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Social Referencing as a Learned Process

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INTRODUCTION

Social referencing has been conceived as the process whereby, in the fourth quarter of their first year, human infants seek out and use information in the facial (but also vocal and/or gestural) emotional expressions of others (most often the mother) to cue/guide their responding in contexts of uncertainty or ambiguity (Campos & Stenberg, 1981; Klinnert, Campos, Sorce, Emde, & Svejda, 1983). Social referencing also has been characterized as infants' perception and use of other persons' interpretations of a situation to form their own understanding of that situation (Feinman, 1982; Feinman & Lewis, 1983). Up to now, the infant social referencing literature has devoted almost total emphasis to describing and delineating this phenomenon, and to emphasizing the feature of affective communication between mother and infant (Campos & Stenberg, 1981; Feinman, 1983, 1985; Gunnar & Stone, 1984; Hornik & Gunnar, 1988; Klinnert, Emde, Butterfield, & Campos, 1986; Walden & Ogan, 1988; Zarbatany & Lamb, 1985). To date, the main etiological theory in the literature has been pre-

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Social Referencing and the Social Construction of Reality in Infancy, edited by [illegible], Plenum Press, New York, 1992.

...t infant social referencing involves prewired responses
...ns, a "prewired communication process" (Campos, 1983).
...n alternative to that nativist theory is proposed here (and in Peláez-Nogueras, 1992), that social referencing can result from the infant's *learning* in contexts of uncertainty that maternal-expressive cues, consequent upon its referencing looking response, can predict reliably positive or aversive consequences for its actions. The results of a paradigmatic study that supports such an operant-learning model of social referencing are presented in this chapter. The reported research demonstrates that the differential cue value (meanings) of originally meaningless maternal facial expressions contingent upon infant referencing-looks can be conditioned readily, depending on the predictive utility of those maternal facial-expressive cues for infant responding in ambiguous contexts. Finally, we emphasize that the maternal expressive cues in social referencing need not relate to conceptions of emotion or affect.

PREFORMATIONISM AND INFANT SOCIAL REFERENCING

Few theories have been advanced to explain how infant social referencing and the maternal facial-expressive and other (e.g., vocal) cues controlling the referencing response come into being, what maintains referencing, and what the nature of the underlying process is. Campos (1983) has proposed that " . . . social referencing is biologically adaptive and involves prewired responses and perceptions . . . [and] serves as an occasion for the operation of much more fundamental processes . . . [such as involve] emotional communication" (p. 85). Elsewhere, in a major handbook chapter on socioemotional development, Campos, Barrett, Lamb, Goldsmith, and Stenberg (1983) assert that

> . . . unlike language or cognition, *the basic emotions*—which we believe include joy, anger, disgust, surprise, fear, sadness, sexual ardor, affection, and possibly others–*utilize a noncodified, prewired communication process*, a process now known to require no social learning either for the *reception* of at least some facial and gestural signals . . . or for the *production* of such. (p. 785)

From this preformationist conception it follows that, early in life, the human infant will perceive/understand the meanings of its mother's emotional facial expressions (with or without vocal or gestural accompaniment) via social referencing. That is, the position assumes that, on an unlearned basis, the mother's facial expression will communicate the meaning of her "emotion" to her infant, and that such a meaning will help the infant to regulate its behavior in ambiguous contexts. Campos *et al.* (1983) have cited three research reports as the basis for their assertion that

the human mother's facial expression will, on an unconditioned basis, communicate her emotional response's meaning to her infant. However, for the reasons detailed, it is not apparent how those reports can support a preformationist assumption.[1]

It is axiomatic that researchers must remain open-minded about whether or not, on an unlearned basis, human infants can perceive the meanings of their mothers' emotional-expressive patterns. Hence, given equivocal macaque data and an absence of definitive human infant supporting data, it is remarkable that Campos (1983) and Campos *et al.* (1983) have advanced their strong assertions that one-year-old human infants—in whom the social referencing phenomenon has been identified—are born with this unlearned ability. Indeed, one can conceive diverse scenarios in the evolutionary history of *Homo sapiens* that involve contingencies of survival and adaptations to ecological demands. Nevertheless, given

[1]In comment, we note the following: First, those three studies (Kenney, Mason, & Hill, 1979; Mendelson, Haith, & Goldman-Rakic, 1982; Sackett, 1966) all investigated rhesus macaque (*Macaca mulatta*) infant and postinfant monkeys, a species with a different evolutionary history than *Homo sapiens*, to which Campos *et al.* generalized the purported findings of those studies. Second, none of the three studies dealt in macaques with infant and postinfant reactions to maternal expressive facial reactions, much less in the humans to which Campos *et al.* generalized the purported findings. Third, Sackett's (1966) presentations of the threatening-macaque infant slide generated, in the observer macaques, not only a relatively high mean incidence of behavior denoting disturbance, but also relatively high mean incidences of vocalizations, play, and exploration, behaviors that do not ordinarily denote disturbance. This result pattern necessarily complicates/dilutes an interpretation that a macaque-threat slide stimulus is a releaser of behavior denoting disturbance. Further, Sackett's threatening-macaque slide presentations evoked more mean vocalizing, behavior denoting disturbance, and play behavior than did the fearful-expression monkey slide which, in turn, did not differ in elicitating mean behaviors than such slides as those showing a macaque infant, or monkey play, withdrawal, or exploration. These mean-result patterns make Sackett's (1966) findings equivocal with regard to innate recognition mechanisms in infant and postinfant (a few days to 9 months post partum) macaques, much less for infant humans showing innate recognition of maternal facial expressions. This is because it is not obvious that presentations of macaque facial-threat slides (or even fear-face slides) "release" an inborn fear response unconfounded by vocalization, play, and exploration behavior in monkeys reared in isolation for most of their lives post partum. Fourth, we note that Kenney, Mason, and Hill (1979) tested macaques for their lip-smacking and grimacing reactions to their own mirror images, or to a human face, during the first 12 weeks of life, and compared mean responses for groups reared with (1) both monkeys and people, (2) only one monkey, or (3) neither monkeys nor people. Their design does not impact on the question of the unlearned versus the learned basis of communication of the meaning of the mother's emotional facial reaction to her infant. Finally, we note that the Mendelson, Haith, and Goldman-Rakic (1982) study of infant macaque gaze aversion and fixation found that infants looked more at the eyes of pictured monkey faces "looking back" than at faces "looking away." Again, it is difficult to see how these findings bear directly on the issue of whether or not the macaque or human mother's emotional facial reaction has innate meaning for her infant.

...at newborns and infants of an altricial species such as humans remain helpless and incapable of locomotion for an extensive period, it is difficult to imagine an evolutionary scenario in which the human species would survive better, or be more advanced in its ecological niche, by its infants having the ability from birth on an unconditioned basis to discriminate the meanings of diverse maternal emotional expressions.

Indeed, what the young human does seem to have acquired via evolutionary adaptation is the specialized capacity to *learn*, that is, to adapt readily to changing circumstances in its ecological niche early and late in ontogeny (Petrovich & Gewirtz, 1984, 1985). In this connection, it may be more reasonable to assume that the actual consequences for infant responses in the presence of maternal facial-emotional expressions, rather than a preprogrammed stimulus–response connection, is what comes to determine the infant's approach or avoidance to ambiguous objects. There is ample evidence in newborns and in infants in the first months of life that they can be trained readily to discriminate between stimuli (visual, auditory, tactile) that cue responses leading to differing consequences (reinforcing or nonreinforcing) by responding differentially to them, very much like what is involved in the social referencing phenomenon (Ling, 1941; Munn, 1965; Peláez-Nogueras & Gewirtz, 1990; Simmons & Lipsitt, 1961; Siqueland & Lipsitt, 1966; Staples, 1932).

Further, there are illustrations in several research realms of the influence of very early, even prenatal, experiential factors that, when overlooked, could imply innate/preformed capacities. A nonhuman example based on research with mallard hens and hatchlings can be instructive. Early work on *imprinting* in precocial fowl had concluded that imprinting was a prewired response of the hatchling based on simple visual exposure of the hatchling to a moving and vocalizing model of the hen, and that there was a critical period for this imprinting (Gottlieb, 1971, 1973; Hess, 1973; Hess & Petrovich, 1973). Subsequent research found relevant to the explanation of imprinting the fact that the hatchling exhibits auditory capacity and organized motor patterns after it breaks into the egg's air space, which can occur as early as 72 hours before hatching. In the egg's air space the hatchling hears the hen's calls, vocalizes, and the hen vocalizes apparently in response, to the point where the hen may vocalize as often as 45 times per minute during the last phase before hatching. The hen's calls heard by the hatchling are the same as the calls she will emit some 48 hours later, when she signals to her brood the move to a new ecological setting, such as a nearby body of water. Experience with the hen's call and preference for it were seen to have an important role in the process of imprinting.

Post hatching, the earlier experience with the hen's call was found to

have a significant role in the imprinting process. The duckling will typically orient to and follow—that is, imprint—its moving and vocalizing hen mother whose calls are familiar, even in contexts where several hens are in the vicinity. This example from imprinting research can illustrate a process that, in early work, involved strong assumptions that imprinting was prewired and limited by a critical period. In later work, those strong assumptions were seen to be unwarranted as an explanation of the imprinting process, for imprinting was seen significantly to involve systematic prior-to-hatching vocal interaction between hen and hatchling. This pattern of prehatching experience led the duckling to exhibit post hatching, a filial pattern of differential orientation to, and preference for, its mother's call. Thus, in the absence of prehatching data, imprinting was considered by some to be entirely preformed, and to result only from exposure to a moving and vocalizing hen model during a critical period (see also Petrovich & Gewirtz, 1991).

A similar instructive case involving human neonates is provided by DeCasper and Spence (1986), who demonstrated that, 3 days post partum, neonates manifested differential preferences (determined via operant preference procedures) for the acoustic patterns of 600-word stories that were read to them, as fetuses, by their mothers 67 times on average during the last 6 weeks of gestation. Preferences were determined via an operant reinforcement procedure wherein the differential-reinforcing value for operant nonnutritive sucking of the earlier maternally read passage and control passages were compared. (This finding indicates that, in the last 6 weeks of gestation, human fetuses can discriminate vocal auditory signals that they must have received in attenuated form through the amniotic fluid which, subsequently, as 3-day-old neonates, they were able to compare to nonattenuated signals.)

These reports exemplify how preformationist assumptions about "prewired" unconditioned processes can be problematic even in the newborn, and much more so in the 1-year old infant who has served as the typical subject of social referencing studies. In the absence of information about systematic prenatal experience with a parent, the newborn duckling's filial response to the first moving and vocalizing object it sees and the human neonate's differential preference for acoustic patterns of stories read by their mothers, could be assumed incorrectly to have been due to preformation rather than to exposure learning. In any case, an empirical question remains at issue at the proximal level of analysis, one that in principle can be answered only by systematic observation and experimentation. In this context, with so little of the required research done, it is puzzling that researcher–theorists of social referencing phenomena and early communication, like Campos and his associates, so readily have

ed that infants of a species so highly adaptable and sensitive to environmental contingencies as *Homo sapiens* operate in a prewired manner.[2] Human evolution reflects an unusual capacity to modify and extend phenotype characteristics as the result of particular experiences (denoting learning). As the Gottlieb, Hess and Petrovich, and DeCasper and Spence analyses have illustrated (and as our analysis assumes), via exposure-learning processes very early in ontogeny, systematic environmental stimulation can influence cued-response patterns of communication between mother and infant, patterns that might otherwise appear unconditioned/prewired to those unfamiliar with the specific behavior and its fetal or early postnatal environmental history.

SOCIAL REFERENCING AS A LEARNED PROCESS

Absent from the social-referencing literature is a conception that is proposed here (and in Gewirtz, 1991) as an alternative to preformationistic/nativistic hypotheses, like the one Campos (1983) and Campos *et al.* (1983) have advanced to explain the social referencing detected in infants during the last quarter of the first year.[3] This alternative is that, early in the first year, social referencing can result from the infant's *learning* that, in contexts of uncertainty, maternal facial-expressive cues (that we assume are originally neutral in value) can come reliably to predict positive or aversive consequences for the infant's actions in those ambiguous contexts or to those ambiguous objects. Specifically, in contexts of uncertainty infant responses such as reaching for or approaching, or avoiding, objects or

[2]At first glance, it could appear that all preformation versus all learning determinants of social referencing are being counterposed. Hence, a comment is in order about how genetic and environmental factors interact in a developmental learning analysis. All learning must occur in a genetic (genotype) frame, where dispositions to learn are inflected by environmental demands for behavioral change (In this sense, behavior is neither innate nor learned.) The genotype provides the template or blueprint basis for development, organizing the processes that enable the organism to employ particular responses—responses that can have environmental consequences. The genetic template must be realized in a real environment. The development of all behaviors, including learned behaviors, "... requires the interaction of environmental and genetic inputs at every stage of the developmental [learning] process" (Fantino & Logan, 1979, p. 475).

[3]In an as yet unpublished work (Peláez-Nogueras & Gewirtz, 1992) we have found in our laboratory that infants as young as 4 months referenced-looked at their mothers' faces in ambiguous contexts. However, during a pretreatment assessment, after their mothers' contingent fearful or joyful emotional expressions were referenced, no differential responding of those 4-month-old infants to the ambiguous objects was found. In contrast, after conditioning, those infants responded differentially to a joyful and a fearful maternal expression.

activities are seen as conditionable instrumental responses that are cued by maternal/caregiver expressions and shaped and maintained by the ensuing consequences (in the form of reinforcing or aversive stimulus events).

Thus, our thesis in this chapter is twofold: First, on the assumption that maternal facial emotional expressions initially have no (unconditioned) cue value when an infant references her mother's face and that the cue value of what appear to be intrinsically meaningful emotional expressions could have been conditioned via experiential learning, our thesis is that the effectiveness of the maternal expressions in cuing the infant's responses in uncertain contexts would depend on support from the pattern of experienced consequences contingent on the infant's behaviors cued, that is, the *predictive* function of social referencing. Among the relevant conditioning details are how consistently responsive the mother is in providing those cues, the degree of concordance between the cued responses and their consequences, the contextual variables involved such as the degree of object ambiguity, and the effectiveness of the consequences for the cued responses on which they are provided systematically contingent. In particular, infants are likely to reference (look at) the faces of adults who provide valid information cues about behavior consequences, and *not* to reference—or to discount—the facial (or vocal) cues of caregivers who provide invalid or inconsistent information about behavior consequences. Second, our thesis is that emotional components can be involved in the maternal facial cues (with or without verbalizations or gestures), but that emotions or affect are incidental and not a required feature of the social referencing process. That is, communication in the form of social referencing does not uniquely require facial emotional expressions for cues to function effectively in guiding infants' responses in ambiguous contexts. Therefore, it is thought that gestural-facial cues, that in no way can be considered to be emotional expressions (like originally meaningless expressions used in the study we report in this chapter), can serve the same predictive function for infant behavior in uncertain contexts as typically do maternal emotional facial, vocal, and/or gestural expressions.

The social referencing phenomenon has been classified in the literature (Feinman, 1982; Hornik & Gunnar, 1988) under two headings: *affective* social referencing refers to the infant's (unlearned) use of facial emotional expressions of others to determine how to feel about an ambiguous event (Campos, 1983; Klinnert, Campos, Sorce, Emde, & Svejda, 1983); *instrumental* social referencing involves the infant's use of cues from others' interpretations of events as indicators of how to act in the uncertain situation, or in the presence of strangers (Feinman, 1983; Feinman & Lewis, 1983). In our view, this distinction between affective and instrumental social referencing is artificial and misleading, as the two social referencing usages appear to be features/outcomes of the very same conditioning

is, at the same time as they convey affective components, the cues conveyed in emotional facial expressions also contain instrumental information, functioning as discriminative cues that can come to control instrumental infant behavior by predicting consequences for that behavior in such uncertain/unknown contexts. Thus, maternal affective expressions can come to be instrumental once they acquire distinct *cue value* for the infant's responses. In this frame, we consider the findings obtained via the experimental paradigm underlying the research reported in this chapter relevant to social referencing phenomena within the entire range, regardless of whether they are termed affective or instrumental.

In the section that follows, an experiment is reported and discussed (Gewirtz, Peláez-Nogueras, Díaz, & Villate, 1990). The experiment was mounted to evaluate the assumption that maternal affective expressive cues contingent on the infant social referencing response can acquire informational value as a result of operant conditioning, resulting from patterns of contingent consequences for infant responses cued by the maternal expressions in interaction in ambiguous settings during the first year. To this end, we explored whether or not originally meaningless (neutral) hand-to-face "facial expressions" could come to function as maternal cues for infant social referencing. One maternal hand-to-face "expression" was to predict for the infant that an approach to each of a series of ambiguous objects would lead to *positive* consequences, and a second hand-to-face "expression" was to predict for the infant that an approach to each of a series of ambiguous objects would lead to *aversive* consequences. The unfamiliar objects were made ambiguous by their being covered by a towel at the beginning of each of their presentations to the infant.

In discrimination-learning training, a stimulus (S+) that is correlated with positive contingencies (i.e., reinforcement) sets the occasion for responding, providing information about the availability of reinforcement for that responding. A stimulus (S−) that is correlated with aversive consequences cues nonresponding, providing information about the availability of aversive contingencies for responding. Once the subject responds differentially in the presence of S+ and S− (by an increase or decrease in frequency or in some other attribute of the response), the behavior is said to be under *discriminative control* (see Figure 1). Obtaining a differential rate of infant reaching-for-the-object responses following each of the two maternal hand-to-face "expressive" cues used in this study would evidence that social referencing, the maternal facial cues, and the ensuing approach or avoidance responses can result from a discrimination-learning process. In the section that follows, we report the study on the conditioning of maternal "expressive" cues that maintain the infant's reference-looking response and determine the infant's subsequent differential responding to each of a series of ambiguous events.

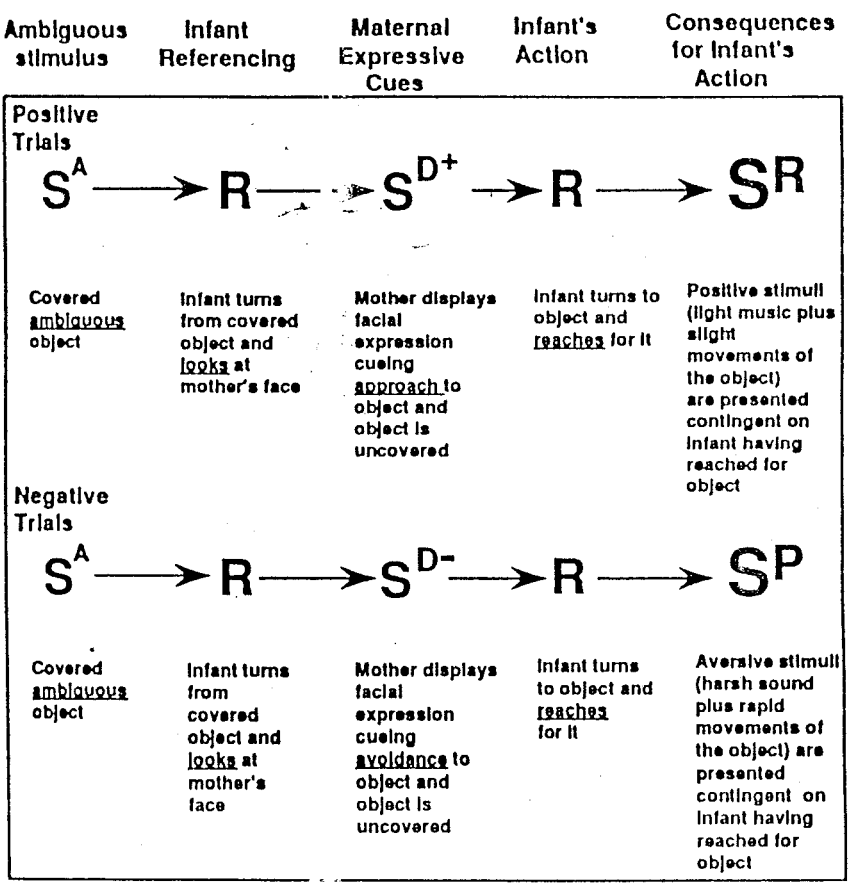

Figure 1. Elements of the social referencing paradigm underlying the experiment being reported. The diagram gives the sequential detail of the social referencing process. The terminal consequences of the positive and the negative trials support the elements and operation of the stimulus–response chains involved.

THE CONDITIONING OF MATERNAL "EXPRESSIVE" CUES FOR INFANT RESPONDING IN AMBIGUOUS CONTEXTS: A PARADIGMATIC EXPERIMENT

Method

As detailed in Gewirtz, Peláez-Nogueras, Diaz, and Villate (1990), the procedure of the experiment being presented and discussed in this chapter involved bringing 20 middle-class infant–mother pairs into the laboratory for 8 to 13 successive weekday training sessions. Mothers brought their

infants to the laboratory daily, provided the infant was not ill and on its regular schedule. These normal, healthy infants included 12 males and 8 females, ranging in age from 9 to 12 months at the start of the experiment. The behavior of the mothers was under the earphone control of an experimenter observing both infant and mother on a split-screen TV monitor in an adjacent room. Mother–infant dyads were assigned randomly to one of two conditions, to counterbalance for the cue value of the particular positive and negative maternal facial cues used and to balance gender in each condition. Beginning in the second treatment session, each of the 20 infants was exposed concurrently (within the same treatment session) to both positive and negative maternal cues.

In the center of the laboratory stood a table on which there was a puppet theater. The infant subject sat in a booster chair attached to the table facing this puppet theater. Out of sight, next to the experimenter behind the puppet theater there were eight covered boxes, each containing a set of eight objects. A total of 64 objects were rotated across all sessions for all subjects. Objects were selected to be unfamiliar to infants of the developmental level of the subjects, and their unfamiliarity was confirmed with each infant's mother before the first session. At the beginning of a session, a mother was asked to choose a box number that had not been previously used with that infant (this cycle was repeated after the eighth session.) In random order during the eight trials of a session, eight objects were presented to the infant by an experimenter through the puppet theater. There were four positive and four negative trials per session (on the third and subsequent treatment sessions). At the beginning of every trial, the object presented was covered by a white cloth that was removed following the infant's turning back to the covered object after referencing (looking at) the mother's face (see Figure 2). By their being covered at the beginning of a trial, the objects were made ambiguous/unpredictable for the infant.

Maternal Cues, Infant Responses, Contingencies, and Sessions. Before the experiment began, mothers were trained to pose the two maternal facial-expressive cues that were later employed (see Figures 3 and 4). These two maternal response-provided cues (i.e., conditioned discriminative stimuli) denoted for the infant that either a pleasant or an aversive consequence would follow the infant's reaching for the ambiguous object. Between presentation of the cues, mothers maintained a natural but unexpressive face (no maternal vocal or gestural expressions-of-emotion cues were emitted to preclude confounding with the facial-expressive cues used in the experiment). For half the subjects, a palms-to-both-cheeks cue of the mother communicated a pleasant consequence for infant reaching (Figure 4), and a maternal fist-to-nose cue communicated an aversive consequence

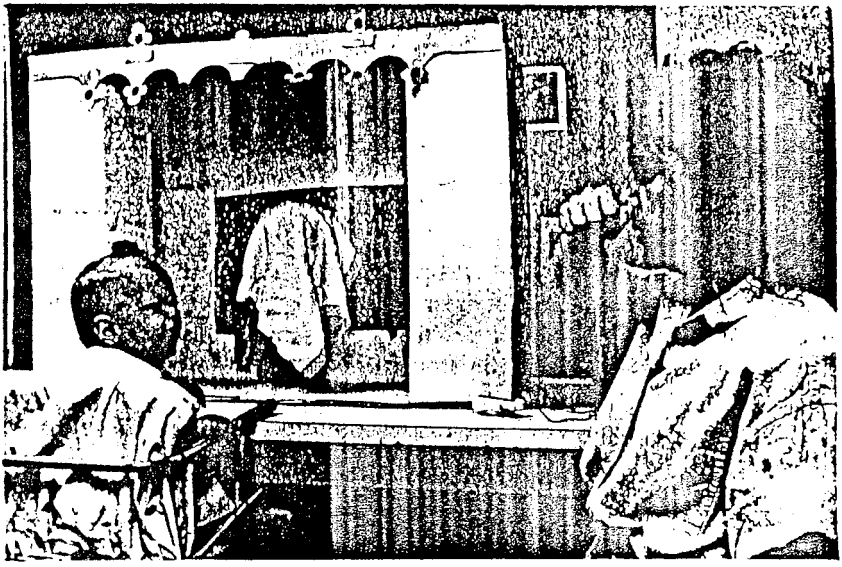

Figure 2. The infant references its mother's face, in response to which the mother displays her facial expression. The covered ambiguous object is directly in front of the infant.

Figure 3. A mother displays the first-on-nose facial expression.

for infant reaching (Figure 3). For the other half of the subjects, a maternal fist-to-nose cue communicated a pleasant consequence for infant reaching, and a palms-to-both-cheeks cue communicated an aversive consequence for infant reaching. Thus, the valence of the cues (positive or negative) was counterbalanced between the two halves of the sample. Once the ambiguous (covered) object was introduced, the mother displayed one of these facial-expressive cues immediately after her infant turned to look directly at her face. When the infant turned back to look at the object, the object's cover had been removed and it was pushed forward into the radius of the infant's reach (about 10 inches from the infant's trunk). The dependent variable was the proportion of positive or negative trials of a session on which the infant reached for the ambiguous object (Figure 5).

For trials on which a maternal facial cue predicted a positive, pleasant consequence for infant reaching to the ambiguous object, the pleasant stimulus was provided by the activation, up to 3 seconds in duration, of a taped musical baby melody accompanied by four slow metronome-like movements of the uncovered object. For trials on which a maternal facial cue predicted an aversive consequence for infant reaching for the ambiguous object, the aversive stimulus was provided by the activation, up to 5

Figure 4. A mother displays the palms-to-cheeks facial expression.

Figure 5. After looking at the mother's face and registering the positive cue in the mother's facial expression, the infant turns to the formerly ambiguous object, now uncovered, and reaches for it.

second in duration, of one of three alternating stimuli (often heard around the home): a harsh door buzzer, a taped sound of a concrete drill, or a food blender. The loudness of these brief aversive sounds did not exceed 82 decibels at the source, some 2.5 feet from the infant. These three alternating sounds, accompanied by four rapid metronome-like movements of the uncovered object, were aversive insofar as they would subsequently be found to be effective in inhibiting infant reaching responses. (Although mothers were consulted routinely on the qualities of the positive and the aversive events, not once did a mother complain that a stimulus intended to be positive or aversive was inappropriate or too harsh for her baby.)

Order of Trials for Cues–Consequences. After the second treatment session, on four of the eight session trials following the mother's positive cue to the infant's referencing response, positive consequences were provided contingent on the infant's reaching for the object. On the other four interspersed trials, following the mother's aversive cue to the infant's referencing response, aversive consequences were presented contingent on the infant's reaching for the object. The conditioning treatment sessions continued for subjects until a predetermined joint reaching-response criterion was attained, determining the final treatment session.

That joint response criterion was that more than 75% of the positive-cue trials, and less than 25% of the negative-cue trials, included infant reaching responses. The range of total number of daily conditioning sessions for this responding criterion to be attained by all 20 subjects was 6 to 12, with a median of 6.5.

In order to minimize the possibility that infants would break down crying and/or that they or their mothers would refuse to continue as subjects, due to the everyday aversive consequences, a sliding scale of increase in the number of aversive trials across sessions was implemented: the proportion of aversive trials was .00 on the first treatment session (day), .25 on the second treatment session, and .50 on all subsequent weekday sessions until the joint response criterion was attained. In an eight-trial session, the order of positive- and aversive-cue consequence trials was random, with the constraint implemented that an aversive-consequence trial was never the first in a session, and that no more than two successive aversive trials occurred. (In retrospect, this procedure, implemented to insure that the infant subjects would continue participating across all trials in a session, was too cautious.)

The Training Procedure

Mothers sat 2 feet to their infant's right, slightly behind the infant and away from the puppet theater, in order to insure the salience of the social referencing response, during which the infant had to turn her head and make eye contact with the mother. Hidden behind the puppet theater, Experimenter A, on each trial, manipulated the ambiguous object (i.e., pushed it forward outside the infant's reach before the infant reference-glanced, and then, after the look, uncovered it and pushed it within the infant's reach) and, as programmed, presented either the positive or the negative stimulus consequence (the independent variable) contingent upon the infant's postreferencing response of reaching for the object (the basis of the dependent variable). From the adjacent room, Experimenter B observed the mother–infant interaction while instructing the mother (via earphones) on how and when to present her facial-expressive cues contingent on her infant's referencing response. Experimenter B also instructed Experimenter A on when to present the positive or aversive stimulus consequence contingent on the infant reaching for the ambiguous object, and on when to initiate and terminate each trial. There was a 5-minute period of acclimatization to the laboratory at the beginning of each daily eight-trial session, and a 10-second intertrial interval.

Shaping and Prompting. The looking-to-mother's-face referencing response was emitted at the start by all but two of the infant subjects. At

the beginning of the training when these two infants failed to exhibit a social referencing response within 55 seconds from the presentation of the ambiguous stimulus, the mother was asked to move an additional two feet away from her infant and/or to clap her hands, to prompt the infant's response of turning to, and looking at, her face. This prompting procedure succeeded rapidly in generating the referencing of mother's face in these two infants, and the prompts were rapidly terminated by a fading process.

Further, in case an infant did not exhibit a full reaching response to the object following the positive maternal cue, starting with the first treatment session (Session 2), the reaching response was modeled by the infant's mother and shaped by use of a *successive-approximations* technique, making the positive musical sound—the reinforcing stimulus—contingent on component arm movements toward the object that approximated successively the responses of reaching and touching the object. In addition, during the first three treatment (i.e., training) sessions, when an infant turned to reference its mother's face, the mother responded with a hand-to-face cue that was accompanied by a brief prompt (either a ⅓-second pleasant musical sound on a positive-consequence trial or a ⅓-second harsh sound on an aversive-consequence trial) that was a sample of the positive or aversive consequences being employed in the study. To preclude the possibility of elicitation or Pavlovian conditioning effects, these very brief prompts were implemented as a transitory discriminative stimulus (S^D) to facilitate the initiation of the training procedure and were faded out rapidly. All contingency prompts were faded out by the end of the third treatment session.

Immediately after the infant turned back from referencing the mother's face to look again at the ambiguous object, Experimenter A behind the theater removed the white cloth, leaving the object uncovered, and quietly propelled it forward to be within the infant's reach. If the infant responded by reaching for the object, Experimenter A immediately presented either the positive or the aversive stimulus. If the infant did *not* reach for the object within 10 seconds, that object was moved back out of the infant's reach but still in view, until the infant looked again toward the mother's face. That procedure was repeated for each of the eight trials of a session. Each trial lasted between 45 and 55 seconds.

Pretreatment Assessment. A baseline was taken in the first eight-trial session for every infant subject. On four interspersed trials, a positive maternal facial cue was contingent upon the referencing response, but if there was subsequent reaching, that reaching was followed by no consequence at all. On the remaining four trials, a negative maternal facial cue was contingent upon the referencing response, but the ensuing reaching (if

it occurred) was followed by no consequence at all. These two sets of four interspersed trials each generated two baseline scores for statistical comparison with last-treatment session scores. There were two subgroups due to the counterbalancing of the maternal cues.

Reliability of Observation. To determine behavior-unit reliability, three pairs of observers independently scored the reaching responses of eight infants (40% of the subject sample) from videotape records, for all trials during those infants' entire experience as subjects. In all, 477 trials in 79 sessions were involved. Overall agreement on the number of reaching responses was 89%. The outcome measures in a trial was whether or not the infant reached for the ambiguous object after turning back from referencing the mother's facial expression in the ambiguous object's presence. The two outcome measures, for the baseline and the last treatment session, were the percentage of trials on which the infant reached for an ambiguous object following the positive maternal cue and the negative maternal cue.

Results and Implications

For within-subjects analyses of the data, Wilcoxon signed-rank nonparametric tests were used with the scores on the percentage of trials on which the infant reached for an ambiguous object following a positive maternal cue and separately following a negative maternal cue. Contrasts within infants were made for percentage reaching scores, separately for the positive and for the negative cues, between the pretreatment (baseline) session and the last treatment session (defined as the session during which there was attained the joint reaching-response criterion for the positive and for the negative cues). In addition, for the final treatment session an evaluation was made of the difference in median percentage reaching scores to positive compared to negative maternal cues. The scores of the total sample (N = 20) were used for the analysis of the data under the counterbalanced design, as between-group Mann-Whitney U tests yielded no reliable differences in reaching between the two different hand-to-face cue subgroups (fist-to-nose vs. palms-to-cheeks) that predicted the same consequences, either for the positive or the aversive consequence, or between the two gender groups under either positive or aversive consequences.

The Wilcoxon signed-rank tests comparing matched-distribution medians within subjects show that:

1. During the pretreatment baseline session, no reliable difference (p = .824, 2 tails) within infants was found on the median of reaching scores between the condition where infants' referencing looks were followed by positive cues with subsequent reaching followed

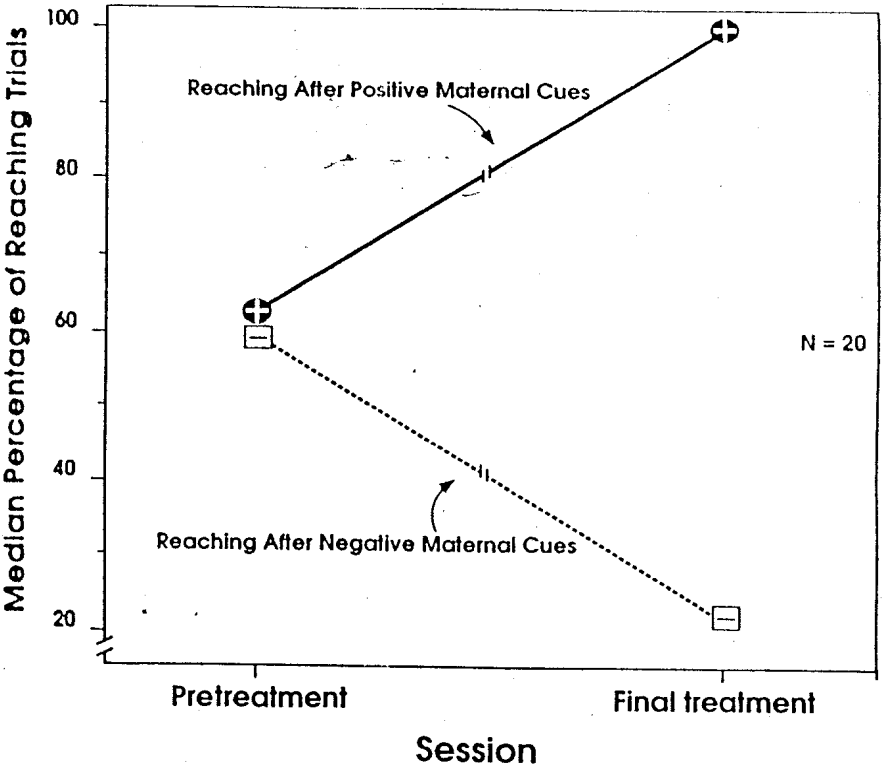

Figure 6. Median percentage reaching for ambiguous objects by 20 infants, after maternal expressive-response cues to infant referencing (of mother's face), under the two cue-and-consequence treatments: after the positive maternal cue (upper line), when reaching for the ambiguous object led to positive consequences, and after the negative maternal cue (lower line), when reaching for the ambiguous object led to aversive consequences.

by no consequence, and the condition where referencing looks were followed by the to-be-negative cues with subsequent reaching followed by no consequence. Figure 6 shows that the medians of infant reaching appeared essentially identical in the baseline session.

2. Within infants, the median percentage reaching scores after positive maternal cues were contingent upon the referencing looks with positive consequences contingent upon the subsequent reaching was reliably higher ($p = .0039$, 1 tail) during the final treatment session compared to the pretreatment baseline session.
3. Within infants, the median percentage reaching scores was reliably lower ($p = .0154$, 1 tail) for referencing looks upon which the negative maternal facial cues were contingent with *aversive* consequenc-

es contingent upon the subsequent reaching during the *final* treatment session, compared to the pretreatment/baseline session.

4. As would be expected from the preceding within-infants result patterns, a within-groups comparison showed that in the final treatment session the median of percentage reaching scores was reliably higher (p = .0001, 1 tail) in the condition where positive maternal facial cues were contingent upon infant referencing looks with positive consequences contingent upon subsequent reaching, compared to the condition where negative maternal facial cues were contingent upon social referencing looks with negative/aversive consequences contingent upon infant reaching.
5. The pattern of change in scores between pretreatment baseline and final session reflects discrimination learning by the infants. In the final session, differential rates of reaching by the infants were obtained after positive and negative maternal cues earlier had been differentially contingent upon the infant referencing response. Thus, every one of the 20 infant subjects reached for the ambiguous object after positive maternal cues were displayed contingent upon the infants' referencing the mother's face, and they did not reach for that object after negative maternal cues were provided contingent upon the infants' referencing responses.

DISCUSSION

Our basic assumption is that, very early in ontological development, experiential learning processes effected by systematic environmental cue and contingency stimulation can influence cued-response patterns of infants, patterns that might appear unconditioned to those unfamiliar with the behavior or its experiential history. In keeping with this assumption, it has been demonstrated in our paradigmatic experiment that infant reaching responses to ambiguous objects in contexts of uncertainty can be conditioned readily to originally meaningless facial cues presented by the mother following infant reference looking, on the basis of the stimulus contingencies that followed those cued infant reaching responses. In this way, this pattern of communicative interaction between the mother or caregiver and the child was shaped and maintained. Further, the results support our assumption that the maternal expressions that can operate in this manner to cue infant responses in uncertain contexts need not be limited to affective emotional information (such as fearful or joyful facial expressions of the mother) or to verbal information (that tells the infant how to behave or cope with the situation) or gestural information, to influence the infant's behavior in those uncertain contexts.

Until now, the literature has provided *no* process theory explanation of the mechanism underlying the infant social referencing phenomenon. Even so, we have noted nativist assertions in the literature to the effect that the human infant is prewired to reference and understand the message conveyed in its mother's facial emotional expressions on an unlearned basis, in order to disambiguate a context and regulate its behavior there. The results from our research support the notion that, rather than being an unlearned pattern, social referencing can emerge from a pattern of everyday learning experiences generated by contingencies in the interactions of the infant with its caregiver in ambiguous contexts. We have demonstrated that, in contexts of ambiguity or uncertainty, through a process of operant learning, two originally meaningless (neutral) maternal facial expressions can come to denote opposite consequences for infant reaching responses: one maternal hand-to-face "expression" came to predict for the infants *positive* auditory-kinetic consequences of their reaching for each of a series of ambiguous stimulus objects placed in front of them, and a second hand-to-face "expression" came to predict *aversive* consequences of their reaching for each of the remaining half of the series of ambiguous objects.

The differential conditioning procedure resulted in every one of the twenty 9- to 12-month-old infant subjects showing that they were, in the same way, influenced to responded differentially by the two distinct maternal facial-expressive cues. Infants in this experiment thus demonstrated having learned which maternal hand-to-face cue denoted which consequence, since they came reliably to reach for ambiguous objects after the maternal cue denoting positive consequences, and reliably to avoid objects after the maternal cue denoting negative consequences, before those contingent consequences were implemented on each new trial. The infant responses were based on the information communicated solely by their mothers' "facial expressions," without vocal or other affective cues being involved.

The results presented cannot rule out definitively the possibility that the infant is "prewired" to understand, in uncertain contexts, unconditioned cues for its behavior from maternal facial expressions. To rule in or out the possibility that infants would respond on an unlearned basis to the maternal affective cues in emotional communication, research would be required at earlier points in the infant's life on the origins of the social referencing process and of the consequences of the action cued by the maternal emotional expressions (Peláez-Nogueras & Gewirtz, in preparation). Even so, the results reported herein lend support to the notion that emotional or affective communication involving facial expressions in the visual modality does not differ from communication involving stimulation in any other modality–auditory, kinesthetic, etc. In the main, the phenomenon of social referencing has been identified in studies with infants

around one year of age. In other research, typically in seminatural settings, maternal facial and vocal emotional stimuli were often confounded, to obscure the role of each modality of maternal affective stimulation in the social referencing communication process (see, e.g., Bradshaw, Goldsmith, & Campos, 1987).

Our experimental tactic was to employ as stimulus cues that were originally meaningless maternal expressions. Even so, the infant subjects learned very efficiently the predictive value of these cues structured for them in the laboratory setting. This may suggest that the biologically meaningful maternal facial emotional cues are not acquired in a different manner by the infant. What has been shown in the research reported is that the valences of the cues maintaining social referencing responses can be trained in infants starting at 9 months of age, around the age when the social referencing process ordinarily appears "naturally." This work lends support to the notion that some portion of the social referencing process, if not all of it, is an outcome of the learning resulting from the commerce between mother and infant in the routine circumstances of everyday interactions.

Social Referencing and Infant Attachment

A corollary of our findings is that if, following the social referencing response, cued infant responses can be conditioned by their consequences on an operant basis, they can constitute one index among numerous potential ones of *attachment* under the social conditioning approach (Gewirtz, 1972a, 1972b, 1976, 1991; Gewirtz & Peláez-Nogueras, 1991). In this respect, the social referencing conception can be related to the conception of attachment. Under the social conditioning approach to attachment, instances of control of infant responses by stimulus cues provided by a caregiver's appearance or behavior have been conceived to be indices of infant-to-caregiver attachment.

It has been noted in the social conditioning approach that infant attachment could be seen as a *metaphor* for diverse infant discriminated operants being under maternal-stimulus control (Gewirtz & Peláez-Nogueras, 1991). In this context, the three conditioned events—infant social referencing, the maternal expressive-behavior cue, and the infant's ensuing approach or avoidance response in ambiguous contexts (like those trained in the experiment reported in this chapter)—may be prototypical behaviors learned during socialization that represent that pattern of infant responses cued by the mother or another attached figure and reinforced by contingent stimuli provided in those contexts. On this basis, in the first 9 to 12 months of life, infant referencing of the mother's facial expressions in ambiguous contexts can serve as one representative index of mother–

infant attachment. This is because the referencing process reflects control of the infant's referencing glances and ensuing responses by maternal response-produced stimuli.

CONCLUSION

The extent to which an infant turns to search its mother's face for expressive cues in contexts of uncertainty very likely depends on past success in obtaining such information, its validity, and its utility. That is, to become functional, maternal cues must be consistently contingent on infant referencing behavior and predict reliably the environmental consequences of the ensuing infant's approach or avoidance in the ambiguous contexts. This pattern will result in strengthening, or at least in maintenance, of the infant referencing pattern and the maternally cued responses, as well as in a reduction in referencing-response latencies. In contrast, it is expected that mothers who are unresponsive, or respond with delays, noncontingently, or inaccurately to their infants' soliciting information via referencing, would rear babies who reference their mother's facial expressions infrequently, if at all. These babies would not rely at all on their mothers for critical information about the world.

In a laboratory setting, it has been demonstrated that the operant-conditioning paradigm can account readily for the acquisition of cue value by maternal facial expressions that are provided (displayed) contingent upon the infant looking to the mother's face for information in an ambiguous context—the social referencing response. It is our assumption that a paradigm like the one employed in the design of this experiment is the basis for infant social referencing in the range of life settings. Even so, that assumption poses a question that awaits empirical validation.

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