Paper I

ICD:461
pp.1–12 (col.fig.: NIL)
PROD.TYPE: COM
3B2
ED: CHANDRA
PAGN: VENKATACHALA SCAN: PUSHPA
Infant and Child Development
Inf. Child Dev. 15: 000–000 (2006)
Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/icd.461

Expression of Negative Affect During Face-to-Face Interaction: A Double Video Study of Young Infants' Sensitivity to Social Contingency

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The purpose was to assess infants' sensitivity to social contingency, taking affective state into account, during face-to-face interaction with the mother in a *double video* set-up. Infants' behaviours during three sequences of live face-to-face interaction were compared to two sequences where the interaction between the infant and the mother was set out of phase, by presenting either the infant or the mother with a replay of their partners' behaviour during earlier live interaction. We found a significant negative correlation between the infant's degree of negative affect and the average time of looking at the mother during the live sequences. A median split was calculated to separate the infants into a *high-negative-affect* group and a *low-negative-affect* group on the basis of their emotional responses during the experiment. The low-negative-affect infants looked significantly more at their mothers than other foci during the *live* but not the *replay* sequences, while the high-negative-affect infants did not show this difference. The results suggest that 2–4-month old infants are able to distinguish between experimental distortion of contingent aspects in live and replay sequences, but that this effect of the replay condition may not be shown by moderate to highly distressed infants. Our findings underline the importance of taking infants' emotional state into account in experiments intended to assess their capacity for intersubjective communication.

Key words: social contingency; mother–infant interaction; negative affect

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1 INTRODUCTION

The foundation of intersubjectivity, which requires reciprocal awareness of actions and emotions manifests itself in early imitation (Kugiumutzakis, 1998; Meltzoff & Moore, 1998; Nagy & Molnár, 2004; Trevarthen, Kokkinaki, & Fiamenghi, 1999). Functionally, imitation is characterized by the important communication features of initiating social contact and responding to others' initiations. Neonatal imitation is therefore a central marker of social contingency in action (Nadel, 2002), which represent an important element in early emotional regulation (Kokkinaki, 2003). The central motivator and regulator for human mental growth may be described as an innate intersubjectivity that enables the infant to regulate interpersonal relationship from early on (Trevarthen, 1979). Furthermore, the infant's motivation and activity in face-to-face communication functions to consolidate situations that are essential for postnatal neurological development (Schore, 1994).

Some developmental researchers have, as pointed out by Reddy, Hay, Murray, and Trevarthen (1997) suggested that what looks like social initiative and contingent responding on the part of the infant, is in fact dependent on the mother's sensitivity to the infant's occasional 'non-social' sounds and behaviour actions, and thus makes it appear like mutual commitment. However, evidence for a mutual regulation of behaviour and affect is found when engagements are examined in detail with attention to their timing and complimentary forms, and is confirmed experimentally in 'still face' studies (Cohn & Tronick, 1983; Murray & Trevarthen, 1985; Tronick, Als, Adamson, Wise, & Brazelton, 1978) and in examination of infants' early interaction with their depressed mother (Field, 2002).

The development of the 'double video' paradigm enabled a more subtle test of the contingent aspects of early communication, further testing the infant's prospective interest in what the mother does. Infants, and their mothers, both show disturbance of emotion when the interaction is out of synchrony and attunement, by presenting a replay of a televised engagement with the partner. Murray and Trevarthen (1985) found that four infants (6–12 weeks of age) evidenced a decline in gaze and positive affect and other behaviour indicative of loss of intersubjective contact during a televised replay of their mothers' behaviour compared to the preceding sequence when they interacted in a televised live interaction. There have been claims that the decline in gaze and positive affect from the live interaction to the subsequent replay interaction could be due to factors such as an increase in infant fussiness (Nadel, Cachob, Kervella, Marcelli, & Réserbat-Plantey, 1999; Rochat, Neisser, & Marian, 1998), familiarity and 'boredom' with the adult (Bigelow & Birch, 1999; Hains & Muir, 1996), memory of the mothers' previous behaviour (Hains & Muir, 1996) or simple reactions to differences in the degree of mothers mirroring the infants' affect (Legerstee & Varghese, 2001).

In their study of 5-month olds, Hains and Muir (1996) found a significant decrease in gaze and smiling from first contingent interaction to the following replay sequence, thus replicating Murray and Trevarthen's (1985) findings. However, a similar decline was found in a control group that did not receive a replay sequence in the second period, and neither of the groups exhibited an increase in gaze and smiling during the third contingent period. This finding was replicated by Bigelow, MacLean, and MacDonald (1996) with 4- and 6-month olds. It was assumed that the results could be due to that the infants had developed a memory trace from the previous live interaction (Hains & Muir, 1996) or that the infants' behaviour during the non-contingent replay sequence carried

over to the subsequent contingent interaction (Bigelow *et al.*, 1996; Hains & Muir, 1996). It is argued that this carryover effect is attributable to expectations the infants form during the sequence of non-contingent interaction (Bigelow, 2001). However, since there are important changes in the infants interest for face-to-face interaction after 3 months, the results could also be an effect of age (Nadel *et al.*, 1999; Trevarthen & Aitken, 2003), or reflect an overall expectations of social contingency that are determined by infants' relational history with their parents (see Murray & Stein, 1991; Pickens & Field, 1995).

Legerstee and Varghese (2001) confirmed the relational history hypothesis by showing that infants of mothers ranking high on affective mirroring at two separate occasions, exhibited more smiling, gazing and vocalization during live interaction compared to when interaction was set out of phase. This suggests that every parent–infant dyad develop their own interaction history (Legerstee & Varghese, 2001), where degree of affective mirroring varies in the normal population but the 'private' interaction style remains stable within the mother–infant dyad (Watson, 1985). From this perspective, one could imply that infants with a history of high affect mirroring get upset during non contingent interaction but are able to repair the interaction failure (see Tronick, 1989) in the following live sequence and not as suggested by Hains and Muir (1996) or Bigelow *et al.* (1996), by expectations of further non-contingent communication formed during the replay sequence in the following contingent interaction. One should, however note that the Legerstee and Varghese (2001) study included only one live and one replay sequence, where mothers and infants were randomly assigned to receive either live or the replay sequences first.

Rochat *et al.* (1998) criticized procedural aspects of earlier double video research, arguing that one consequence of Murray and Trevarthen's (1985) design was that the infants were at their peak social performance during the live sequence. Thus, the decrease in gaze and smiling could be caused by a natural decline in social interaction more than sensitivity to procedural changes. When Rochat *et al.* (1998) attempted to control for this by introducing fixed exposures of the mother to the infant in each sequences, they failed to replicate Murray and Trevarthen's (1985) results. There were other important differences in the method that reduced the changes for communication through the double video, and they (Rochat *et al.*, 1998) did not succeed in obtaining a level of pleasurable 'proto-conversational' engagement. Nadel *et al.* (1999) remarked that when Rochat *et al.* (1998) compared the infants' amount of social behaviour during live and replay sequences without controlling for a mutual engagement in the initial phase of the experiment, the comparison could have been between two non-contingent interactions. To examine more carefully social expectancy for social contingency Nadel *et al.* (1999) modified the double video procedure by inserting seamless shifts between live and replay sequences and controlled for the extent to which the mother and the infant were interacting before the experiment started. They (Nadel *et al.*, 1999) replicated Murray and Trevarthen's (1985) findings, and most importantly, showed that the infants evidenced an increase in gaze and positive affect during a second live sequence compared to the preceding replay sequence. This reached however, only statistical significance when three infants who became upset during the replay and second live sequence, were excluded.

Recently, we (Stormark & Braarud, 2004) extended the double video set-up to five sequences, Live1–Replay1–Live2–Replay2–Live3, each with a duration of 30 s, with seamless shifts between the sequences. The difference between the first and the second replay sequence was that during the second replay the mother was presented with a replay of their infant while the infants saw their mother

live. This technical arrangement represents a non-contingent interaction similar to the traditional replay but the difference is that the infants' responses during the second replay cannot be accounted for by memory of previous maternal behaviour. The results showed that the infants looked significantly more at their mother than other foci during the three live sequences but did not show this preference for looking at the mother during the replay sequences, thus supporting the conclusion from microanalyses of the patterns of expressive exchange in protoconversations (Trevarthen, 1979, 1993) that young infants are, indeed, able to distinguish between contingent and non-contingent responses from their mothers.

Elsewhere, it has been found that infants express concordance of affective face and behaviour configuration, differently distributed to different experiences and contexts (Weinberg & Tronick, 1994) and to social and non-social situations (Legerstee, Corter, & Kienapple, 1990). Thus, the whole spectrum of expressed affective modalities would allow the infant to adapt behaviourally and emotionally to different situations and contexts. However, despite the fact that the 'fussiness' hypothesis have been discussed (see Hains & Muir, 1996; Nadel *et al.*, 1999; Rochat *et al.*, 1998) and it is found that infant crying may disqualify a contingency test (see Nadel *et al.*, 1999), the majority of 'double video' experiment have only reported amount of gaze and positive affect (Legerstee & Varghese, 2001; Nadel *et al.*, 1999; Rochat *et al.*, 1998) or prosocial behaviour (Legerstee & Varghese, 2001). Murray and Trevarthen (1985) did report several effects, but this was only on a small number of subjects.

The purpose of the present study was to examine if young infants' sensitivity to social responses is related to the extent to the amount they display negative affect during the experiment. It was hypothesized that those infants who adapted to the situation would evidence sensitivity to different qualities of maternal communication in concordance with low negative affect. Assessment of mothers' amount of gaze was included to ensure that the mothers evidenced positive social contact. The experimental set-up included five sequences, three live and two replay sequences in a Live1–Replay1–Live2–Replay2–Live3 order.

METHOD

Subjects

45 mothers (mean age: 28 years, range 20–39) and their infants with a mean age of 11 weeks and 3 days (range 6–17 weeks) participated in the study; 23 boys and 22 girls with no history of antenatal, natal or postnatal complications. Of the mothers, 43 were married or co-habitants and 2 were single mothers. Socioeconomic status was assessed by mothers' level of education: 14 had a master degree, 16 a bachelor degree, 17 had graduated from high school and 1 mother had the minimum 9-year compulsory school. The mothers were recruited to the study during the home visit by the nurse right after birth or at the Well Baby visit at the local health care centre when the infants were 4–6-weeks old. This study was part of a larger longitudinal project on infant emotional development.

Procedure and Apparatus

In the laboratory the mother was explained that the purpose of the study was to investigate young infants' sensitivity to social interaction using a closed-circuit

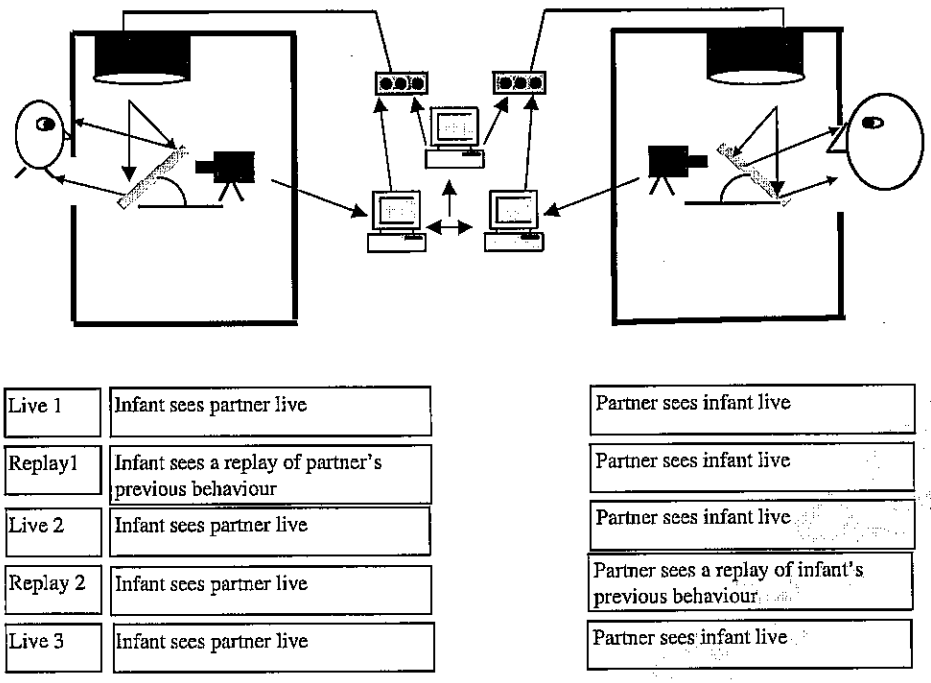

Figure 1. Schematic outline of the experimental set-up

TV system. The mother was told that the experiment included several sequences, but she was not informed about the shift between live and replay conditions. When the mother and the infant had adjusted to the laboratory setting, they were separately seated in two adjacent sound- and light-proof rooms where they could see and hear each other through a closed-circuit TV system (see Figure 1; see also Stormark & Braarud, 2004 for a more detailed description).

Coding of Data

The behaviour of the mother and the infant was scored using The Observer Video Pro version 3.0, on a frame-by-frame basis, yielding a temporal solution of 41.67 ms. The coder could move back and forth between the frames and pick among the mutual exclusive behaviour elements from the behaviour classes. Since we hypothesized that infants' sensitivity to social contingency is dependent on low amount of negative affect, we were interested in observing the infants gaze foci and affective expression by head and arm movements. The coding classes of *gaze behaviour* and *affect behaviour* were scored independently.

The coding class 'gaze behaviour' was based on Murray and Trevarthen (1985) and Nadel *et al.* (1999). Since the double video camera in the double video laboratory was placed behind the one-way mirror in a position adjusted to the infants face, the coder could easily score *gaze at mother* whenever the infant's gaze was directed at the coder. *Gaze at own body* was scored whenever the infant looked at some part of his or her own body. This included also looking at arm or hand in movement. *Gaze at the surroundings* was scored when the infant looked at the walls of the booth or in a direction that did not involve gaze at mother or gaze

Table 1. Coding classes for infants affect behaviour

Behaviour class	Behaviour element
Negative vocalization and facial expression	Cry, yawn, silent
Hand and arm movements	Hands on body, hand and arms out, hands and arms silent along body, one arm down/one hand on body, both hands on body, one arm out/one hand on the body, hands together, one arm silent along body/arm out
Head movements	In motion, no movement

at the body. After gaze at own body and gaze at the surroundings were scored separately, they were added together as score of total amount time gazing away from the mother. *Eyes closed* were scored each time the infant closed his or her eyes, as in eye blink and in closed eyes.

The coding classes for the infant's negative affect behaviour was partly derived from Weinberg and Tronick's (1994) IRSS (the Infant Regulatory Scoring System) and Trevarthen's and colleague (Murray & Trevarthen, 1985; Trevarthen, 1979, 2001; personal communication) work on the infant's total pattern of affective activities in communication with a social partner. Coding classes for infants affect behaviour is shown in Table 1. The behaviour class 'negative vocalization and facial expression' comprised behaviour associated with negative affect such as infant *crying* (see Bowlby, 1988) and *yawning* (Murray & Trevarthen, 1985). Crying was scored for every onset of cry vocalization until the infant stopped crying. Yawn was scored whenever the infant expressed, on face value, the facial expression of yawning. *Silent* was defined as the opposite of both infant crying and yawning, and were therefore scored as long as the infant did not express cry vocalization or show the facial expression of yawning.

The behaviour class 'hand and arm movement' comprised all types of movement, positions and combination of hands and arms movement. The infants' co-ordination and integration of their hands and arm activity is found to be a multi-behavioural expression of infants motivational state and changes in affective motivation related to the infants experience with a social partner (see Legerstee *et al.*, 1990; Murray & Trevarthen, 1985; Weinberg & Tronick, 1994). The behaviour elements in each behaviour class were mutual exclusive. Scoring of one hand and arm gesture or position marked the onset of that behaviour to offset, which initiated scoring of a new gesture or arm and hand position.

The behaviour class 'head movement' included the mutual exclusive behaviour element of *head in motion* and *no movement*. The behaviour is a part of the infant's multi-behavioural expression of affective state where, for example, increased head movement is associated with distress (Kopp, 1989), and is defined as distancing and escape behaviour by Weinberg and Tronick (1994).

The behaviour elements 'hands touching the body', 'one hand touching the body/other hand relax' parallel the description of displacement activities in Murray and Trevarthen's (1985) definition of negative affect, and together with 'head movements' they were further added together and constituted a component of the negative affect score.

The coder who scored the video files was blind to the order of the sequences and to the identity of the mother–infant pairs. This was achieved by renaming the

video files in a randomized order. The video files of the mother and the infant were scored separately, neither carrying any cues to the coder about which was the corresponding sequence for the partner, mother or infant, nor which of the sequences was the recording of contingent or non-contingent interaction.

Inter-rater reliability (between the coder and another person who also was blind to the order of the sequences) were calculated on the scores for 5 dyads, and the scores were 0.962 for infant's gaze foci; 0.979 for mother's gaze foci; and 0.951 for infants affect. The behaviour element 'eyes closed' doesn't imply any direction of gaze and was excluded from further analysis.

Design and Statistical Analysis

All infants ($N = 8$) who showed fretting and crying in any sequences of the experiment were excluded from the statistical analyses. Descriptive data demonstrated a great variability in negative affect in the infant group, and only four infants of the total sample did not show any sign of negative affect during the experiment. Correlation analyses were conducted to calculate the relationship between average amount of looking at mother during all three live sequences and total amount of negative affect. A median split of the amount of overall negative affect expressed during the experiment was implemented to separate the infants into low- and high-negative-affect groups.

The experimental design for infants' negative affect and gaze was a two-way within-group factorial design comprising groups (low-negative-affect infants vs high-negative-affect infants) × sequences (Live1, Replay1, Live2, Replay2, Live3). Infant gaze were subjected to a three-way factorial design involving Groups (low-negative-affect infants vs high-negative-affect infants) × foci (at mother vs away from mother) × sequences (1–5). To ensure that there were no difference in amount of mothers' social communication to their infants, an ANOVA was conducted on Groups (mothers of low-negative-affect infants, mothers of high-negative-affect infants') × sequences (1–5) × gaze (at the infants, away from the infant).

RESULTS

There was a significant negative correlation between the infants' negative affect score and amount of gaze at mother during all the three live sequences ($r = -0.35$, $p < 0.05$), but not during the two replay sequences ($r = -0.17$, $p < 0.31$) which indicates that the infants intensity of negative affect have an influence upon the infant's ability to communicate with social gaze during contingent interaction.

A two-way ANOVA was conducted for a further investigation of differences in amount of negative affect between the low- and high-negative-affect groups, in each sequence. There was a main effect of negative affect ($F(1, 35) = 62.217$, $p < 0.00001$) reflecting a significant higher amount of negative affect in the high compared to the low-negative-affect group during Live1 ($F(1, 35) = 8.97$, $p < 0.01$), Replay1 ($F(1, 35) = 33.42$, $p < 0.0001$), Live2 ($F(1, 35) = 38.47$, $p < 0.0001$), Replay2 ($F(1, 35) = 36.88$, $p < 0.0001$) and Live3 ($F(1, 35) = 4.47$, $p < 0.05$; see Figure 2), which suggest for two qualitatively different subgroups of infants when comparing their affective state. Within each group of infants, there were no significant differences in amount of negative affect during the five sequences, except that the

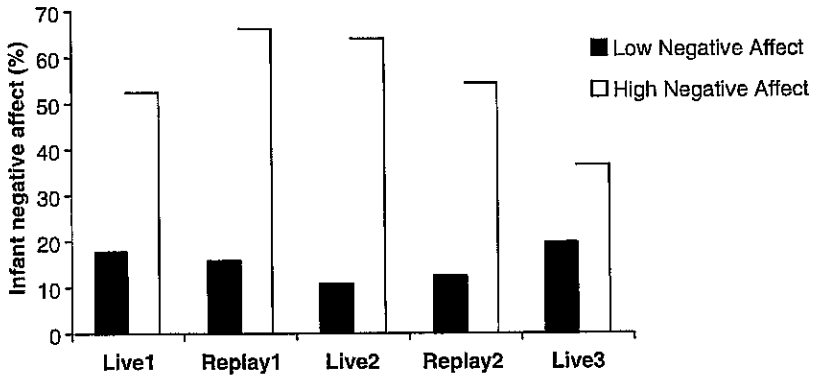

Figure 2. Mean proportional negative affect during the Live1, Replay1, Live2, Replay2, Live3 sequences in the low- and high-negative-affect groups

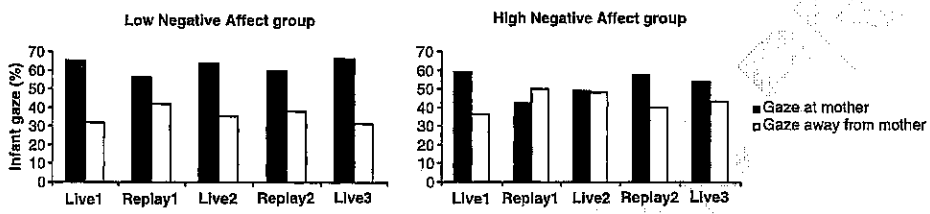

Figure 3. Mean proportional infant gaze at mother and away from mother during the Live1, Replay1, Live2, Replay2, Live3 sequences in the low- and high-negative-affect groups

high-negative-affect infants showed a significant decrease in negative affect from Replay2 to Live3 ($F(1,35) = 11.10$, $p < 0.01$).

To examine whether the amount of negative affect have an influence on the infants' sensitivity to social contingency, a two-way within-group analysis was conducted on the low- and high-negative-affect infants. The results showed that there was a significant main effect of foci of gaze in the low-negative-affect infants ($F(1,18) = 5.55$, $p < 0.05$), indicating that the infants had a significant preference for looking at their mothers than other foci during Live1 ($F(1,18) = 5.22$, $p < 0.05$), Live2 ($F(1,18) = 4.29$, $p < 0.05$) and Live3 ($F(1,18) = 7.047$, $p < 0.01$), but that there was no such preference for looking at their mothers during Replay1 or Replay2 (see Figure 3). There were no significant differences in the amount of gaze foci between the sequences. In the high-negative-affect infants, there was neither a significant preference for the mother in the live sequences, nor a significant difference in amount of gaze foci between the sequences (see Figure 3).

There were no differences in mothers' gaze at infants between the mothers of low- and high-negative-affect infants across the five sequences.

DISCUSSION

In the history of double video research, various results are reported in relation to infants' expectations for and sensitivity to contingency. The present study sought

to clarify if the variation in the distribution of amount of gaze at mother over live and replay sequences was associated with the infants' affective state. The results showed that there was a negative relationship between the infants' degree of negative affect and average amount of their looking at the mothers in all three live sequences, but not during the replay sequences suggesting that there was a large variation in amount of negative affect among the infants. A median split was used to separate the infants' into two groups of low and high negative affects, and the results showed that there was a significant difference between the two groups in all five sequences when comparing the amount of negative affect. The amount of negative affect was stable across conditions for the low-negative-affect infants while the high-negative-affect infants showed a significant decrease in distress from Replay2 to Live3. The most interesting finding was that the low-negative-affect infants showed a significant preference for looking at the mother in all three live sequences but not in the two replay sequences, and that the level of gaze at mother was significantly higher at the live than the replay sequences. Neither of this was evident in the high-negative-affect infants, who did not show a preference for looking at mother during any of the sequences of the experiment.

We hypothesized that the infants would evidence sensitivity to social contingency, but this was only evident in infants judged to score low on signs of negative affect. The findings in this group replicate the main findings of Murray and Trevarthen (1985), Nadel *et al.* (1999) and Stormark and Braarud (2004). Neither memory of previous seen maternal responses (Hains & Muir, 1996), carryover effect from the replay sequences to the subsequent live sequences (Bigelow *et al.*, 1996; Hains & Muir, 1996), nor fatigue can account for these results. In fact, the low-negative-affect infants actually evidenced their highest proportional amount of looking at mother during Live3, in accordance with what we have reported earlier (Stormark & Braarud, 2004).

The high-negative-affect infants' did not show sensitivity to social contingency that could be taken to support the findings of Rochat *et al.* (1998) results. However, these authors had fixed conditions, and the comparison between their live and replay conditions is possibly a comparison between two sets of non-contingent interactions. The findings of the present study cannot be explained this way; establishment of mutual gaze between infant and mother was a requirement for starting the experimental session of Live1 for each dyad and the amount of gaze at the mother was approximately the same for the high- and low-negative-affect infants. The fact that the high-negative-affect infants' showed 16% decrease in gaze at the mother from Live1 to Replay2 with only a small increase (about 5%) in the subsequent Live2 could, on face value, be taken to support Hains and Muir (1996) and Bigelow *et al.* (1996) suggestions that an expectation of non-contingent communication had been formed. It is, however, probable that the lack of significant preference for the mother in the three live sequences was caused by the infants' affective state more than by an expectation of non-contingent communication formed during Replay1, since there was no significant difference between Live1 and Replay1.

The variability in the infants' affective state could be due to internal factors like sleepiness, hunger or general fussiness, and external factors such as the novelty of the laboratory setting. The distorted quality of the interaction in the replay sequence of the double video procedure resembles the negative affect produced in the 'still face' paradigm (see Murray & Trevarthen, 1985; Weinberg & Tronick, 1994). The fact that the high-negative-affect infants evidenced a significant decrease in negative affect from Replay2 to Live3 could reflect a longer latency for adaptation in this infant group, compared to the groups of infants with low

negative affect. According to Tronick's (1989) postulation of early communication as an affective communication system, one could therefore argue that the mothers of the high-negative-affect infants failed to guide and regulate the infants' emotional state after the disruption of the interaction. However, one should recall that these mothers did not show any significant difference in amount of gaze at infants compared to the mothers of the low-negative-affect group. Thus, the infants' degree of negative affect could be an expression of the infants' adaptability to the laboratory situation in general. Rochat *et al.* (1998) stressed the lack of ecological validity in the double video set-up, where both the novelty of the laboratory setting and the arrangement with mother and infants placed in two different rooms could make both participants uncomfortable.

The most important finding in this study was that 2–4-month-old infants in optimal conditions are able to distinguish between the artificial, yet subtle, distortion of contingent responses in live and replay sequences. The fact that 30 s intervals are sufficient to recognize the different quality of maternal behaviour, but also sufficient to re-establish communication with the mother after two non-contingent sequences, is supportive of the idea that 2–3-month olds are highly sensitive to social contingency, but that it will only be evident when infants show few signs of negative affect.

It is acknowledged that in the present findings the estimation of infants' affective state is only based on gestural expressive behaviour and head movements. It is thus not yet clear whether scoring infants' facial expression would yield the same or different results than what is reported here.

Yet, our findings highlight the importance of the infants' well-being for the success of any experimental study of communication. Infants who show signs of distress will not be able to, or interested, in playful interaction with his or her caregiver. Instead, the baby will withdraw its attention from the caregiver and express negative affect, as is also seen in 'still face' studies where the infants are found to use negative affect to attract the mothers attention (Mayes & Carter, 1990) or to end the dialogue (see Tronick, 1989).

Clinically, the findings emphasize the coherence of multi-behavioural expression of infants affective state, and therefore have implication for evaluating and describing typical and atypical emotional behaviour in young infants (see also Weinberg & Tronick, 1994).

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to professor Colwyn Trevarthen for the advices given in his review of the paper.

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