Social Perception in Infants

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8 Emotional Regulation of Interactions Between Two-month-olds and Their Mothers*

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INTRODUCTION: THE STATUS OF INFANT EMOTIONS

Perception and expression of affect play a crucial role in the regulation of human interactions. Nevertheless, the origins of emotional regulations remain obscure. While many developmental psychologists have used infant expressions of affect for inferring perceptual discrimination, preference, learning, and cognitive processing, as yet no coherent theory has been formulated on the origins of affective expression itself or of its role in developing interpersonal communication. Recent advances in the descriptive study of mother–infant interactions, using new video and film technology, have still to produce the required theory.

In many accounts of emotional development—from Bridges' in 1932 to recent studies—affective expression in the first 3 to 6 months is described as being limited and disorganized, only gradually becoming well-articulated and differentiated. At first, it is claimed, there is a diffuse body reaction produced by a poorly organized general state of arousal, reactive only to internal physiological conditions or to quite gross quantitative changes in the physical environment and with little specificity of stimulus content. For example, Sroufe (1978) considers early smiling to be a "completely passive process" set off by stimulation of just sufficient intensity to jog the nervous system: "It is a matter of arousal rising above some hypothetical threshold, with the smile occurring with the relaxation as arousal again declines. It is not until the third month, however, that *psychological processing of the stimulus content* (recognition) leads to the smile, which may be suggested to indicate *pleasure*" (p. 481; emphasis as in original).

Other psychologists attribute more cognitive processing of the environment to infants in the first few weeks or months. Applying theories of attention developed by Hebb, Hunt, and Berlyne, they conceive of affect and arousal as being governed by the degree of discrepancy or mismatch between the incoming stimulus and a previously established internal standard or schema. McCall and McGhee (1976) and

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Kagan (1975) adopt Berlyne's discrepancy hypothesis, claiming that an organism with the elementary sensory-motor processing of a young infant will attend to and affectively respond to new stimuli as an inverted U-function of their physical or conceptual discrepancy from a well-familiarized, standard stimulus. In research which assumes a reduced or physicalist view of the young infant's cerebral processes, conditions for recording affective displays are generally simplified and lacking in "ecological relevance," even when the research is specifically addressed to the question of affective expression and its determinants. Thus, it is not possible to affirm any relationships between discrepancy and affect that might apply in real life (see McCall and McGhee, 1976). Nevertheless, the discrepancy model is continually advanced to explain both attentive and affective behaviors in face-to-face interactions between infants and adults. For example, the infant's avoidance and distress when the behavior of the partner is perturbed in some way is assumed to be caused by information that is strongly discrepant from learned standards (Koch, 1967).

An alternative explanation for the patterning of attention and affect in mother–infant interactions is based on the principles of instrumental or operant conditioning. Here it is proposed that automatic reflex-like systems in the infant are set to define contingent relationships and recognize certain time intervals between the initially random or unintended acts of the infant and events in the world—be they the motions of a motorized mobile or a display of lights rigged up to respond to infant movements with a short delay, or the similarly responsive movements of an attentive partner (Papoušek, 1977; Watson, 1977).

The infant's expressions of affect and direction of attention are thought to reflect the degree of predictive control that the infant builds up as the reactive events recur. Papoušek's meticulous operant conditioning studies recorded clear emotional displays accompanying the learned movements of 3-month-olds. Pleasure was expressed when the infant predicted successfully, and distress occurred when expectations failed (Papoušek, 1967). Likewise, Watson (1972) recorded exuberant smiling and cooing in 8-week-old infants when they had achieved control over a contingency mobile. Both authors considered the infant's social awareness to be extremely limited at this time and proposed that human social responses were learned on the basis of innate sensitivity to contingent events.

In all of the studies presented above, affect was seen as a secondary concomitant or index of cognitive processing or arousal. In most studies, no special innate functional significance is attributed to affect in the interpersonal sphere, except to elicit or reinforce maternal care. Expressions are not considered evidence either of emotions in the infant or of a specific awareness of human beings. In contrast, Darwin emphasized, more than 100 years ago, the major evolutionary pressure on development of communicative and cooperative functions, including the expression and perception of affect. In his treatise on the expression of emotion, Darwin (1872) attempted to elucidate the utilitarian basis for the form of affective movements; for example, he showed that the act of spitting out unpalatable material is similar to the expression of disgust. He proposed that the repeated association through the generations of such practical movements with particular motivational states, led to the

expression coming to represent the associated state of mind (Principle of Serviceable Associated Habits). Now, although the facial display may no longer be linked to its original eliciting circumstances, the expressive movements occur when the same, or an analogous emotional state or sensation is experienced. Not only did Darwin propose that the mechanism for expression of different emotional states was innate, but, more controversially, he supposed their perception to be direct: "A young infant understands to a certain extent, and as I believe at a very early period, the meaning or feelings of those who tend him, by the expression of their features" (Darwin, 1877 (pp. 293–294)). Although Darwin felt that he had no adequate explanation for the development of the perception of affect, he proposed that this development along with that of the expression of emotions and other organized states of feeling and attending, had evolved in the service of more effective modes of communication and cooperation, conferring great selective advantage on the species possessing them.

As the review by Charlesworth and Kreutzer (1973) makes clear, psychological science has tended to neglect Darwin's theory of emotions over the past century. However, evolutionary theory has been incorporated into psychoanalytic thought. It is particularly evident in the thinking of the British Object Relations school, and of Bowlby, who also owes a debt to ethology. These psychoanalysts have been ready to attribute an inborn sensitivity in the infant to the emotional states of caregivers, and to the ongoing process of interaction with them. Melanie Klein, in particular, considered that the infant possessed complex adaptive responses with clear emotional components from the first weeks of life (Klein, 1952; Segal, 1964). More recently, researchers with psychoanalytic and ethological interests have brought this perspective to the more systematic study of early mother–infant interactions (Bateson, 1975; Brazelton et al., 1975; Stern, 1971, Wolff, 1963). They have argued that infants under 3 months have the capacity to interpret the form of the partner's expression and direction of attention in terms of communicative and personal significance, and to respond adaptively in kind. These claims depart significantly from the reductionist views outlined above.

The nativistic Darwinian perspective gains support from what is now a fairly substantial body of evidence demonstrating the very young infant's capacity both to discriminate and express human features and qualities of action. Fantz (1963) found some time ago that 2-month-old infants show an orientational preference for face-like versus scrambled drawings, and this has since been confirmed for newborn infants (Goren, Satry, and Wu, 1975). Newborns are able to discriminate quite specific facial movements, for example, tongue protrusion (Meltzoff & Moore, 1977) and posed emotional expressions (Field et al., 1982; Field, this volume) and, moreover, are able to imitate these movements. The great majority of adult facial movements are produced by newborns in a systematic and patterned order (Oster and Ekman, 1977) and infants born blind smile normally (Eibl-Eibesfeldt, 1970; Freedman, 1964).

Infants appear predisposed from birth to respond to the human voice. Alegria and Noirot (1978) report that infants 1 hour old will orient to the sound of gentle human speech, and De Casper and Fifer (1980) found that at one or two days infants will

. to produce their mother's voice. Changes in heart-rate and respiration r. .l that neonates can distinguish the special frequency characteristics of the voice, and they prefer speech sounds to sounds of nonhuman objects, and female to male voices (Eisenberg, 1975). One-month-olds will suck nonnutritively to produce their mother's voice, but only if it shows normal intonation patterns (Mehler et al., 1978). Kuhl and Meltzoff (1982) showed that 5-month-olds can identify which silent visual image of lips articulating a sound matches a previously heard vowel sound. Evidence is accumulating that the quality of emotion is transmitted with particular precision and refinement in the human voice, by pitch and intonation characteristics and quality of the voice, and that these aspects have high salience in infant perception (Scherer, 1979; Trevarthen, 1983a).

A further important feature is that young infants, like other animals born weak and dependent on parental care, demonstrate early discrimination and rapidly developing preference for their own mother's individual qualities. They appear to learn to identify her voice before birth (Spence and De Casper, 1982) and her face shortly after birth (Field, this volume). By 6 days, infants prefer the smell of their mother's breast pad to that of another mother's (McFarlane, 1975), and by 2 weeks they show more relaxed postural adjustments to their mothers picking them up in the dark and in silence than to another woman (Widmer, 1979). This evidence for "imprinting" to a particular caregiver indicates that categorical awareness of human qualities is harnessed to rapid learning, serving to establish immediately after birth a unique motivational relationship to that committed person, a relationship that will serve future mental development.

Observations which show infants making selective orienting to diverse signs of personal expression, including features of speech, are clearly of interest to a theory of the origin of communication. Yet, in a sense, the capacities revealed in experiments to date are no more than the bare bones, the minimum sensorimotor requirements, for those higher-order, supramodal, motivational functions that are the concern of this paper, that is, the early development of the perception and expression of interpersonal affect. In themselves, the sensorimotor capacities measured by single factor experiments do not constitute the apprehension of personal affective qualities, or the appropriate expression of feeling that psychoanalysts and ethologists have claimed. To test such claims the experimentalist must turn to more "real life" situations, to investigate how the infant's perceptual and expressive capacities actually function in their interactions with persons.

With these considerations in mind, two experimental studies were carried out to examine in detail the sensitivities and expressive capacities of infants under three months old. These were studied in the context of interactions with their mothers where the style of the mother's communication was perturbed in various ways.

EXPERIMENTS ON AFFECTIVE REGULATION OF MOTHER-INFANT INTERACTIONS

In the first study, in between periods of "normal" face-to-face interaction in which the mother was simply asked to "chat to her baby," the mother was requested to

make two kinds of "breaks of contact" with her at. Both of these change involved the mother becoming unresponsive and altering her style of behavior, bu the quality of the two changes was very different. The first was a naturalistic break After 30 seconds of positive interaction, the mother was interrupted for approximately 30 seconds by the experimenter (I.M) who entered the room and asked her few causal questions, the mother turning away from her baby to look over he shoulder and talk to the experimenter (*Interruption* Condition). The second chang was unnatural. After a second period of "normal" face-to-face communication following the interruption, the mother was signalled to become unresponsive an expressionless for 45 seconds while continuing to look at her baby (*Blank-face Condition*). This was succeeded by a third and final phase of normal interaction Filming of mother and baby was started once they were settled and their interaction was well-established, and it continued for 3 minutes while these five short episode took place.

The laboratory visits and experimental treatments are shown in Table 1. In a pilo study three boys and two girls were filmed in Normal and Blank-face conditions at 6 or 7 weeks. The full experiment, with both Interruption and Blank-face conditions was carried out with two female and one male subject who visited repeatedly between 6 and 12 weeks of age. There was no indication that the brief disturbances of interaction between mother and infant left any effect on the behaviour of the infants on repeated visits. Analyses are based on data pooled from all visits. The mothers were British, white, from social classes II and III (U.K Registrar-General's classification). All had uneventful full-term pregnancies followed by normal deliveries.

Recording sessions were adjusted to suit the baby's schedule of wakefulness. Mothers and babies were transported by taxi to and from the laboratory in the Psychology Department at Edinburgh University. When the infant was in a contented and alert state, mother and baby were taken into the observation room. The mother sat opposite her baby who was supported in a chair designed to allow free head and limb movement, the trunk being held with a wide elastic band round the

Table 1. Ages of Subjects and Treatments

	Age in weeks						
Subjects	6	7	8	9	10	11	12
F	B						
M	B						
F	B						
M	B						
M		B					
F		IB		IB	IB	IB	
M		I		IB	B	IB	IB
F	IB		IB	IB	IB	IB	IB

B = Blank-face
I = Interruption

stomach. A mirror was placed beside the baby so that a reflection of the mother's head and torso appeared alongside the baby in the camera view. A Bolex 16-mm ciné camera in the adjoining room was aimed along a line over the mother's right shoulder to obtain near full-face views of the mother and baby (see Figure 1).

In order to obtain more evidence about the infant's adaptive capacities and sensitivities to different parameters of interpersonal behaviour, a further perturbation was devised that, unlike the Interruption and Blank-face conditions, held the form of the mother's communication constant, but disrupted its temporal relationship to the infant's behaviours.

A double closed-circuit television system was designed (see Figure 2) in which essential features of face-to-face interactions are retained. Each partner sees a video image of the other that is full-face, and life size, with eye-to-eye contact. The images of the two partners are relayed via videorecorders to monitors, permitting the timing of the display of one partner to the other to be instantaneous, live or in real time – or delayed by any chosen interval of time. In this case the behavior of the mother was replayed after a 30-second interval in which the tape was rewound. The behavior the baby hears and sees during the replay is exactly the same as was successfully communicated with in the preceding live sequence, but in the replay, of course, the mother's behavior is unresponsive to the baby's. The behavior was analysed from a ciné film of the baby, and the TV image of the mother reflected in the mirror beside the baby.

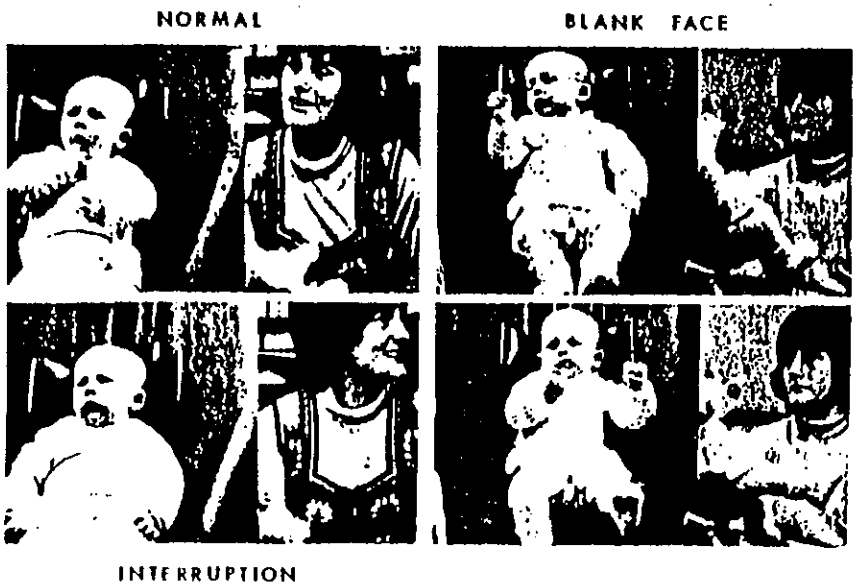

Figure 1. Stills from cine films of Experiment 1 showing typical infant reactions in the three conditions

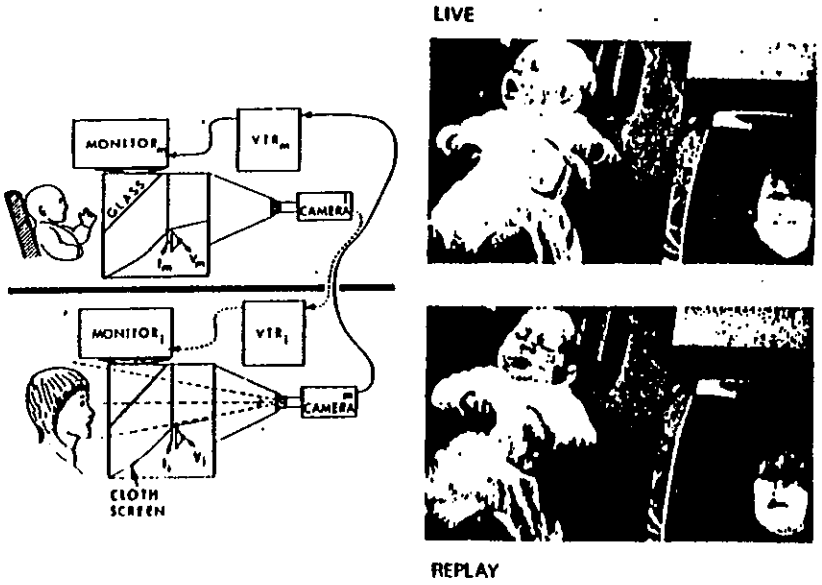

Figure 2. *Left:* Apparatus for double video communication, infant and mother in separate rooms, each viewing the video image of the other. *Right:* Stills from movies of infant reacting to Live and Replay conditions. Image of mother seen reflected in a mirror at the side of the infant.

Eighteen sessions were run with four infants, two boys and two girls, between 6 and 12 weeks old. In each case the baby's behavior was filmed throughout one minute of *Live Interaction*. Then, after a ½-minute delay in which the tape of the mother's communication was rewound, recording continued for 1 minute during the Replay Condition, and finally for ½ minute of live interaction.

Results of Experiment 1: Scoring and Analysis of the Data

On the basis of previous descriptions of normal and perturbed infant communicative behavior and preliminary viewing of the films from Experiment 1, the occurrence of the following easily distinguished infant behaviors was scored in ½-second time blocks by LM; these were grouped in four higher order categories (see Table 2). The categories of Direction of Attention, Communicative Effort, and Affect were scored independently for one whole session containing both control and experimental conditions by a trained observer (Penelope Hubley) who was blind to the interaction condition (the image of the mother being obscured). The percentage agreement between the two coders was very high; 94% for the Direction of Attention, 89% for Communicative Effort, and 87% for Affect.

The behavior of the infants during the perturbed conditions (*Interruption* and *Blank-face* in Experiment 1 and *Replay* in Experiment 2) was compared to that of the preceding periods of normal or live interaction.

Table 2. Behaviors Scored as Present or Absent in Each 1/2 Second Time Block from Ciné Film

1. *Direction of Attention*
   The infant looks: (1) to his mother's face
   (2) away from her and into the room or down to the floor
   (3) to his own hand or body part or
   (4) to the intruder

2. *Communicative Effort*
   (1) Tonguing - the tongue being either protruded between open lips, or being pushed forward into the lower or upper lip
   (2) Wide open shaped mouth
   (3) Mouth a little open and relaxed
   (4) Mouth closed

3. *Affect*
   Positive:
   (1) Open palms (left and right hands distinguished)
   (2) Eyebrows raised
   (3) Eyebrows relaxed
   (4) Smiling
   Negative:
   a. Distress
   (1) Frowning
   (2) Raised frown
   (3) Thrashing the arms—held outstretched and tense (left and right arms distinguished)
   (4) Head drooped down
   (5) Crying
   b. "Displacement" type activities
   (1) Fingering the clothes (left and right hands distinguished)
   (2) Fingering the face (left and right hands distinguished)
   (3) Sucking the fingers or thumb (left and right hands distinguished)
   (4) Yawning
   (5) Grimacing/sneering
   (6) Biting or chewing the lower lip

4. *The level of activity*
   The positioning of the limbs relative to the body (left and right limbs being distinguished)
   (1) Arm raised up to or above shoulder level
   (2) Arm raised up, but below shoulder level
   (3) Arm down at the side
   (4) Arm in front of the body
   (5) Arm out to side beyond body

Frequency of Individual Behaviours Across Conditions. The proportion of the ½-second time blocks in each condition occupied by each identified category of behavior was calculated by subject and by session and expressed as a percentage. Then *t*-tests for related samples were performed for each behavior across the normal control condition and each experimental condition, by subject and by session. The

frequency of occurrence and the probability levels of these analyses appear in Tables 3 and 4.

During the period of normal interaction preceding the interruption (see Figure 1 and Table 3), the infants looked at their mother's face most of the time they made active tonguing movements and wide open shaping of the mouth, and smiled frequently. The expression of the brows was generally relaxed, with very few frowns, or displacement type activities. These features are typical of the behavior of infants in positive interaction with their mothers (Brazelton et al., 1974; Stern, 1974; Trevarthen, 1979; Trevarthen et al., 1981).

When the mother was interrupted (Figure 1) the baby's attention to her de-

Table 3. Frequency of Infant Behaviors, Expressed as a Percentage of Condition Time with Statistical Analysis of Changes (across Normal, Interruption and Blank-Face Conditions)

	Interruptions			Blank-face Conditions			
Infant Behavior	Normal	Interruption	*p*	Normal	Blank-face		*p*
1. *Attention*							
Gaze to mother	90.2	76.9 (fall)	(.1)	88.8	64.5	fall	.001
Gaze away/down	9.8	8.4	NS	10.1	34.2	rise	.001
2. *Communicative Effort*							
Tonguing	21.1	9.3 fall	.02	28.7	23.0		NS
Mouth wide open	26.0	2.4 fall	.001	22.3	18.0		NS
Mouth relaxed	34.8	38.7	NS	42.2	33.2	fall	.05
Mouth closed	39.2	58.9 rise	.01	35.4	48.7	(rise)	.1
3. *Affect*							
a. Positive							
Eyebrows raised	32.8	23.9	NS	33.0	13.8	fall	.001
Eyebrows relaxed	49.9	48.1	NS	45.2	27.4	fall	.001
Smiling	31.8	3.3 fall	.001	23.6	4.2	fall	.001
b. Negative							
Distress:							
Frowning	5.4	7.1	NS	3.1	30.1	rise	.01
Raised frown	11.9	20.9 rise	.05	18.7	28.8	(rise)	.1
Displacement activity:							
Left hand finger clothes	22.4	27.3	NS	24.4	30.7	(rise)	.1
Left hand touch face	0.2	0.8	NS	0	1.3	(rise)	.1
Right hand touch face	1.1	1.9	NS	3.9	6.1	(rise)	.1
Yawn	...	...	...	0	0.4	(rise)	.1
Grimace/sneer	0	0.3	NS	0.2	10.0	rise	001
Bite/chew lower lip	0.1	0.6	NS	0.2	2.7	rise	.02

Note: Probabilities by the *t*-test for related samples, two-tailed.
NS = not significant.
Possible trends are bracketed.

Table 4. Communicative and Emotionally Expressive Behavior that Cooccur with Either Looking to, or Away From, the Mother's Face in Normal, Interruption and Blank-face Conditions (Probabilities by Binomial Sign Test)

Normal	p	Interruption	p	Blank-face	p
1. Behavior cooccurring with looking to the mother's face					
Tonguing	.1	Tonguing	01	Wide open shaping of mouth	1
Wide open shaping of mouth	.01	Smiling	03	Raised brows	001
Raised brows	.06			Smiling	.01
Smiling	.06			Grimace/pout	.1
				Frowning	.1
2. Behavior cooccurring with looking away from the mother's face					
Neutral expression	.06	Neutral expression	.03	Neutral expression	01
Relaxed brows	.09	Mouth closed	.09		

creased, not because he became withdrawn or distressed (no increase was found in the amount of looking down or to his own hand), but because his attention was caught by the experimenter's entrance (regard to the experimenter, 14%). Mouthing and tonguing movements, interpreted as communicative effort, decreased, as did the very active signs of positive affect that characterise normal interactions. Smiling and raising brows were no longer sustained to the same extent by active engagement between the baby and his mother. Nevertheless, the interruption of the mother did not distress the infant. Even though these signs of excited, happy behavior diminished, displacement activities or other signs of distress did not increase and a relaxed expression was maintained.

A markedly different pattern of behavior occurred when the mother posed a blank face (Figure 1 and Table 3). Within a few seconds the infant showed distress in peculiar, sneering grimaces of the mouth, increased handling of the clothes, touching the face, sucking the fingers, and frowning. Efforts at communication, defined by a wide open mouth and tonguing postures were sustained, and even intensified at first, the whole sequence being toned with negative affect and accompanied by active gesturing of the limbs. This initial reaction gave the impression of protesting or straining to reinstate interaction with the mother. This phase was followed by withdrawal: the infant averted his gaze downward from the mother's face, looking to her overall only 34% of the time. The realxed expression faded and the infant almost never smiled. This profile was quite different from the quiet interest seen during the interruption.

Patterning of Gaze. Differences found in the amount of time the infant di- [illegible] mother's face across the Normal, Interruption, and Blank-face

face conditions confirm descriptive reports that this infant behavior is highly sitive (Brazelton et al., 1975; Stern, 1971). It has been claimed that when mother's behavior is distorted in some way the infant briefly glances at her, n continuous looks occurring during normal interactions (Brazelton et al., 1 Carpenter et al., 1970, 1974; Stechler and Latz, 1966).

We examined the infant's visual attention in more detail. All periods of gazir the mother separated by even ½ second of looking away were recorded as belon to one of the following categories:

1. Short looks lasting 2½ seconds or less;
2. Looks of intermediate length lasting between 2½ and 5 seconds;
3. Long looks over 5 seconds.

The total number of looks, of all durations, was calculated for each condit summing scores for babies and sessions, and converted to proportion of t number number of looks. The results of this analysis are shown in Figure 3. Du Normal interaction most looks fall into the long category (57.3%). A sm number are glances under 2½ seconds (30.1%), and a few more of intermed length (12.6%). This distribution changes however in the Blank-face condition:

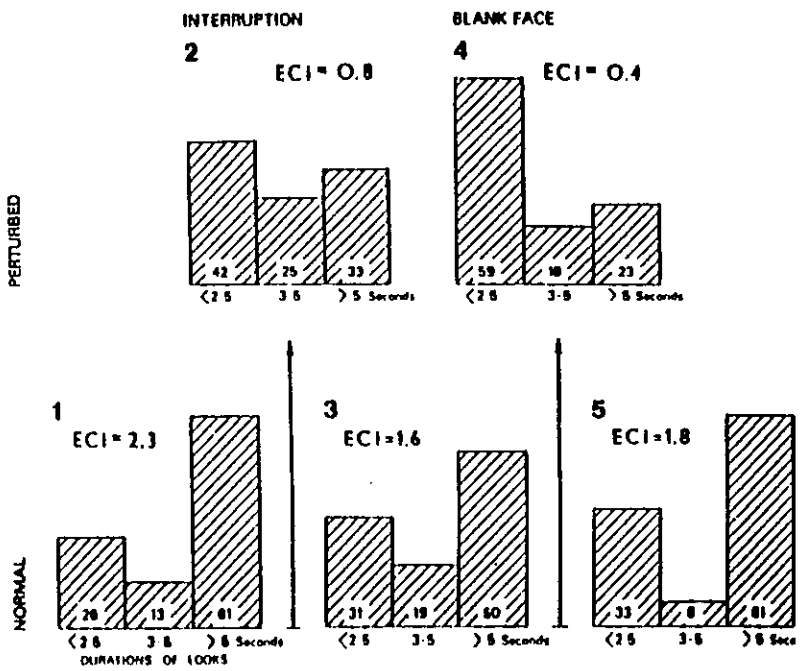

Figure 3. Distributions of eye contact of the infant with the mother for Experiment I = Eye-contact index for infant, the ratio of looks greater than 5 seconds to looks than 2.5 seconds.

number of short glances doubles (to 59.1% of the total gaze bouts), there are far fewer long, continuous looks (only 23.2%), and there is a slight increase in looks of intermediate length. A similar but less marked pattern of change is seen in the Interruption condition. These results parallel the descriptions of affective change, and reveal that it is not simply the overall amount of looking that changes across conditions. Gaze to the mother becomes differentially organized, with a consistently higher proportion of long, sustained, continuous looks in Normal happy, face-to-face communication compared to the many short glances evoked during the distressed, Blank-face condition.

The change in the infant's visual orientation to the mother is clearly expressed by the ratio of looks over 5 seconds in duration to short glances less than 2.5 seconds in length. This Eye Contact index for the infant (ECi) is above 1 in normal interaction and below 1 in perturbed interaction (see Figure 3).

The Cooccurrence of Gaze at or Away from the Mother with Other Behaviors

Since the pattern of gaze was found to be so sensitive to the different conditions, we decided to examine the coordination of the direction of gaze with affective expressions and communicative behaviors. Measures were taken for the different conditions of the frequency of cooccurrence in ½-second time blocks of looking either to or away from the mother's face and those behaviors held to be indicative of communicative effort, or expressive of either positive or negative affect.

The number of times such pairs of behavior cooccurred in the ½-second time blocks, expressed as a proportion of condition length by subject and by session, was compared with the degree of cooccurrence one would expect to obtain if the behaviors were independent. Obtained and expected frequencies were then compared, by subject and session, and submitted to the Binomial Sign Test (after the method of Fogel, 1977). The results of this analysis are shown in Table 4.

In all conditions, gazing to the mother's face is accompanied by communicative behavior (tonguing and wide open shaping of the mouth) and signs of positive affect. When the infant is looking away from the mother no such active efforts are shown. In the Blank-face condition the infant showed a tendency to display negative affect when looking to the mother. This gives support to the conclusion that the infant was soliciting responsiveness from the mother, or attempting to reinstate a normal interaction. In the Normal and Interruption conditons, on the other hand, if negative affect is shown, it is not systematically related to the direction of attention towards the mother.

The above detailed analysis of infant responses to two perturbations of maternal communication reveals coherently organized and complex expressions of affect and attention in the infant that are systematically sensitive to change in the form and direction of the mother's behavior.

Results of Experiment 2

Frequency of Individual Acts. The frequency of occurrence of behavior and probability levels for the double video experiment are shown in Table 5. During the

Table 5. Frequency of Infant Behavior, Expressed as a Percentage of Condition Time, with Statistical Analysis of Changes, across Live and Replay Video Conditio

Infant Behavior	Live	Replay		
1. *Attention*				
Gaze to mother	89.3	63.4	fall	0(
Gaze away/down	9.4	35.2	rise	.0(
2. *Communicative Effort*				
Tonguing	29.2	19 5	fall	05
Mouth wide open	20.4	5.0	fall	.00
Mouth relaxed	48.3	38.7	(fall)	.1
Mouth closed	31.3	36.3	rise	.00
3. *Affect*				
a. Positive:				
Eyebrows raised	38.3	15.6	fall	.00
Eyebrows relaxed	46.7	38.0	(fall)	.1
Smiling	4.9	1.0	(fall)	.1
b. Negative				
Distress:				
Frowning	0.5	25.4	rise	.00(
Raised brown	14 5	20.9	rise	.02
Displacement activity:				
Left hand finger clothes	15.9	24.6	(rise)	.1
Right hand finger clothes	14.9	34.4	rise	.00
Left hand touch face	0	1.5	(rise)	
Right hand touch face	0.3	1.8	(rise)	.1
Yawn	0	0.8	(rise)	
Grimace/sneer	0.4	7.7	rise	.00
Bite/chew lower lip	0.1	1.5	(rise)	.1

Note: Probabilities by the t-test for related samples, two-tailed. Possible trends are bracketed.

live TV presentation of the mother's image the infant behaved much as in t periods of normal interaction in the first study, except that the mood seemed le exuberant (smiling decreased from 32% time in face-to-face communication to 5' time in the live double video condition). However, infants maintained eye conta with the mother and made active movements of tongue and lips, and gestured wi their arms. In the Replay, there was a marked change, and the baby turned awa from the image of the mother. Signs of distress indicated by frowning, grimacin yawning, and touching the face and clothes increased, while expressions of positiv affect diminished. However, as compared to the profile seen in the Blank-fac condition, the level of tonguing, of wide open mouth postures, and to some exte the occurrence of excited limb gestures was lower.

Gaze. The change of pattern of distribution of gazes to the mother between th Live and the Replay conditions in this experiment is very similar to the one foun between the Normal and Blank-face conditons above (Figure 4). In the Live condi

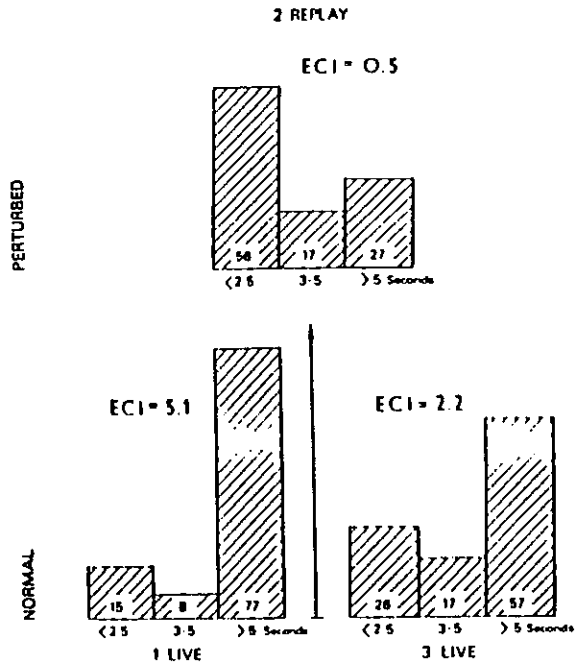

Figure 4. Distrubutions of eye contact of the infant for the mother for Experiment 2. ECI = Eye-contact index for the infant as in Figure 3.

tion, most looks were of at least 5 seconds duration (77%), very few were of intermediate duration (8%) and 15% were short glances. In the Replay, however, the majority of looks are short (56%) and only 27% were maintained for more than 5 seconds. There were large changes in the infant's Eye Contact index as in Experiment 1.

Cooccurrence of Communicative and Affective Acts with Direction of Gaze

The difference in the quality of response to the Blank-face vs. the Replay perturbations is revealed again in the results of the pattern of cooccurrence between the direction of the infant's gaze with communicative and affective expressions (Table 6).

In the Live condition, as in the Normal face-to-face interactions, expressions of positive affect and communicative acts were coupled with looking to the mother's image, whereas less active and more neutral expressions occurred when the infant looked away. During the Replay, this pattern was maintained for signs of positive affect, as in the Blank-face condition, with smiling and raised brows, though infrequent, occurring only when the baby looked at his mother. But, unlike the [illegible] to the Blank-face presentation, expressions of negative affect in the Replay

Table 6. Communicative and Emotionally Expressive Behavior that Cooccur with Either Looking to, or Away From, the Mother's Face in the Live and Replay Video Conditions

Live		Replay	
	p		*p*
1. Behavior cooccurring with looking to the mother's face (Probabilities by Binomial Sign Test)			
Tonguing	.01	Eyebrows relaxed	.04
Wide open shaping of mouth	.004	Raised brows	.002
Mouth relaxed	.1	Smiling	.1
Raised brows	.006		
Smiling	.03		
2. Behavior cooccurring with looking away from the mother's face			
Mouth closed	1	Mouth closed	05
Neutral expression	.03	Eyebrows frown	.004
Relaxed brows	.09	Neutral expression	.1

accompanied looking *away*, and expressions of communicative effort did not occ when the baby was looking at the mother to any significant degree.

Thus, whereas the patterning and organization of acts in the Blank-face conditio gave an impression of solicitation or effort oriented to the mother to reinsta mutually responsive interaction (the baby continuing to make arm gestures an other efforts at communication while looking at his mother), the feeling conveye by the infant's behavior in the Replay is one of detached, unhappy puzzlement confusion. The infant occasionally looked at his mother in an expressionless, hes tant fashion (mouth and eyebrows relaxed) with little active gesturing, and the perhaps made a smile or tonguing movements upon some chance coincident interaction with the mother's replayed behavior. But the, he turned away, frowni grimacing, fingering his clothes, or yawning when this relationship between h own acts and those of his mother was no longer apparent.

CONCLUSIONS

The findings of these three perturbation studies attest to a fine sensitivity in ve young infants to the immediate affective quality of maternal behavior; its form a its relationship in time to the infant's own acts are both important. The parametc of interactive behaviour that are discriminated in the two experiments and the sha of the infant's responses to the perturbations are different. Each kind of disturban gives rise to a distinctive motivational state coordinating and integrating discre acts in profiles that convey a personal significance.

The effects observed do not support a discrepancy hypothesis. If infant affect a attention were governed by the mismatch between the currently perceived config

ration of maternal behaviour and a learned schema for her (incorporated such properties as "*en face* position," "tone of voice," "characteristic rhythm" [Carpenter, 1974; Stern, 1974]), then the interruption, involving changes in all of these parameters, would be more distressing than the double video replay, where the characteristics of maternal style of communication are unchanged. In fact, the interruption was not distressing. It is unlikely that infants have learned to tolerate interruption simply because it is a commonly occurring change in mothers' behavior. Even more acute distress is observed in cases where the infant is confronted with a pathological, anxious, and clinging, or aggressive, form of maternal response that is nevertheless the norm for that mother. For example, a detailed analysis of mother–infant interaction where the mother was clinically depressed, and was anxious, intrusive, and rejecting in her handling of her infant, revealed extreme withdrawn and avoidant behavior in an apparently normal 8-week-old baby (Murray 1980, 1983a). Similar cases have been described by Robertson (1963), Fraiberg (1980), and Field (1983).

Our results also pose problems for explanations of affect and attention to persons in terms of the infant's discovery of predictable contingent relations between his own activity and events in the world. Of course, the relationship in time between the mother's acts and those of the infant is clearly an important component in the control of the interaction, and one to which the infant is highly sensitive—this is shown by the puzzlement or confusion rapidly evoked by the replay of the mother's responses in the double video apparatus. But the factor of contingency is not sufficient to account for the distinctive behavior patterns, that are shown by the infants during the three perturbations. In particular, this theory fails to predict the lack of distress during the interruption, where contingency between the infant's acts and the mother's is lost.

The more complex motivations attributed to infants by psychoanalytic and ethological theorists are substantiated by the distinctive quality of response evoked in the infant by each of the different kinds of perturbation. The infant shows quiet interest during Interruption, solicitation, or effort to reengage in reciprocal interaction during the Blank-face perturbation, and puzzlement and confusion in the double video replay—each pattern of response involving a coherent and complex coordination and integration of infant behaviors. These results suggest that infants of 6 to 12 weeks have the capacity to detect features of the structure of the mother's behavior (e.g., direction of her gaze, her facial expression, rhythm of movement and voice quality). In addition, they appear to respond to the constellation of these in terms of coordinated structures of interpersonal and emotional value, and finally they regulate their own expressions in appropriate, complementary response patterns that can be perceived by the mother as particular emotions. This close coordination of behavior between mother and infant requires a circle of emotional communication.

Certain groupings of expressive features may be relatively fixed in the individual and convey an underlying set or range of motivational or coordinative qualities that adults identify as personality characteristics (e.g., of posture, voice, facial expression, or gait). These provide the background or context for variations that express momentary adjustments of interpersonal intentions and affect, such as the fine changes of expression examined here—the shifts of direction of gaze, facial muscle movements, changes of configuration of the vocal apparatus. The sensitivity of infants as young as 6 weeks to these complex signals of communicative and emotional state are only revealed in a detailed analysis of changes in the occurrence and organization of infant acts and expressions in response to normal and systematically perturbed adult interactive behaviour. Where few measures have been used, for example, scoring for the presence of single, ill-defined categories of infant act like "smiling" or "vocalizing" in the context of very reduced and artificial stimulus conditions, these capacities for perceiving emotion have not been detected.

Fine grain examination of infant responses also provides evidence about the regulation of emotional states in relation to the quality of interpersonal engagement. In periods of "successful" interaction during the first 3 months, there is a close correspondence between the emotional expressions of mother and infant. This may rely to a great extent on the mother's empathy and identification with her infant's experience. Her effort to identify with the infant's feeling is revealed in her baby talk which is almost exclusively about what she imagines her baby to feel, and she shadows the expressions of her infant in a reassuring and supportive fashion (Murray, 1980; Sylvester-Bradley and Trevarthen, 1978). The infant's affective response is not imitative because, when the quality of the mother's communication changes, the infant behaves in complementary fashion that varies with his level of development. Thus an 8-week-old in the Blank-face condition initially is moved to recreate and sustain the previous mutual interaction, with a whole repertoire of coordinated communicative acts and gestures being brought into play. When the mother's responsiveness is still not forthcoming the infant looks withdrawn and sad. In contrast, a 6-month-old's reactions are more elaborate and extensive: first he might play the clown with vigor and then look around the room or examine objects (Trevarthen, 1983a).

It is important to emphasize that regulation of affective and personal states of mind is not a one-way process—the mother's behavior determining the infant's. Each of the infant's distinctive responses to the different presentations was identified by the mother as an active meaningful response to the perturbation of their communication, and each provoked highly consistent mirroring emotional reactions in her. For example, a feeling of concern was almost invariably elicited by the baby's sad-faced response to the Blank-face presentation, a typical comment being, "Oh dear, are you in a huff with me now?"

The mutual, two-way control of the interaction and its affect was even more clearly illustrated in a study where the mother was presented with replayed sequences of her infant interacting with her in the double video situation (Murray, 1980, 1983b). When the mother, unaware that she was to view a replay, was presented with a video sequence of her infant recorded during a normal, live interaction a few minutes previously, her baby-talk systematically changed. Its affectionate tone was reduced, and she spoke of her infant as behaving in an odd

way. Her utterances revealed that she felt her infant was strangely unaware and avoidant. Several mothers said that there must be something 'wrong' in their own behavior that was disturbing the infant. The mothers expected infants to be highly responsive to their own feelings in a positive or constructive manner.

A nonreductionist interpretation should be made of these data on the communicative abilities of 2-month-olds, including their abilities to have and perceive emotions (Trevarthen, 1983a,b). Infants are sensitive to the contingency of response of human partners, but not *just* to this. They detect features of persons that are discrepant with learned standards; but do not *just* detect such discrepancies. They are ready to engage in interpersonal contacts and form active emotional relationships with particular persons before they are ready to handle and manipulatively explore objects. To discriminate the behaviors of persons as early as 2 months after birth and to respond so efficiently, they must possess a set of processes in which human stimuli are categorized in emotional and expressive terms. To this extent, the forms and communicative values of human emotions are innately formulated even though their uses in regulation of contacts and relations undergo considerable development in infancy and childhood.

Subsequent developments reveal the importance of emotional expression in the regulation of all forms of play and teaching. The 2-month-old uses expressions of feeling in direct face-to-face encounters to assist the mother in establishing a balance of mutual awareness that supports expressive motives in the infant and allows "turn-taking" in proto-conversations. After 3 months, the mother must introduce a more vigorous style of play to obtain engagement, and her behavior is both more aggressive and more humorous. In Bateson's sense she employs "meta-communication" (Bateson, 1955). Mock serious or mock aggressive assaults and exaggerated expressions elicit laughter in the infant. Teasing games obviously test the infant's growing ability to predict the mother's actions and presentation of herself. Then, as the infant becomes increasingly interested in exploring objects, any partner seeking to play will do so by varying the presentation of the object to cause the infant to laugh. This kind of game brings out the important function of the infant's expressions of pleasure, interest, annoyance, or avoidance as regulators of the presentation of objects and events by adults. The habitual forms of expression of affect in play constitutes a description of the range of motivation of that particular child for engagement with others in shared experiences. In other words, it describes a personality which is friendly, comical, timid, independent, depressed, etc. Increasingly, it becomes clear that the child is guided by consistent self-image or controlled autonomy of feelings to mark out play relations with other persons. Preferences for particular persons permit routines of play to be learned and practised.

Towards the end of the first year the same fundamental organization of emotions used to express feelings towards other persons in simpler direct engagements is shown in developing proto-linguistic utterances and gestures. Thus as the child performs "acts of meaning" and starts to deliberately make messages that have recognizable functions of language in communication with other people, the emotional quality of expression regulates the essential interpersonal basis of joint awareness of objects and events.

These developments in the first year show that the natural process of cognitive development is one in which the child uses actions to obtain experiences and extend forms of knowledge in collaboration with trusted adults. It is not just a solitary endeavor of the child limited by stages of object awareness, and its collaborative or intersubjective controls are entirely dependent upon the emotional mechanism that regulates interpersonal contacts and relationships from the early weeks of life.

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