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Emerging Sensitivity to the Timing and Structure of Protoconversation in Early Infancy

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Thirty-six 2-, 4-, and 6-month-old infants were videotaped while interacting with a female adult stranger engaging in either organized or disorganized 1-min peekaboo games. Two-month-old infants gazed and smiled equally at the stranger, regardless of the relative organization of the peekaboo game. In contrast, 4- and 6-month-old infants smiled significantly more and gazed significantly less in the organized peekaboo condition than in the disorganized peekaboo condition. These results suggest that from a diffuse sensitivity to the presence of a social partner, infants by 4 months develop a new sensitivity to the narrative envelope of protoconversation, in particular the timing and the structure of social exchanges scaffolded by adults. These observations are interpreted as evidence of developing social expectations in the first 6 months of life. This early development is viewed as announcing and preparing the communicative competence that blossoms by the end of the 1st year.

When infants start to smile in response to social stimulation, there is an apparent change in the way they relate to the world. Smiling is indeed associated with major developmental changes in infancy. Social smiling emerges by 2 months of age (Spitz, 1965; Wolff, 1987) and is the first clear sign of positive social attunement (Stern, 1985). Aside from evidence of neonatal imitation, and in particular the converging evidence from various laboratories that neonates are capable of reproducing tongue protrusion performed by an adult model (Meltzoff & Moore, 1977; see Anisfeld, 1991, for a review), the emergence of socially elicited smiling corresponds with the beginning of unambiguous mutual engagement with others in face-to-face interaction. It entails reciprocity of feelings and affects. Infants express a new sense of their social surroundings, and parents witnessing the first display of shared social pleasure in their infant's smile commonly report the intense experience of discovering a person in their baby (Rochat & Striano, 1999a). Such discovery changes the way parents and caretakers frame their interactions with the infant, who now provides unambiguous cues for solicitation and maintenance of playful interactions (Kaye, 1982). Social smiling is essential feedback for caretakers because it enriches the way they relate to the infant (Fogel, 1993). On the basis of the expression of reciprocal pleasure, interactions are fine-tuned, and games proposed to the infant are actively adapted by caretakers (Papousek & Papousek, 1995). Such fine tuning pertains in particular to the form and the timing of the games initiated by caretakers in their interactions with infants (Watson & Ramey, 1972).

Smiling is at the core of the emotional coregulation that binds infants to others in new ways. Spitz (1965) noted the following regarding the new propensity of 2-month-olds to respond to an adult's face with a smile: "This smile is the first active, direct, and intentional behavioral manifestation, the first indicator of the infant's transition from complete passivity to the inception of active behavior, which henceforth will play an increasingly important role" (p. 86). Although one might disagree with the characterization of "complete passivity" during the newborn period (Rochat & Senders, 1991), Spitz's comment tried to capture what appears to be an important developmental transition occurring by the 2nd month postnatal.

Aside from smiling, other important behavioral changes index the 2-month transition: changes in crying patterns across cultures (Barr, Bakeman, Konner, & Adamson, 1987), changes in visual scanning and tracking of faces (Bushnell, 1979; Haith, Bergman, & Moore, 1977; Johnson, Dziurawiec, Ellis, & Morton, 1991), differential attention to persons and inanimate objects (Legerstee, Pomerleau, Malcuit, & Feider, 1987), a marked increase in the amount of time spent in an alert active state (Wolff, 1987), the first qualitative change in the control of movements (Hopkins & Prechtl, 1984), evidence of active exploration in imitation (Meltzoff & Moore, 1994), and evidence of emerging self-exploration (Rochat & Striano, 1999a). In the context of the development of social cognition, the emergence by the 2nd month of social smiling and the novel propensity to explore faces in long bouts of dyadic exchanges index what can be referred to as emerging intersubjectivity, construed as the sense of shared experience manifested by infants interacting with social partners (Rochat & Striano, 1999b). Primary intersubjectivity corresponds with the first affective attunement that young infants manifest in face-to-face interactions with social partners through contingent smiling, gazing, and other socially elicited gestures (Stern, 1985; Trevarthen, 1979). Primary intersubjectivity entails rudiments of turn taking, sensitivity to

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timing, and contingency in dyadic social exchanges (Fogel, 1993; Stern, 1977; Trevarthen, 1979).

From 3 months of age, infants rarely express positive affect outside of positive face-to-face exchanges with social partners. This expression is contingent on analogous affect initiated by mothers (Cohn & Tronick, 1987). Between 3 and 6 months, infants start to show marked reactions to the sudden adoption of still faces by social partners in ongoing positive face-to-face exchanges. During still-face episodes, infants are typically reported to smile less, look away, display negative affect, and show enhanced self-comforting behavior (Cohn & Elmore, 1988; Mayes & Carter, 1990; Muir & Hains, 1993; Toda & Fogel, 1993). The still-face phenomenon is remarkably robust and is interpreted as an index of young infants' affective attunement to social partners in dyadic exchanges (Stern, 1985) and as evidence of early social expectations (Muir & Hains, 1993).

Questions remain regarding the information to which infants are sensitive when they are engaged in face-to-face interaction and what develops between 2 and 6 months when infants are still highly dependent on the play initiative of caretakers and when face-to-face interaction dominates play periods. Mothers who demonstrate a lack of sensitivity to their infants' emotional expressions and who are noncontingent in response to their infants' social signals are disruptive of the interactive flow in face-to-face exchanges (Field et al., 1988). Infants of withdrawn mothers show significantly more distress because they are provided with less regulatory support to control negative affect (Cohn & Tronick, 1987).

Using an experimental paradigm in which mothers and infants interacted through a closed-circuit video system, Murray and Trevarthen (1985) reported that from 2 months of age, infants showed marked changes in behavior when interacting with their mothers live on TV as compared with a replay of a previous session. Compared with the live condition, in the replay condition they were reported to show less gazing, less positive affects, and more distress behavior (e.g., grimacing and self-comforting). These observations suggest that by 2 months infants are sensitive to social contingency and in particular the timing of their mothers' affective attunement in dyadic exchanges. However, these results were not replicated in a recent experiment in which condition order and age were systematically controlled (Rochat, Neisser, & Marian, 1998). Using a similar paradigm, other investigators confirmed Murray and Trevarthen's findings in infants between 4 and 8 months (Bigelow, 1999; Nadel & Tremblay-Leveau, 1999) and in 5- to 6-month-olds interacting with a female stranger and not their mothers (Muir & Hains, 1993). If there is some evidence that by at least 5 months infants are sensitive to social contingency in face-to-face interaction, the issues of what constitutes social contingency and what information is picked up by the infants to account for such sensitivity remain open. The present research is an attempt to understand further what underlies early social monitoring and how it develops from the moment infants start to demonstrate affective attunement through eye-to-eye contact and social smiling.

Microanalyses of face-to-face interactions between mothers and infants have shown that mothers are the main organizers and initiators of dyadic social exchanges (Stern, 1977). Mothers scaffold their infants within particular play frames characterized by exaggerated contours, marked changes of tempo, and systematic repetitions (Bruner, 1979; Gergely & Watson, 1999; Kaye, 1982). Infants are typically provided with "packages" of facial–visual–tactual and auditory stimulation, which infants detect and use to regulate their social responses (Beebe & Gerstman, 1984). Such social responsiveness is based on the precocious ability of infants to detect intermodal invariants (Spelke, 1981) and to process amodal information (Meltzoff & Moore, 1997). Stern (1977, 1999) proposed that a major feature of early social monitoring is the detection of intermodal (amodal) information that specifies vitality contours or tension fluctuations in the behavior of social partners. Vitality contours are framed within bursts of interactive engagement interspersed with periods of relative quiet. The model of tension fluctuations within dyadic exchanges between mothers and infants is typically in the form of a crescendo–peak–decrescendo, or successive episodes of built-up, maximum tension, and release phases (Stroufe & Waters, 1976). Peekaboo, which perfectly fits such a three-step tension envelope, is the prototypical social scaffolding provided by mothers to their infants to create an emotional stir, captivate, and establish intersubjectivity and social contingency (Watson, 1972). At a cognitive level, such games allow infants to form visual schemas and to orient their attention toward specific outcomes that are scaffolded first by the combination of repeated speech signals and gestures from social partners (Greenfield, 1972). They provide infants with intermodal regularities in a well-defined temporal order that are framed within a crescendo–peak–descrescendo vitality (tension) envelope. Peekaboo might provide optimum scaffolding to young infants in coregulating their emotion with others and in building social expectations. It also offers a window into their developing ability to monitor others and to pick up relevant social information on which infants can establish primary intersubjectivity.

The present research provides observations on the development of infant social monitoring between 2 and 6 months of age in the context of organized and disorganized (scrambled) peekaboo games initiated by an adult female stranger. Two specific questions guided this research: (a) To what extent are young infants sensitive to the timing and organization of peekaboo? (b) If infants show such sensitivity, when does it emerge in early development?

We tested and compared infants in the context of organized versus experimentally disorganized peekaboo games. As a general hypothesis, we expected that from the time infants started to demonstrate primary intersubjectivity, as indexed by social smiling (at 2 months of age), they would show global, undifferentiated positive affective attunement to the social partner initiating peekaboo games. From general attentiveness and positive attunement at 2 months, infants would progressively demonstrate more specific expectations regarding the relative organization and predictability of the play game initiated by the social partner. In particular, we expected that by 4 months, infants would begin to manifest differential responding to organized versus disorganized peekaboo games.

Method

Participants

Thirty-six infants (24 boys and 12 girls) were tested and included in the final sample for analysis. All were full-term and healthy babies according to medical birth records (1- and 5-min Apgar scores of 8 or above) and

parental reports at the time of testing. The infants were divided into three age groups: eleven 6-month-old infants (mean age = 6 months 12 days, range = 5 months 23 days to 6 months 27 days), fourteen 4-month-old infants (mean age = 4 months 12 days, range = 3 months 28 days to 5 months 2 days), and eleven 2-month-old infants (mean age = 2 months 13 days, range = 1 month 24 days to 2 months 29 days). Fifteen additional infants were tested but were not used in the final analyzed sample because of excessive fussiness. Infants lacking overall engagement with the experimenter during testing by manifesting bouts of fussiness or full-blown crying lasting 10 s or longer were not included in the final sample for analysis. The participants were recruited from a participant pool consisting of infants born in the Greater Atlanta area. Parents were contacted by phone and invited to participate with their infants. Ninety percent of the parents were from White, middle-class backgrounds.

Setup and Apparatus

The experimenter and the infant faced each other for dyadic exchanges in the following setup. The infant was placed in an infant seat that was located in the middle of a table facing the experimenter. The experimenter's seat was placed 30 cm from the edge of the table so that the experimenter was directly in front of the infant's seat. Occluders (measuring 71.0 × 55.5 cm) made of Styrofoam were set up on both sides of the infant's seat to prevent the infant from being distracted.

A zoom-lens video camera (Panasonic Model AG-186) was set up on an adjustable tripod behind and above the experimenter's seat, providing a close-up view of the infant's face. A miniature video camera (Computar Model EM200-L38) was mounted above the infant's seat, providing a simultaneous close-up view of the experimenter. A third video camera (Samsung Model SAC-410NA) was set up at one end of the table, providing a side view of both the experimenter and the infant. The images from all three cameras were synchronized and simultaneously recorded on an S-VHS recorder (Panasonic Model AG-1960) by a four-way split screen (Robot Model MV45). The video camera recording the infant was also connected to a separate S-VHS recorder (Panasonic Model AG-1300) to provide a single view of the infant for later scoring. A digital time code (Burst Electronics Model TC-3 SMPTE) was superimposed on the video recording throughout the study.

During testing, the experimenter wore a miniature earpiece that was invisible to the infant throughout the entire session. The earpiece was connected to an audiotape recorder (Sony Model TCM-82V) placed on the experimenter's lap. The experimenter used two audiotapes for the study. One audiotape contained instructions for the experimenter to perform 60 s of successive organized peekaboo games (n = 7) interspersed with 3-s pauses. The other audiotape contained instructions for the experimenter to perform 60 s of successive disorganized peekaboo games (n = 7). As depicted in Table 1, an organized peekaboo game performed by the experimenter consisted of three basic units composed of both vocalizations and gestures: an approach phase (Unit 1), a peak phase (Unit 2), and a release phase (Unit 3). As depicted in Table 2, a disorganized peekaboo game consisted of both vocalizations and gestures in a random order over a 60-s period. In both the organized and disorganized conditions, the duration was 60 s, and the quantity of behavior displayed by the experimenter to the infant in terms of both vocalization and gesture units was equivalent. What varied systematically between the conditions were the relative packaging and the temporal organization of the units composing the peekaboo games. Note that in both the organized and disorganized conditions, the behavior composing each unit was equally repeated within the 60-s period. What varied across conditions was the relative organization of the repetition (i.e., packaging of multimodal stimulation and temporal regularity).

Procedure

All testing sessions began with the experimenter (trained adult female stranger) interacting with the infant and trying to make the infant smile through positive gestures and vocalizations, without touching the infant, over a 30-s free-play period. The goal of this free-play interaction was for the experimenter to capture the infant's attention. After the first free-play period, the experimenter presented the infant with a first peekaboo game, either organized or disorganized, over 60 s and following the audiotape instructions. The first peekaboo game was followed by a second 30-s free-play interaction period, followed by another 60-s peekaboo game, different from the first one. Testing ended with a final 30-s free-play interaction. Overall, testing lasted for 3 min. The order of peekaboo conditions (organized vs. disorganized) was counterbalanced across infants of each age group. Another experimenter who stood behind the infant, checked on the recording apparatus and cued the other experimenter for timing.

Table 1
Timing and Script for the Organized Peekaboo Condition

Second	Basic unit	Unit (taped cue)
0	1	Look, look, look (lean forward)
3	2	Peekaboo (hands up, hands down)
6	3	Yes (lean back, nod)
10	1	Look, look, look (lean forward)
13	2	Peekaboo (hands up, hands down)
17	3	Yes (lean back, nod)
20	1	Look, look, look (lean forward)
23	2	Peekaboo (hands up, hands down)
26	3	Yes (lean back, nod)
29	1	Look, look, look (lean forward)
32	2	Peekaboo (hands up, hands down)
35	3	Yes (lean back, nod)
38	1	Look, look, look (lean forward)
41	2	Peekaboo (hands up, hands down)
44	3	Yes (lean back, nod)
47	1	Look, look, look (lean forward)
50	2	Peekaboo (hands up, hands down)
53	3	Yes (lean back, nod)
55	1	Look, look, look (lean forward)
57	2	Peekaboo (hands up, hands down)
60	3	Yes (lean back, nod)

Scoring

Two independent coders analyzed the video recordings of the infants during the organized and disorganized peekaboo games. The starting times for the games were recorded to ensure that the same 60-s period was being viewed by both individuals. Gazing and smiling of the infants were coded as dependent measures. Gazing was operationally defined as a look at the experimenter that was longer than 1 s and ended when the infants looked away for longer than 2 s. Smiling was defined as the co-occurrence of eye and mouth movement. The sides of the infants' eyes formed slight crinkles as their cheeks raised, and the corners of the infants' mouths turned upward. Using a computerized event recorder, while viewing the video recordings of the infants' faces in real time, coders recorded bouts of gazing and smiling by pressing different keyboard keys, each corresponding to one channel of the event recorder. Following recent reports on young infants' social responding using the same two dependent measures (Hains & Muir, 1996a, 1996b) and on the basis of numerous data demonstrating differential sensitivity of these measures in the context of the still-face paradigm (Muir & Hains, 1993), gazing and smiling were scored and analyzed as separate, not necessarily related, social responses. Smiling did not always entail simultaneous gazing at the experimenter. Smiling that occurred as infants gazed away from the experimenter or while they were not engaging visually with the experimenter were coded as smiling responses.

Table 2
Timing and Script for the Disorganized Peekaboo Condition

Second	Basic unit	Subunit (taped cue)
0.0	3	Yes
1.5	2	Hands up
2.5	3	Nod
3.5	2	Hands down
4.5	1	Lean forward
5.5	2	Peekaboo
7.0	3	Lean back
8.0	2	Hands up
9.0	2	Hands down
10.0	3	Yes
11.5	1	Look, look, look
13.0	3	Nod
14.5	1	Look, look, look
15.5	1	Lean forward
16.5	3	Nod
17.5	1	Look, look, look
18.5	3	Lean back
19.5	2	Peekaboo
21.0	2	Hands up
22.0	1	Look, look, look
23.0	2	Hands down
24.0	3	Nod
25.0	1	Lean forward
26.0	3	Yes
27.0	2	Hands up
28.0	2	Hands down
29.0	3	Lean back
30.0	1	Lean forward
31.0	2	Peekaboo
32.5	3	Yes
34.0	3	Lean back
35.0	2	Hands up
36.0	1	Lean forward
37.0	3	Nod
38.0	1	Look, look, look
39.0	2	Hands down
40.0	3	Lean back
41.0	2	Peekaboo
42.0	1	Lean forward
43.0	3	Nod
44.0	3	Yes
45.5	2	Hands up
46.5	3	Lean back
47.5	2	Hands down
48.0	1	Look, look, look
49.0	2	Peekaboo
50.0	1	Lean forward
51.5	3	Yes
53.0	2	Peekaboo
54.0	3	Lean back
54.5	2	Hands up
55.0	2	Hands down
56.0	3	Nod
57.0	3	Yes
59.0	2	Peekaboo
60.0	1	Look, look, look

Coders were undergraduate students working in the laboratory for research credit. They knew about the general aim of the study but were unaware of which experimental condition they were scoring and did not know the exact age of each infant they coded. Coders based their scoring exclusively on the infant's close-up view with the sound turned off to remove any auditory cues regarding which of the two experimental conditions the infant was in. Informal pilot observations indicated that on the basis of the close-up view of the infant used for coding, it was difficult to discriminate reliably a specific age in 2- to 6-month-olds. Intercoder reliability was assessed on a random sample of one third of all infants who were included in the analysis for all conditions. Percent agreement between the coders was 99% for gazing and 94% for smiling. In addition to the channels of the event recorder used to record smiling and gazing, a third channel was used to record simultaneously the digitized audio portion of the videotape that was picked up during the peekaboo game. This sound recording was digitized by a Ceder Sound Digitizer (Ceder Technology, Phoenix, Arizona) and was imported into the computer on the third channel of the event recorder.

The coding sheets provided by the event recorder consisted of synchronized data collected simultaneously on the gazing channel, the smiling channel, and the digitized audio channel. A template of both the organized and disorganized peekaboo conditions was matched onto the hard copy of the digitized audio recording and coding sheet, which reconstructed the exact sequence of the experimenter's gestures and vocalizations in either condition. By using a conversion ruler (1 cm = 1 s on the recording sheet), this technique enabled us to analyze gazing and smiling in relation to the whole experimental condition and in relation to each of the three basic units of the peekaboo game (crescendo, peak, and release). For the disorganized condition and to compare it with the organized condition, we added the coding of each subunit forming one of the three basic units of the organized peekaboo game. The coding of infants' behavior in each basic unit was precise to the 10th of a second.

On the basis of this technique, we compared the two conditions, on the whole, in terms of percent gazing and percent smiling during the 1-min peekaboo game. We also compared the percent gazing and percent smiling during Unit 3 (release phase) of the peekaboo game in each condition. We chose this unit because it represented the closure of a game episode following its peak. Furthermore, post hoc control analyses of the scored videotapes revealed that the third unit was the most similar in overall duration for all infants across organized (M = 21.97 s, SD = 1.01 s) and disorganized (M = 22.19 s, SD = 0.76 s) peekaboo conditions.

Results

We first present the results comparing overall percent duration of gazing and smiling by the infants according to age and condition. Again, these measures were considered as separate expressions of infants' social sensitivity, with one not necessarily implying the other. A 3 (age) × 2 (condition) mixed-design analysis of variance on percent duration of gazing yielded a significant main effect of age, $F(2, 33) = 3.46$, $p < .04$. Post hoc Duncan tests revealed that the percent duration of gazing was significantly reduced in the 2-month-olds as compared with the 4-month-olds and in the 4-month-olds as compared with the 6-month-olds ($p < .05$). Neither an effect of condition nor any significant interaction between age and condition was found.

Regarding the percent duration of smiling, a 3 (age) × 2 (condition) analysis of variance yielded a significant main effect of condition, $F(1, 33) = 13.74$, $p < .0008$. No significant age main effect nor any significant age by condition interaction was found. Figure 1 indicates that the main effect of condition was mainly due to 4- and 6-month-olds' increased smiling in the organized versus the disorganized peekaboo condition.

We further compared gazing and smiling between conditions in relation to the third basic unit (release phase) of the peekaboo game. As indicated in the Method section, we chose this unit because it represented the closure of a game episode and it was the most comparable in terms of overall duration across conditions for all infants. The degree of significance of the statistical results for

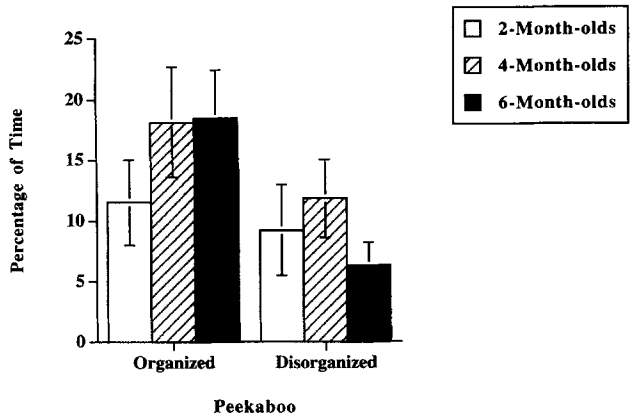

Figure 1. Mean percentage of time the groups of 2-, 4-, and 6-month-old infants smiled in the organized and disorganized peekaboo conditions. Vertical lines depict standard errors of the means.

their interpretation was based on an adjusted .025 alpha level, following the Bonferroni procedure to control for Type I error (.05 divided by two comparisons).

A 3 (age) × 2 (condition) analysis of variance was performed on the percentage of gazing during Unit 3. The analysis revealed a significant main effect of condition, $F(1, 33) = 5.85, p < .021$, as well as an Age × Condition interaction, $F(2, 33) = 4.01, p < .027$. The analysis yielded no significant main effect of age. As shown in Figure 2, 2-month-olds gazed at the experimenter for comparable proportions of time during Unit 3 in both peekaboo conditions. In contrast, 4- and 6-month-olds gazed more at the experimenter during the disorganized condition than during the organized peekaboo condition. There was a marginal effect of condition for the 4-month-olds ($p < .06$) and a significant effect for the 6-month-olds when considered separately, $F(1, 33) = 9.48, p < .004$.

Regarding the percentage of smiling during Unit 3, the analysis of variance yielded a significant main effect of condition, $F(1, 33) = 21.22, p < .0001$, as well as a significant Age × Condition interaction, $F(2, 33) = 5.09, p < .01$. No significant main effect of age was found. Analyses of the simple effects yielded significant main effects for the 4-month-olds, $F(1, 33) = 15.98, p < .0001$, and the 6-month-olds, $F(1, 33) = 16.60, p < .0001$, but not for the 2-month-olds. As shown in Figure 3, in contrast to gazing, the 4- and 6-month-old infants showed a statistically significant decrease in their amount of smiling during the disorganized presentation (disorganized condition) of the subunits forming Unit 3 (release phase).

Discussion

The aim of this research was to explore the extent to which young infants are sensitive to the timing and the organization of protoconversation in games commonly provided by social partners when infants, by 2 months of age, start to show the first signs of affective reciprocity through social smiling. The general question guiding the research pertained to what underlies the emerging affective attunement infants manifest by the 2nd month postnatal and in particular the kind of information young infants detect in protoconversation with caretakers.

The experiment was specifically designed to compare young infants' social responses and emotional coregulation in controlled but naturalistic dyadic exchanges with an adult stranger engaging in organized or disorganized peekaboo games. Results show that 2-month-old infants engaged in monitoring (gazing) and reciprocating (smiling) with the adult stranger. However, their social response was markedly different compared with that of 4- and 6-month-old infants. Two-month-old infants showed undifferentiated gazing and smiling whether the peekaboo game was organized or disorganized. In general, 2-month-olds tended to maintain eye contact with the stranger for longer periods of time and to smile equally whether the peekaboo game was organized or disorganized. Their social monitoring and reciprocity, although evident, appeared to be controlled by the diffuse sense of a dyadic exchange that included eye contact and dynamic positive affects displayed by the adult stranger. By 2 months, infants showed clear sensitivity to the social engagement of an adult stranger, but this

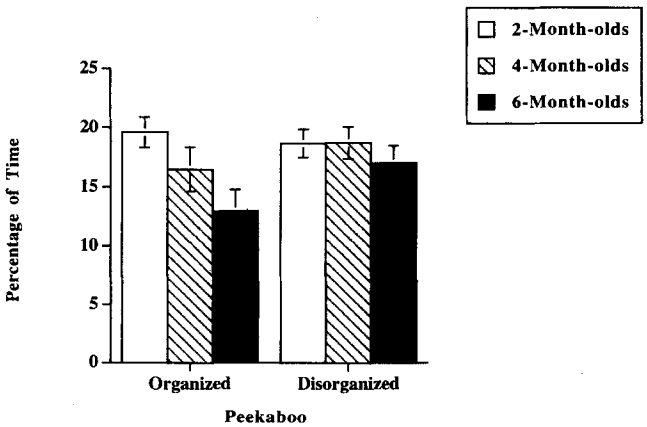

Figure 2. Mean percentage of time the groups of 2-, 4-, and 6-month-old infants gazed at the experimenter during Unit 3 (release phase) of the organized and disorganized peekaboo conditions. Vertical lines depict standard errors of the means.

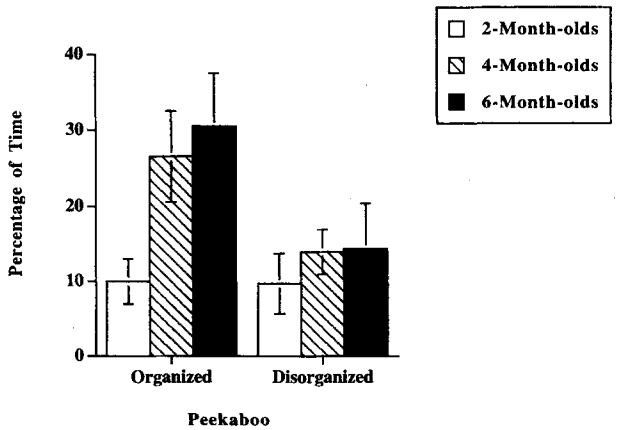

Figure 3. Mean percentage of time the groups of 2-, 4-, and 6-month-old infants smiled during Unit 3 (release phase) in the organized and disorganized peekaboo conditions. Vertical lines depict standard errors of the means.

sensitivity was still nonspecific to the structure, and hence the quality, of the protoconversation that was framed and initiated by the adult.

In contrast, by 4 months, infants started to show discrimination of the relative organization of the social exchange framed by the experimenter, manifesting less smiling and more gazing in the context of a disorganized as compared with an organized peekaboo game. From 4 months on, in the context of an experimentally disorganized peekaboo game, infants were less inclined to reciprocate with smiling and appeared to engage in increased visual monitoring of the social partner. By 4 months, infants tended to engage in enhanced visual exploration of the experimenter's face in the disorganized peekaboo condition, probably gathering more cues for social monitoring and the elaboration of new social expectations.

When infants, by 4 months, start to respond differentially to either the organized or the disorganized peekaboo game, they demonstrate an emerging sensitivity to intermodal invariants that specify a conversation, in particular the coconstruction of a narrative exchange. This sensitivity goes beyond mere affective attunement and the diffuse sense of being in contact with a social partner. We view it as the first expression of a discrimination between more and less meaningful dyadic exchanges. By 4 months, infants appear to become discriminant of the quality of social exchanges, in particular whether they are more or less predictable, hence more or less meaningful. They become sensitive to the narrative envelope provided by the experimenter in terms of an organized succession of combined auditory and visual stimulation. This narrative envelope is characterized by a particular pattern of tension or vitality contour (Stern, 1999) that has a beginning (crescendo of tension phase), a middle (tension peak phase), and an end or closure (tension release phase). As we mentioned in the introduction, this pattern is common in the early social games scaffolded by caretakers who typically engage in repetitive gestures, particular vocal intonations, and exaggerated facial expressions. Such games are usually well delineated, with either marked pauses or contrasted exchanges in between repetitions. The organized peekaboo game used in the present research perfectly fits this profile. Within the organization of the basic narrative envelope of tension buildup and release, such games offer a succession of optimum packages or coordinated units of intermodal stimulation (Beebe & Gerstman, 1984; Stern, 1977; Tronick, Als, & Adamson, 1979).

In contrast, the disorganized peekaboo game that we experimentally created did eliminate the basic narrative envelope of tension buildup and release while breaking the coordinated intermodal stimulation into a rapid succession of discrete units (see Table 2). By responding differentially to this condition, 4- and 6-month-olds demonstrated a developing sensitivity to the timing and the structure of social exchanges, beyond mere social contact. By 4 months, infants start to monitor social partners in relation to the timing and the structure of what they do in dyadic exchanges and the extent to which they can more or less relate to them by predicting outcomes (Greenfield, 1972).

There are at least two alternative interpretations to the one proposed here. One alternative is that the developmental progression reported here might be due to the exposure to peekaboo routines that 4- and 6-month-olds had and 2-month-olds did not have. Although it is evident that because of their age older infants had more exposure to play routines initiated by caretakers, systematic posttest interviews of the parents who brought their infants for testing did not yield any suggestion that their infants, even the 6-month-olds, had been systematically exposed to peekaboo routines resembling the one manipulated in the present research. If older infants were more familiar with the experimental situation, it was probably due to the general dyadic situation of face-to-face exchanges that might include some play routines analogous but not identical to the one used in the present experiment. Considering that the degree of familiarity with dyadic games might vary significantly from infant to infant depending on parental style, an interesting avenue for future research would be to capture the relative impact of different levels of exposure to structured play routines on the development of early social monitoring. Research on infants of depressed mothers (Field et al., 1988) and on mothers that are more or less contingently responsive to their children (Bigelow, 1999) suggests that relative exposure to socially attuned play routines might play an important role in the early development of social monitoring and emotional coregulation. Such exposure might foster learning and improved attentional skills in the monitoring of others in face-to-face interactions. More research is needed to specify the particular mechanisms underlying the reported developmental change.

Another alternative interpretation of our results is that the organized peekaboo condition offers repetitive behavior and the disorganized condition does not. Accordingly, 4- and 6-month-olds might simply detect the presence or absence of behavioral repetition. This interpretation is problematic when one considers that in both conditions behavior was equally repeated but within different temporal arrangements. Rather than the presence or absence of repetition, infants by 4 months detected different types of repetition. By 4 months, infants appear to become sensitive to both the intermodal packaging of stimulation and the regularities in the temporal succession of behavioral units performed by the experimenter. One can assume that it is the intermodal packaging of stimulation and the temporal regularities (i.e., tempo or rhythm) that determine the narrative envelope (the crescendo of tension, its peak, and then its release) of the peekaboo game, hence its distinct effectivity as a game. Future research should elucidate further the respective roles that intermodal packaging and the temporal arrangement might play as factors of infants' developing social responsiveness in protoconversation. In our view, the effectivity of games framed by caretakers, such as the peekaboo script, probably depends on a combination of both. On the basis of our findings, we propose that it is an ability to detect such combinations that infants start to develop by 4 months.

We view this development as indexing a major change in early social monitoring. By becoming sensitive to narrative envelopes and invariant timing in protoconversation, infants develop the basic foundation for the generation of social expectations, from which social partners can be differentiated and privileged relationships can grow. It also corresponds to the establishment of conversational frames within which intersubjectivity can develop and communicative skills can be scaffolded, long before and probably in preparation of language development (Bruner, 1979).

This research adds to the general agreement that by at least 5–6 months, infants show signs of a sensitivity to social contingency in face-to-face interaction with an adult partner (Muir & Hains, 1993). However, little is known regarding the nature of social

contingency detection in infancy and what it corresponds with in terms of mechanisms and information picked up by the infant. Our findings suggest that social contingency detection rests, at least in part, on the infant's relative ability to pick up invariant information regarding the timing and the structure of meaningful narrative envelopes, with predictable vitality contours as in the organized peekaboo game. It is based on such information that infants start modulating their social responses and expressing emotional coregulation and relative affective attunement in protoconversation. Note that in the present research, the experimental 1-min peekaboo game episodes were always preceded by 30 s of positive and contingent social exchanges between the experimenter and the infant. The general context in which the peekaboo episodes took place was a normal contingent interaction between the infant and the adult, who maintained positive engagement through constant eye contact, attuned gestures, and vocalizations. The peekaboo games were conducted as experimental play routines initiated by the experimenter when the infant was attuned to her as a contingent social partner. Because of this general context, the differential responding to the two experimental peekaboo conditions emerging by 4 months provides relevant information regarding the early development of social monitoring, in particular the bases on which infants start to modulate their social responses in dyadic exchanges.

If, by the 2nd month, infants start to open up to the social world with the emergence of socially elicited smiling (Spitz, 1965; Wolff, 1987), starting to manifest positive social attunement and the first clear signs of primary intersubjectivity, they rapidly develop a sensitivity to the timing and the structure of face-to-face protoconversation. The detection of invariant information specifying particular narrative envelopes in protoconversation allows infants to predict communicative outcomes from which they can discriminate among social partners and the quality of their relationship to them (Fogel, 1993). It is also based on the development of such social expectations that infants can develop intersubjectivity with others, intersubjectivity considered as the foundational aspect of early social cognition (Hobson, 1993; Rochat & Striano, 1999b). Social expectations developing in the context of protoconversation are probably a major aspect of early social cognition, prior to language. They announce well-documented social cognitive development occurring by the end of the 1st year.

By 9 months, social cognitive skills develop that entail a new stance, the intentional stance, whereby infants start to understand others as intentional and monitor their attention toward objects in the environment (Tomasello, 1995). Social behavior indexing an intentional stance appears to coemerge by the end of the 1st year (Carpenter, Nagell, & Tomasello, 1998) and is interpreted as being linked to a novel understanding of people as intentional (i.e., having plans and volition) and to the developing capacity of infants to relate their own and another person's perspective on things in the environment (Tomasello, 1995). This is commonly interpreted as a major step in the development of social cognition, a necessary step for the development of symbolic functioning and language acquisition (Carpenter et al., 1998). By the end of the 1st year or the beginning of the 2nd year, infants are reported to manifest mutual engagement in more complex contexts than face-to-face exchanges, involving social partner as well as objects in the environment, as in instances of joint attention (Scaife & Bruner, 1975), social referencing (Campos & Sternberg, 1981), and symbolic gestures. This level of mutual engagement rests on a novel sense of shared experience with people, described as secondary intersubjectivity (Trevarthen, 1979). Many questions remain regarding what announces and prepares infants to take the intentional stance.

As shown with the present research, social competence develops early in dyadic face-to-face exchanges, with infants by 4 months becoming sensitive to information specifying others as interactive agents, in particular the narrative envelope of the play games they initiate with the infants. We propose that the social expectations starting to develop by the 4th month of life in dyadic face-to-face exchanges prepare and announce the intentional stance infants take by 9 months (Tomasello, 1995) and the symbolic communication emerging by the 2nd year (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979). Future research should help capture the potential link between the primary intersubjectivity developing in early face-to-face protoconversation and the secondary intersubjectivity developing by the end of the 1st year.

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