

## Maternal Emotional Signaling: Its Effect on the Visual Cliff Behavior of 1-Year-Olds

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In human psychological research, emotional expressions are generally treated as behavioral responses or as outcomes of cognitive appraisal processes. Thus, they are viewed as external indexes of internal states. Relatively little attention has been given to the function of such displays as regulators of interpersonal behavior. This lack of attention contrasts sharply with clinical experience and everyday life, wherein the emotional reactions of another can have powerful effects on the perceiver, such as in eliciting empathy or inducing moods. It also contrasts sharply with studies in nonhuman primates where emotional signaling has been a topic of considerable interest. Facial expressions such as fear, anger, and playfulness, as well as the intensity of emotion, serve communicative functions among monkeys, as has been reviewed by Chevalier-Skolnikoff (1967) and Hinde (1974). Furthermore, the development of responsiveness to maternal facial signals among infant chimpanzees in the wild has been documented (Lawick-Goodall, 1967); in this, infants responded to postural and facial expression variations in their mothers, which indicated the moods and subsequent behavior of the latter. More recently, some theoreticians have speculated about the "catching of fears" (Bowlby, 1973) and about emotional expressions as

parameters of observational learning (Bandura, 1977; Campos and Sternberg, 1981).

A major turning point for human emotions research occurred when two separate teams of investigators demonstrated the apparent universal communication value of specific emotional expressions. Cross-cultural studies of adult facial expression have shown that particular patterns are recognized reliably (such as joy, fear, anger, sadness, surprise, and disgust) and, correspondingly, there also seems to be a species-wide, intuitive capacity to express these emotions (Ekman et al., 1969; Izard, 1971). These findings have generated a number of lines of investigation. Among them is research leading to measurement advances in specifying the facial patterning involved in emotional signals that are recognized. In addition, it has led to research demonstrating that discrete emotional expressions occur in response to specific eliciting circumstances (Hiatt et al., 1979; Stenberg et al., 1983).

We believe the latter two lines of research have made possible the empirical study of the communicative and regulatory functions of emotional expressions. Our logic is as follows. If the observer can identify emotional expressions and can assume that the expressing person is reacting to relevant environmental circumstances, then it seems quite likely that the attitude and/or behavior of that observing person will be influenced by noting the other's emotional expressions (i.e., a communicative function). Beyond this, to the extent that emotional expressions influence the behavior of the observer, they can be said to be serving a *social regulatory* function.

Our human infancy research has begun to investigate the developmental roots of the social regulatory functions of facial expression. We have come to realize that a process we have called social referencing occurs when an infant is confronted with an ambiguous circumstance: the infant looks to the face of another in order to search for emotional information to help appraise or evaluate the ambiguity. The infant's subsequent behavior then reflects a revised appraisal of the environment. Accordingly, the following series of studies investigates social referencing using one ambiguous circumstance, namely a modified visual cliff. We sought to determine whether 1-year-olds confronted with this kind of ambiguous circumstance would (a) look to mother's face and (b) use the emotional information in the mother's experimentally manipulated facial pose to guide their subsequent exploratory behavior.

### Method

Subjects were middle-class volunteers who had been recruited from birth announcements in the neighborhoods of the University and the Health Sciences Center and whose infants were normal at birth. In response to postcard inquiries, they had expressed an interest in participating in studies of normal psychological development. Subjects coming to our laboratory were included in the study if (a) they did not become distressed at any time *prior* to noticing the drop-off, (b) they spontaneously referenced mother's face after observing the drop-off (defined as an uninterrupted sequence of looking *down* at the depth and *up* to mother's face), and (c) the mother's facial signal adequately represented the pose taught during pretraining as verified by a manipulation check.

In the first three studies to be reported below, of 145 infants coming into the lab, 11% were unable to be included in the study because of distress during the warm-up, 21% because they did not engage in visual referencing of mother's face, and 8% because mother's pose was judged as inadequate when scored by an observer naive to the hypothesis of the study.<sup>1</sup> Overall, therefore 40% of the original infants were not included. Because of the question being asked, criteria for subject inclusion from Study 4 were different; these data will be presented with the results from that study.

To create an ambiguous circumstance, we chose to manipulate depth – a physical dimension that can be varied to elicit avoidance of heights in infants, no avoidance at all, or a threshold of uncertainty. The visual cliff apparatus permits this manipulation of height quite readily (Walk, 1966). The cliff is a plexiglass-covered table divided into two halves: a shallow side under which a patterned surface is placed immediately beneath the plexiglass, and a deep side under which is placed a similar surface some varying distance beneath the plexiglass. Pilot testing revealed that setting the depth at 30 cm and placing an attractive toy (a Fisher-Price musical ferris wheel toy, model no. 969) on the deep side elicited infant pauses at the edge and frequent looks to the mother but no clear avoidance of the depth.

Before each trial, infants were placed on the shallow side of the cliff and entertained there by a previously familiarized experimenter, while mother positioned herself on the far (deep) side of the table. A second

experimenter, monitoring the infant's behavior on a videotape screen from an adjacent room, was able to provide mother with instructions by means of a wireless earphone. Mother placed the attractive toy directly on the deep surface (to increase the ambiguity concerning the tactual solidity and visual transparency of the deep side) and began smiling to encourage her infant to approach the drop-off. When the infant advanced to within 38 cm of the drop-off, oriented toward the depth, and looked up to mother's face, the mother was instructed to signal her infant with one of the discrete emotions designated below.

Mothers had been trained in posing the desired facial expression in accordance with the descriptions of Izard (1980) and Ekman and Friesen (1975); they used no words, sounds, or gestures. For fear, the facial expression manipulation involved raising and drawing together of the brows, eyes open wide with sclera showing, and the mouth opened and the lips pulled back. For anger, the brows are drawn down and together, the upper eyelids are lowered, and the mouth is either open and square-shaped, or the lips are pressed together. For interest, there is a slight raising of the eyebrows, the eyes are widened slightly, and the mouth is closed and the face relaxed. For happiness, the corners of the lips are drawn back and up, the cheeks are raised, and the lower eyelids are raised but not tense. For sadness, the inner corners of the eyebrows are drawn up, the skin below the eyebrow is triangulated with the inner corner up, and the corners of the lips are drawn down.

Maternal facial expressions were scored independently by a naive rater who had achieved reliability on MAX training (Izard, 1980). All expressions during times of visual referencing were scored for the presence of components that would be expected for the given emotion according to Ekman and Friesen's *Unmasking the Face* (1975). Facial expressions met criteria of having predicted components in two or three facial zones and no components belonging to other target emotions. On those unusual occasions when only one facial zone met the predicted pattern, the posed feature had to be an indicator of the intended emotion and no other (for example, a smile or "sad brows").

A trial was terminated when the infant either crossed the deep side (touching the toy, mother, or the end wall) or when 120 s elapsed from when the infant entered the region of the drop-off. All trials employed split-screen videotape recordings, with one camera constantly focused on the infant's face and body and a second camera on the mother's face.

Tapes were scored for three infant behavioral categories: (a) *hedonic tone* – rated every 10s on a 5-point scale ranging from a broad smile (rating of 1) through neutral interest to overt distress (rating of 5), (b) *maternal referencing* – the total number of times an infant looked at mother's face after an initial instance of looking from the depth immediately to mother's face, and (c) *coping behavior* – the presence or absence of crossing the deep side, and the frequency of retreat back onto the shallow side, defined as turning his or her back to mother and moving back onto the shallow side. Reliabilities for each of these dependent variables, calculated as exact agreement between two naive judges, ranged from .80 to 1.00, with a mean of .94.

## Results

### First study: happy versus fear signal

The first study compared infant responses to this uncertain situation when mothers signaled either happiness or fear. Thirty-six middle-class mothers and their 12-month-old infants were randomly assigned to a smiling condition ( $N = 10$  males, 9 females) and to a fear condition ( $N = 9$  males, 8 females).

The mother's emotional signaling had three dramatic effects on the infants' behavior. First, it significantly influenced the infant's tendency to cross the cliff or not. When mother posed a fearful expression none of the 17 infants ventured across the deep side. In sharp contrast, 14 of the 19 infants who observed mothers' happy face crossed the deep side,  $\chi^2(1) = 20.49, p < .0001$ . Second, the fear pose created a negative motivational valence: 11 of the 17 infants in the fear condition retreated, whereas only 3 of the 19 infants in the joy condition retreated,  $\chi^2(1) = 5.38, p < .03$ . Infants in the fear condition usually vacillated back and forth in the midzone of the cliff and then moved back to the shallow side. Third, the fear expression generated a significantly more negative hedonic tone in the infants,  $F(1, 34) = 4.03, p < .05$ . These findings are summarized in table 16.1.

### Second study: interest versus anger signal

A second study was conducted to determine whether the regulatory effect of social referencing could be observed with different emotions.

**Table 16.1** Effect of mothers' facial expressions on infant behavior

| Variable                                           | Study 1             |                      | Study 2                  |                       | Study 3                 |
|----------------------------------------------------|---------------------|----------------------|--------------------------|-----------------------|-------------------------|
|                                                    | Joy<br>( $N = 19$ ) | Fear<br>( $N = 17$ ) | Interest<br>( $N = 15$ ) | Anger<br>( $N = 18$ ) | Sadness<br>( $N = 19$ ) |
| Percentage of infants crossing deep side           | 74%                 | 0                    | 73%                      | 11%                   | 33%                     |
| Mean number of retreats per minute to shallow side | 0.420               | 1.08                 | 0.420                    | 0.72                  | 0.660                   |
| Mean rating of hedonic tone                        | 1.62                | 2.12                 | 2.00                     | 1.92                  | 1.92                    |
| Mean number of references per minute               | 3.60                | 2.46                 | 5.70                     | 2.94                  | 4.59                    |

Two different emotional signals, interest and anger, were used. These emotions were selected because they not only represented a positive and negative emotional signal but, like enjoyment and fear, they both seemed to provide situationally relevant messages concerning the appropriateness of crossing versus not crossing the cliff.

Thirty-three 1-year-old infants and their mothers comprised the sample for the second study, with 15 randomly assigned to the interest condition (8 males, 7 females) and 18 to the anger condition (11 males, 7 females). The instructions, training, and trial procedures as well as the subsequent data scoring techniques were identical to those reported for the first study.

Results again revealed a powerful effect of mothers' emotional signaling on infant crossing behavior (again, see table 16.1). When mother posed an anger expression, only 2 of the 18 infants ventured across the deep side, while 11 of the 15 infants who observed mother's interest expression crossed the deep side,  $\chi^2(1) = 13.29, p < .001$ . Infants who saw mother's angry expression while at the visual cliff edge tended to actively retreat by moving back onto the shallow side: 14 of the 18 infants in the anger condition retreated, and only 5 of the 15 infants in the interest condition did so,  $\chi^2(1) = 5.22, p < .05$ . Unlike the results of the initial study, there were no significant differences in infant hedonic tone.

As discrete emotional expressions, fear and anger appear to be situationally relevant in the child's appraisal of the deep side of the cliff. Fear

provides a warning that there is danger and the infant should avoid the drop-off to insure his or her safety. Anger serves as a restraint, prohibiting the infant from approaching further. Both fear and anger, however, also convey a negative hedonic tone, which might be the mediator of the avoidance behavior in both cases, independently of the discrete emotional information (Izard, 1977).

### *Third study: sadness signal*

A third study was conducted to look at the effects if mothers signaled sadness. Sadness is a fundamental emotion, which conveys a negative hedonic tone, but its discrete emotional information does not imply avoidance or prohibition. In a third study we, therefore, investigated the reactions of an additional eighteen 12-month-old infants (6 males and 12 females) on the visual cliff while their mothers posed sadness. Results indicated that 6 of the 18 infants successfully crossed the deep side when mother's face conveyed sadness. The mean number of references by infants from this group was higher than any other, suggesting that these infants might be puzzled or uncertain about the facial signal itself or its meaning in the present context, among other possibilities.

A comparison of the crossing behavior in the negative emotion conditions revealed a significant difference between sadness and fear (Fisher Exact Probability Test,  $p = .01$ ) and a nearly significant difference for sadness and anger ( $p = .09$ ); the difference between fear and anger was not significant ( $p = .26$ ). These findings suggest that the appropriateness of the context for an emotional signal must be taken into account; the most contextually appropriate emotion (fear) elicited the most consistent avoidance of heights.

### *Fourth study: fear signal without uncertainty*

The final study in the series addressed a separate issue related to the importance of context. In order to determine whether the expressions influenced the infant's evaluation of an ambiguous situation, or whether they were effective in controlling behavior merely because of their discrepancy or unexpectedness, we tested an additional 23 infants (11 males and 12 females) with the visual cliff table modified to consist of two shallow sides separated by a center strip .3 m wide. The mothers were instructed exactly as they had been in the fear condition described

above. They smiled broadly until the infant reached the center of the table, then shifted to a previously trained fear facial pose. The results obtained in this condition were quite different from the earlier study, revealing very little referencing and no effect of the facial expression on crossing behavior. Seventeen of the infants tested in this condition did not look to the mother at all and merely continued crossing to reach her or the toy. Among the six babies who referenced, two of the mothers gave poor signals, and the infants were eliminated from the study. Those four babies who looked to the mother and received a fear signal crossed to the toy in spite of her fear pose. This behavior was in marked contrast to that of the babies who saw the mothers' fear face after noticing the slight drop-off (Fisher Exact Probability Test comparing for fear in the two contexts,  $p = .0004$ ). The findings described earlier, therefore, seem interpretable as a social referencing process – the infant must seek out emotional information for that information to be maximally effective in regulating behavior.

## Discussion

The form of emotional communication we have referred to as social referencing appears to have a powerful and consistent effect on infant behavior. Social referencing, as we have defined it, is a process whereby an individual seeks out emotional information in order to make sense of an event that is otherwise ambiguous or beyond that individual's own intrinsic appraisal capabilities (Campos and Stenberg, 1981; Klinnert et al., 1982). Under the conditions of our experiment, the tendency to visually reference mother and to respond according to an emotional message is already well established at 12 months of age, and it appears rather dramatic to mothers and researchers alike who view our videotapes. Under other conditions, such as the entry and approach of a stranger, social referencing effects have been shown at 10 months of age (Feinman and Lewis, 1983). Two sorts of experimental questions remain to be answered before any general application of findings about social referencing. These questions have to do with the role of *selection* of subjects and the role of *context* for social referencing.

First for selection factors. Our experiments looked at a relatively narrow set of infants. Volunteers were middle-class, and not all children were able to complete the testing. We did not include children who were

crying during the warm-up phase or children who never looked at mother (except for the fourth experiment). Because of selection factors our results may, therefore, represent children who are functioning at a relatively high capacity. We need to understand more about individual differences among children who do and do not reference (e.g., Feinman and Lewis, 1983). Related to this, we need to know more about individual differences concerning internal "state" factors affecting children who may or may not attend or who may or may not be involved in appraisal. Furthermore, are there subtle differences in social referencing based on individual differences and the history of the relationship between mother and infant? A series of studies is planned to explore these questions, some of which use heart rate as a sensitive measure of change related to attentional processes and emotional state.

Now for the questions regarding context. We need to know more about situations generating "uncertainty." In our experiments, we did a considerable amount of pilot work to develop a definitive zone of uncertainty. If the "deep side" of the visual cliff was deeper, infants showed fear and avoidance; if it was shallower, they showed no uncertainty and crossing to the toy occurred without referencing. This precise adjustment was necessary to establish our experimental condition. But it is important to realize that the visual cliff is a situation that is highly controlled and one in which the infant has relatively few options, considering his or her complex behavioral repertoire. We need research involving more complex experimental situations – situations in which there are richer opportunities for behavioral regulation and coping. Recent work of Gunnar and Stone (1983) has underscored the importance of uncertainty in social referencing tasks involving unfamiliar toys. We are currently doing experiments in a variety of other uncertainty situations, which include a toy robot, a collapsing house, the approach of strangers, and a variety of social situations.

In addition to contextual questions about the setting, there are contextual questions about the emotional signal, including appropriateness. Again, it seems important to emphasize that, for reasons of experimental control, we limited the signal to a manipulation of the face alone. We now need to study other channels of communication besides the facial channel. Emotional signaling occurs through the vocalic channel of emotional communication, and it is likely that posture and gestures are also important. Research also needs to be done in more complex contexts – those in which emotional signaling occurs in

multiple channels at the same time, as would be the usual case in the infant's world.

There are other interesting questions that arise from this line of research. What is the developmental onset of social referencing? What is the role of learning? Of maturation? Do emotional expressions regulate behavior by eliciting feelings in the perceiver, or are they merely cues that guide behavior? What is the relationship of social referencing to the past history of individual infants in relationship to attachment and to particular socialization experiences? What is the relationship of social referencing to empathy? What happens in situations of conflicting emotional signals?

We have emphasized future experimental approaches, but the latter questions indicate that we also need to explore naturalistic settings for the occurrence of social referencing and related phenomena. Social referencing is only one form of emotional signaling. Whatever else, these experimental effects that seem so impressive need to be understood in terms of their real-life significance.

#### Note

- 1 The breakdown according to numbers of subjects eliminated for the first three studies is as follows: infant distress during warmup (12, 2, and 2); no maternal referencing (7, 15, and 8); inadequate mother pose (6, 2, and 3).

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