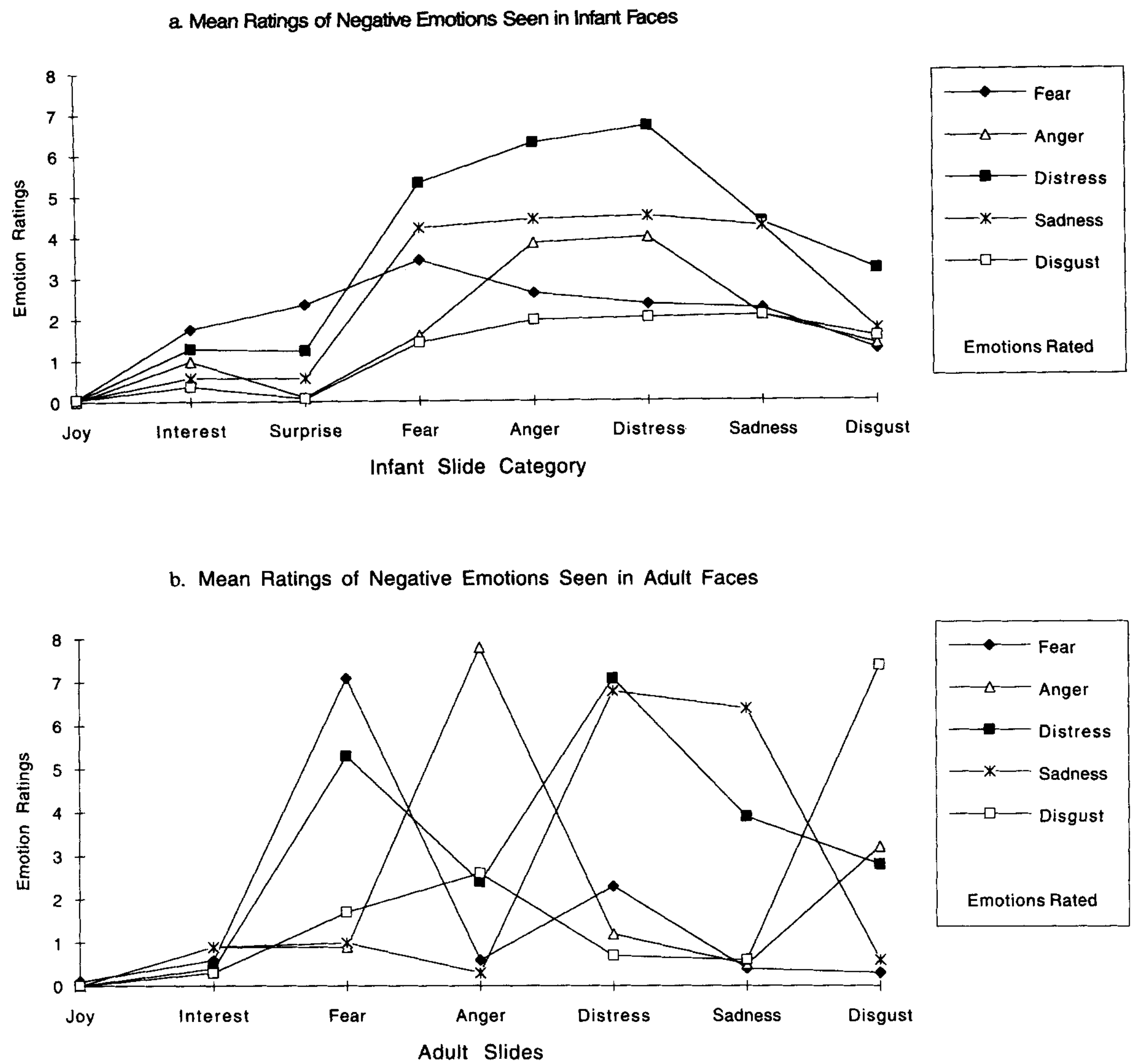

Figure 1. Mean ratings of the extent to which subjects perceived each of five negative emotions in facial expressions in each slide category, with 0 = *not at all* and 8 = *strong. Panel a*: slides of infant faces (ratings averaged across slides within each category); *Panel b*: slides of adult faces (one slide per category).

sity expressions. Both infant and adult negative affect expressions were seen as communicating negative emotions. Thus, as shown in many earlier studies, untrained adults can accurately discriminate between positive and negative affect expressions in infants and adults.

2. The Max-specified infant expressions of discrete negative emotions were perceived as showing either distress or blends of several different negative emotions. Although two sadness slides were judged differentially in Study 1, in Study 2 not one of the 17 discrete negative expressions was perceived as expressing the predicted emotion to a significantly greater extent than other negative emotions. Note that judgments of older infants were not more accurate (in terms of Max predictions) than those of younger infants. In fact, as shown in Tables 1–3, judges did not perceive discrete anger, fear, and sadness expressions even in 13- to 20-month-olds. This does not necessarily mean that recognizable facial expressions of discrete negative emotions are not present in older infants. Rather, it might simply mean that Max formulas do not adequately capture infants' expressions of these emotions.

3. Distress was the most frequently judged emotion for the distress/pain slides in Study 1, and distress was rated significantly higher than any other emotion for infant distress/pain slides in Study 2. Thus, our use of the general term distress did not prevent subjects from selecting this label for slides classified by Max as *physical* distress. Whereas distress was seen as a prominent component of Max-specified infant expressions of fear, anger, sadness, and disgust, this was not the case for adult expressions of these emotions. Thus, it is unlikely that our use of the general term distress served as a distractor that prevented

subjects from identifying discrete negative emotions in the stimulus expressions.

4. The ratings of standardized adult facial expressions were both more accurate and more discrete than the ratings of infant expressions. Only three of the seven adult expressions were seen as showing emotion blends. The joy expression, a low-intensity smile, was seen as showing high interest. The fear expression was seen as blended with surprise, as in earlier cross-cultural studies. And the expression used as our distress stimulus, which had the facial components of a sadness/distress blend, was accurately perceived as such. Further research is needed to discover whether untrained observers reliably differentiate distress and sadness expressions in adults. Our findings suggest that they would, because the adult sadness expression was perceived as showing significantly more sadness than distress.

5. The fact that the adult slides were rated as showing relatively discrete emotions is all the more remarkable, because the preceding infant slides might have produced a response set for perceiving high levels of distress and multiple negative emotions in any negative affect expressions. The findings for adult slides reassure us that the viewing conditions were adequate and that the judges could identify the universal patterns of facial expression identified in earlier cross-cultural studies. The fact that observers made systematic, rather than random, errors in attributing emotions to infant negative affect expressions indicates that the features of the infants' facial expressions were clearly visible. In other words, judges agreed on what they saw in the infants' faces, even if this was not consistent with Max classifications of the slides.

One possible objection to Study 2 is that the adult expressions were posed, whereas the infant expressions were, of course, spontaneous. However, recall that the infant stimuli were selected to fit Max formulas for discrete expressions of each of the basic emotions in infants. According to the Max manual, these formulas and the prototypical exemplars used in Max training materials were based on "cross-culturally standardized photographs of the expressions of the fundamental emotions (in adults)" (Izard, 1983, pp. 34–35). By this account, the Max-specified infant expressions used in Studies 1 and 2 involve the same invariant, universal facial configurations as the posed adult expressions used in earlier cross-cultural studies.[5] Therefore, in terms of the logic of the observer judgment study (Darwin, 1872/1965; and see Oster et al., 1989, pp. 115–116), we can use these expressions "to test whether the facial patterns [Max] identifies as signals of particular affects are indeed identified as those affects by untrained observers" (Izard, 1983, p. 41). Because most of our stimuli were selected from Max and Affex training materials, they are representative of the facial configurations investigators using Max in their own research would code as expressions of the basic emotions in infants.

We should emphasize that our conclusions concerning the infant slides do not depend on a comparison with the adult slides, which we analyzed separately. Even without the infant–adult comparisons, the analyses reported here clearly demonstrate that Max-specified infant facial expressions of negative emotions were not accurately identified. We should also emphasize that we speak of emotion blends only in relation to adults' attributions of emotion to the stimulus expressions. The notion of blends is problematic with respect to negative affect expressions in infants, because the term presupposes the existence of two or more separate and distinguishable expressions, corresponding to different negative emotions. Instead, the infant expressions judged as showing multiple negative emotions may in fact represent less finely differentiated negative affect expressions or variants of distress.

Study 3: Direct Measurement of Stimulus Expressions

Rationale

The fact that untrained observers did not perceive discrete and highly differentiated negative emotions in Max-specified infant facial expressions does not necessarily demonstrate that the infant expressions do not involve the same patterning of facial muscle actions as universal adult expressions of those emotions. Untrained adults may have difficulty identifying the relevant cues in infant faces, or they may be influenced by preconceptions about the capacity of infants to experience or express certain emotions. Study 3 was designed to be a more direct test of Izard's (1983) claim that the facial configurations identified by Max formulas are morphologically the same as their adult prototypes.

Although Max is described as an anatomically based coding system, the basic Max codes do not represent independent, mutually exclusive facial muscle actions. In some cases, visibly distinguishable muscle actions or combinations of actions are lumped together under the same basic code and cannot be distinguished. For example, downturned mouth corners, raising or pouting of the lower lip, and horseshoe-mouth and kidney-mouth configurations are all designated by Max Code 56. Moreover, Max is not a comprehensive coding system; facial actions that are presumed not to be involved in emotional expression are ignored by the system. Because Max formulas were derived, a priori, from stereotyped adult expressions, certain components of salient infant facial expressions (e.g., cry and precry faces) are ignored. Therefore, Max formulas may overlook potentially meaningful infant expressions as well as differences between infant and adult expressions (see Oster & Rosenstein, in press, for a detailed discussion). Some of the components ignored by Max formulas are also present in spontaneous adult facial expressions, including expressions of distress and grief.

For these reasons, we decided to use a more fine-grained coding system to measure the facial actions present in the infant and adult slides used in Studies 1 and 2. The Facial Action Coding System or FACS (Ekman & Friesen, 1978) is a purely descriptive, anatomically based system whose basic units are exhaustive and mutually exclusive. Any complex facial configu-

[5] The reason why posed rather than spontaneous expressions have been used in studies of adult universals is that spontaneous emotional expressions in adults are often inhibited and modulated by display rules (Ekman, 1973; Izard & Malatesta, 1987). According to Malatesta and Izard (1984, p. 161), because infants are incapable of modulating or regulating their emotional expressions, they spontaneously make the kinds of intense, stereotyped facial expressions usually seen only in the posed facial expressions of adults. Similarly, Malatesta-Magai and Izard (1991), citing an unpublished study by Izard, Haynes, and Slomine, report that discrete facial expressions are far more frequent than blends in young infants.

ration can be described in terms of its constituent muscle actions. Baby FACS (Oster & Rosenstein, in press) describes in detail the appearance changes produced by FACS action units (AUs) and combinations in infants' faces, taking into account infant–adult differences in facial morphology (Oster & Ekman, 1978). Baby FACS does not specify a priori formulas for identifying emotions. Instead, coders can describe precisely the expressions shown by infants of a given age and can specify precisely how these might differ from adult facial expressions.

Method

Coders

Two certified FACS coders, unaware of the designated slide categories, served as the principal coders. Both were trained in Baby FACS. A third certified FACS coder, unaware of the purposes of the study, was involved in the final reconciliation of coding discrepancies.

Materials and Procedure

The 39 slides (32 infants and 7 adults) used in Studies 1 and 2 were projected onto a small screen in a dimly lighted room to permit close-up examination of the faces. The infant slides were coded before the adult slides. Working separately, the two coders independently identified the individual AUs (identified by code numbers) present in each slide, including intensity levels for certain AUs. Intercoder agreement on each slide (the number of AUs agreed on by the two coders multiplied by 2, divided by the total number of AUs indicated by both)[6] averaged .88 (SD = .12) for the infant slides and .89 (SD = .11) for the adult slides. Disagreements usually concerned whether a subtle action, seen by both coders, was actually present. All differences were reconciled by conference among the coders. The high intercoder agreement obtained for the infant expressions is another indication that the patterning of facial muscle actions was clearly visible in the stimulus slides.

Emotion Classification

Because we wanted to get an independent assessment of how similar the stimulus expressions were to adult prototypes, we sent the results of the FACS coding with no other identifying information about the stimuli to Paul Ekman's laboratory, where they were analyzed by the FACS interpretations dictionary (Friesen & Ekman, unpublished database program). The FACS dictionary stores information about multiple variants of each of the universally recognized facial expressions of emotion identified in previous research on facial expression both within and between cultures.

The FACS interpretations dictionary, like Max, is based on assumptions derived from universal adult facial expressions. Its validity for classifying infant facial expressions has never been established, and we are not suggesting it as an alternative to Max. Instead, our aim here was to ask whether facial configurations with the component AUs present in the Max-specified infant expressions would—if they were present in an adult face—fit the "templates" for specific discrete emotions. An affirmative answer would support the claim of DET that the facial expressions of the basic emotions are invariant throughout life.

Results and Discussion

A complete discussion of the facial coding and FACS dictionary emotion interpretations is beyond the scope of this article.[7] We report here only the extent to which the FACS-coded stimulus expressions fit the dictionary's templates for universal adult facial expressions. The interpretation of all but one of the adult slides (the neutral interest face, which could not be interpreted) fit the a priori slide classification, as expected. The slide that we used as a distress stimulus (C-1-18, a sadness/distress blend) was interpreted as pure sadness, which is consistent with Ekman and Friesen's (1976) judgment norms—obtained in studies that did not include the term distress as a possible choice. Interestingly, both of the Max coders classified this expression as a sadness/fear blend, reflecting in part a misinterpretation of the partially open cry-mouth configuration (Max Code 53). The Max coders also misidentified the adult disgust expression as anger, based on the angular, squarish mouth (Max Code 54).

For the infant slides, the dictionary's interpretations matched Max classifications for all three happiness slides and two of the three surprise slides. However, two Max interest expressions were not interpretable, and the third (A-015, which had raised brows) was seen as surprise. Among the negative affect expressions, two of the four distress/pain stimuli were interpreted as pain (a provisional category in the FACS dictionary); the others were seen as unspecified negative expressions. Only 3 of 19 Max-specified expressions of discrete negative emotions in infants fit adult templates of those emotions. Discrete sadness was identified in two of seven Max-coded sadness slides (X-082 and A-193); one other was seen as possible sadness, another as a sadness/anger blend, and three were uninterpretable. Discrete disgust was identified in one of three disgust slides (X-076); one other was interpreted as possible disgust and the third as a sadness/disgust blend. None of the five anger stimuli was identified as anger: Four were seen as possible pain, the fifth as unspecified negative affect. These results are consistent with the judgment data from Studies 1 and 2. None of the infant fear stimuli was interpreted as showing this emotion; instead, they were all seen as sadness or possible sadness.

Because interest and pain have not been as extensively studied as the other expressions, the FACS dictionary's templates for these expressions in adults are still rudimentary. Similarly, the FACS dictionary does not distinguish between discrete sadness expressions and more intense, crylike expressions of grief or distress (like the expression in Slide C-1-18); all are interpreted as variants of sadness. Nevertheless, because the FACS dictionary's sadness category is overinclusive compared with Max, the dictionary would have interpreted all of the Max-specified infant sadness expressions as discrete sadness if they in fact resembled variants of the adult prototypes. The finding that more than half of the infant sadness slides were not interpreted

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[6] This is the standard method of calculating interrater reliability used by FACS coders (Wexler, 1972, cited by Ekman & Friesen, 1978). The formula takes into account the large number of basic action units (AUs) and the fact that each coder may select a different number of AUs in describing a particular expression. It weights disagreements more heavily when fewer AUs are involved. It is a conservative measure of reliability, because it disregards agreement on which AUs are not present.

[7] The Baby FACS coding and FACS dictionary interpretations of each slide are available from Harriet Oster.

as such is consistent with the observers' judgments of these slides.

The clearest test of the Max formulas was provided by infant expressions of negative emotions that are not generally viewed as variants of distress. Disgust was identified, alone or blended with sadness, in all three disgust expressions, suggesting a basic similarity between the infant and adult expressions. But the fear slides were interpreted as sadness, and the anger slides were interpreted as pain or nonspecified negative emotion. The FACS dictionary interpretations are not necessarily more correct than the Max emotion classifications. However, because the FACS dictionary and Max formulas were derived from the same universal adult facial expressions, the lack of concordance poses serious problems for the claim that the facial expressions of the basic emotions are fully differentiated and invariant throughout life (cf. Malatesta-Magai & Izard, 1991, p. 12).

Our Baby FACS coding of the slides suggests that the infants' negative affect expressions differed from prototypical adult expressions of negative emotions. On the one hand, nearly all of the infants' negative affect expressions involved distress components (e.g., the raised cheeks and squinted lower eyelids of cry faces), which were not present in the adult anger, fear, or disgust expressions or in the low-intensity sad expression used in our study. On the other hand, salient components of the adult expressions of specific negative emotions were lacking in the infants' faces (e.g., raised upper eyelids in both anger and fear). Clearly, more detailed descriptions of spontaneous expressions of emotion in children and adults—including expressions of pain and distress—are needed to trace changes and continuities in emotional expression.

Summary and Conclusion

The results of Studies 1 and 2 call into question the "social validity" of Max formulas for identifying facial expressions of discrete negative emotions in infants (cf. Izard et al., 1980, p. 139). Except for the Max-specified distress/pain expressions—which were interpreted primarily as distress—these expressions were not accurately identified by untrained adult observers. The results of Study 3 further indicate that, except for disgust, Max-specified facial expressions of negative emotions do not involve the same pattern of facial muscle actions as universal adult expressions of those emotions. Thus, our findings fail to support the claim that infant facial expressions, as represented by Max formulas, "are identical in all essential aspects to adult expressions that have been shown to be universal" (Izard & Malatesta, 1987, p. 531). The findings of all three studies, consistent with earlier findings on the elicitors of infants' facial expressions (e.g., Camras, 1988), indicate that certain Max distinctions may be arbitrary: for example, the distinction between the configurations identified as distress/pain (cry face with closed eyes) and anger (cry face with narrowly open eyes). Other Max categories (e.g., interest and sadness) are quite heterogeneous, encompassing facial configurations that could differ in their affective meaning and signal value as well as appearance.

Although our results fail to support the claim that infants show adultlike, fully differentiated facial expressions of specific negative emotions, this does not necessarily mean that negative affect expressions in young infants are global and undifferentiated, as Bridges' (1932) classic model indicated. Although the experience of emotion and the patterning of facial expressions are likely to be less finely differentiated in infants than in adults, we agree with Sroufe (1979) that precursors of specific negative emotions may be present within the first months of life. Thus, we believe that there are both changes and continuities in emotional development and that emotions and their expressions develop in concert with perceptual, cognitive, and language abilities; self-regulatory capacities; and major behavioral systems such as attachment and exploration (cf. Bloom, 1990; Cicchetti & Schneider-Rosen, 1984; Sroufe, 1979).

In agreement with other investigators who have emphasized the biological adaptiveness of emotions and emotional expressions (e.g., Bloom & Beckwith, 1989; Campos & Barrett, 1984; Izard, 1977; Izard & Malatesta, 1987), we believe that infants' facial expressions can provide reliable information about the infant's "state of mind" and that they serve both internal and external signaling and regulatory functions. However, we would argue that the messages communicated by these expressions are not necessarily the same as those communicated by adult expressions. Rather, certain distinctive infant facial expressions may signal information that is crucial for the infant's survival and normal development. This proposition is consistent with an ontogenetic perspective on behavioral evolution (Oppenheim, 1980), which views the characteristics and capacities of young organisms as adaptive in their own right, and not just as immature or precocious versions of adult traits.

An examination of whether infants of a given age show differentiated negative affect expressions should thus not be limited to the question of whether they show adultlike expressions of specific, discrete emotions. Using descriptive coding systems such as Young and Décarie's (1977) ethologically based system and the more fine-grained Baby FACS (Oster & Ekman, 1978; Oster & Rosenstein, in press), investigators have identified a number of distinctive facial configurations in young infants, including measurably different variants of cry and precry faces and configurations descriptively labeled pouts, horseshoe-mouth configurations, kidney-mouth faces, and so forth. These configurations involve different patterns of facial muscle action, and there is some evidence that they have different behavioral correlates (cf. Oster, 1982; Oster & Ekman, 1978). They may thus reflect different states of mind in the infant and may convey different messages to caregivers. However, because these distinctive infant expressions may not map perfectly onto adult emotion categories, their meaning cannot be defined a priori. Instead, we must discover their meaning for the infant and caregiver. This task requires precise and objective descriptions of infants' facial expressions, along with detailed analyses of their antecedents and behavioral correlates and analyses of the caregivers' spontaneous responses to these expressions in naturally occurring (or experimentally manipulated) social interactions.

The results of all three studies reported here indicate that extreme caution should be exercised in applying formulas derived from stereotyped adult expressions (especially expressions of negative emotions) to infants. Formulas for classifying or interpreting adult facial expressions could be used for purposes of comparison, to describe similarities and differences between adult prototypes and infant facial expressions. But even for this purpose, comparisons would have to be based on a comprehensive coding of the facial muscle actions present in the infant and adult faces, rather than a selective coding of actions presumed to be relevant to emotion; and the coding system would have to take into account infant–adult differences in facial morphology.[8] The crucial point is that we cannot simply assume that infant facial configurations that fit relatively crude formulas for discrete emotions in adults necessarily reflect those specific emotional feeling states in infants, or even that they involve the same patterning of muscle actions or the same temporal dynamics as the adult prototypes.

Researchers who use such formulas to label infants' facial configurations in terms of adult emotion categories, without testing the validity of the formulas or of the rules for inferring emotion for infants of the same age they are studying, risk making three kinds of errors:

1. Infant facial expressions that fit a priori formulas for a particular discrete emotion may not in fact reflect that emotion or feeling state in infants of a particular age.[9] In that case, researchers using the coding system will systematically misidentify that emotion and thus risk drawing dubious or erroneous conclusions about normative response patterns, developmental changes, or, worse, individual differences and their significance. Several widely cited findings should be critically reexamined as a result of the questions raised here: for example, that older infants showed anger rather than distress in response to pain stimuli (Izard, Hembree, & Huebner, 1987); that anger was the dominant response to separation in the Ainsworth Strange Situation for all attachment groups; and that insecure-resistant infants, typically described as angry, showed more sadness than secure infants (Shiller, Izard, & Hembree, 1986).

2. Researchers using a priori coding systems may make errors of omission as well as errors of commission. They may fail to identify facial expressions that differ from adult prototypes but that signal a particular emotion nonetheless. For example, a facial configuration that does not fit the adult fear template may be reliably related to situations believed to elicit fear and may have consistent behavioral correlates suggesting the presence of that emotion in infants.

3. If we simply assume that a particular facial expression represents a particular emotion (based on its fitting an a priori formula), we may fail to discover what specific information that expression actually conveys about the infant's perceptual–cognitive processes, behavioral tendencies, and emotional state. Even if the adult emotion label is not completely erroneous, it cannot tell us as much about the message or meaning of an infant expression as a detailed, empirical analysis of its situational determinants and behavioral correlates (Kagan, 1978; Smith, 1977).

In conclusion, we believe that until basic questions about the origins and differentiation of facial expressions of emotion are resolved, attempts to label infant facial expressions—particularly negative affect expressions—in terms of discrete adult emotion categories are premature. Because we cannot simply assume that facial expressions emerge full-blown in their adult-like form at a particular age, detailed studies are needed to trace the development of facial expressions throughout the first years of life. We hope that the findings of the present investigation will help to stimulate such studies.

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[8] Friesen and Ekman's (1984) earlier EMFACS, like Izard's Max, was based on a selective coding of facial muscle actions. Its replacement, the FACS dictionary, can be applied to infant facial expressions that have been comprehensively coded with Baby FACS, as in Study 3. However, the FACS dictionary's interpretation rules ignore certain actions and combinations that are salient components of infant facial expressions. The distinction between sadness and more intense grief or distress expressions is also ignored, as noted earlier. For these reasons, infant expressions that fit the FACS dictionary's templates for discrete negative emotions might in fact differ from the adult prototypes, and these differences might reflect significant differences in the signal value and affective meaning of the infant and adult expressions.

[9] The likelihood of making errors of commission with Max is increased by the rule that allows a discrete emotion to be coded if movements specified by the formula for that emotion are present in only two of the three areas of the face. This rule disregards the findings of several studies (reviewed by Oster et al., 1989) showing that for adult facial expressions, different areas of the face are important for communicating different emotions.

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