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The role of maternal affect attunement in dyadic and triadic communication

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Abstract

The influence of maternal affect attunement on the relationship between gaze monitoring during dyadic communication at 3 months and coordinated attention during triadic communication at 5, 7 and 10 months was examined in a longitudinal study. Although most infants engaged in gaze monitoring at 3 months and in coordinated attention at 5, 7 and 10 months, a regression analysis revealed that gaze monitoring at 3 months significantly predicted coordinated attention at 10 months only when maternal affect attunement was high. These findings are discussed in terms of theories that emphasize the role of social interaction in the development of meaningful communication and continuity in mental state awareness during the first year of life.

Keywords: Gaze monitoring; Coordinated attention; Affect attunement; Intersubjectivity

Sometime during the first year of life, infant communication changes from dyadic to triadic interactions. Whereas the proto-conversations infants engage in during the dyadic period involve monitoring people's gazes in order to *share emotional experiences*, triadic communication involves coordinating with people's gazes in order to *share experiences about the world* (Trevarthen, 1979). As such, coordinated attention (CA) is considered an important socio-cognitive achievement, and is hypothesized to play a central role in the development of mental state awareness and pre-linguistic and linguistic communication (Baron-Cohen, 1991; Bruner, 1991).

Theoreticians have proposed different developmental pathways for the ontogeny of communication and mental state awareness in infants. For instance, some linguists posit that because the language children hear does not provide enough information for them to learn the abstract structures of generative grammar, they must have an innate language acquisition device (Chomsky, 1965). Social interactionists on the other hand argue that language acquisition is not the work of the child alone, but is socially and cognitively constructed under the guidance of attuned caretakers. Consequently, these theorists focus on the richly structured socio-cultural environment in which children live, and argue that it is this structure that enables human infants to acquire meaningful pre-linguistic as well as linguistic skills. Thus, communication is seen as a cultural skill and is acquired in part, during dyadic and triadic interactions under the auspices of supportive parents (see Bruner, 1999; Vygotsky, 1978).

For instance, Bruner (1999) proposes that early parent–infant interactions occur within common "formats" or "routines" where infant and caregiver are jointly attending to the same objects or events, such as picture book reading or object play during triadic communication. During these routines, infants maintain a common focus of attention with

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their partners. They readily perceive what the object of attention is for the adult, which makes the task of determining reference easier for them. Even after children acquire their first words, they continue to benefit from such joint attentional abilities (Markus, Mundy, Morales, Delgado, & Yale, 2000).

There is a substantial amount of developmental literature which has revealed that maternal interactive skills promote a link between pre-linguistic and linguistic development. Maternal responsiveness during the first 6 months of life has been found to predict the size of speaking vocabulary (Ruddy & Bornstein, 1982), language comprehension (Tamis-LeMonda & Bornstein, 1989), and the production of meaningful gestures (Legerstee, Van Beek, & Varghese, 2002), at 12 months. Maternal interactive skills were also found to be related to infant mental capacity, specifically their performance on the mental scales of the Bayley at 21 months (Crockenberg, 1983), and attention span and symbolic play at 13 months (Bornstein & Tamis-LeMonda, 1997).

Not only does research suggest that pre-linguistic and linguistic communication are related, and that maternal skills foster this relationship, but that pre-linguistic communication such as present during triadic engagement has its foundation in dyadic engagements. For instance, Trevarthen (1979) proposes that infants become capable of CA, because they are progressing from primary intersubjectivity (i.e., the ability to share emotions with others) to secondary intersubjectivity (i.e., the ability to share with others things they perceive in the environment). Bruner (1999) argues that the progression from primary to secondary intersubjectivity is facilitated through "narrative scaffolding" where caretakers treat infants as if "they have things in mind". If these theoretical propositions are supported by empirical findings, this would suggest that the ability to share experiences follows a continuous developmental pathway.

Research with children with autism has shown that impairments in dyadic relationships continue to exist in triadic relationships (Hobson, 2002; Loveland & Landry, 1986; Sigman, Kasari, Kwon, & Yirmiaya, 1992; Sigman, Mundy, Sherman, & Ungerer, 1986). Compared to typically developing infants with the same mental age, children with autism tend not to monitor the gazes of others during dyadic interactions and have difficulty making eye contact with others during triadic interactions. Gaze monitoring and CA have been argued to indicate mental state awareness in infants, because typically developing infants, but not infants with autism, monitor the gazes of people more when in ambiguous situations (presumably to inquire about the goal of the actor), than when in non-ambiguous situations (Phillips, Baron-Cohen, & Rutter, 1992). The lack of these skills in infants with autism has also been linked to their problems with Theory of Mind development (Baron-Cohen, 1991; Charman et al., 1997, 2000).

Until now, most researchers interested in the development of CA have examined the development of this ability during the final quarter of the first year. For example, Carpenter, Nagell, and Tomasello (1998) found in a longitudinal study that infants began to coordinate attention between people and objects by 9 months of age. The number of joint engagement episodes increased from 1.6 at 9 months to 4.3 episodes at 15 months. The authors proposed that the occurrence of triadic abilities, in the sense that they involve child, interlocutor and some object external to the dyad, reveals that both participants have a shared goal over which they coordinate their activity during this period. This enables each member of the dyad to be aware of something the other is attending to and allows each member to anticipate the other's actions. Carpenter et al. (1998) found that in their study CA emerged together with successful performance on other joint attentional tasks, such as imitative learning, social referencing, and goal detection between 9 and 12 months. Consequently, they argued that infants undergo a so-called cognitive revolution during this period, at which point they understand the basics of goal-directed actions. Prior to the 9-month-old benchmark, infants may have strong inclinations to share emotions with others, while engaging in dyadic communication, but they do not perceive communication as meaningful interpersonal sharing. Thus, according to these authors, mental state awareness in others appears at 9 months and not before. Given that an understanding of mental states of others defines sociality in humans and is a prerequisite for meaningful communication, it remains unclear why infants should be denied mental state awareness and be assigned an evolutionary disadvantage during the first 9 months of life.

It should be noted, that Bakeman and Adamson (1984) found that 6-month-old infants in their sample engaged in CA at a similar rate as the 9-month olds (2.3 and 2.0, respectively). The finding by Bakeman and Adamson (1984) that CA can be observed in infants younger than 9 months of age, may be due to the facilitating effect of the social partner that increases the production of joint attention in children once it is established (i.e., Hobson, Patrick, Crandell, Garcia Perez, & Lee, 2004). Such hypothesis is plausible, because in their study, Bakeman and Adamson (1984) contrasted the amount of CA infants produced when playing with adults and with peers, and showed that at all ages CA was produced significantly more when infants interacted with their mothers and female strangers.

Other studies have reported that the quality of maternal interaction affects the joint focus of attention. For example, depressed mothers spend less time engaged in joint focus than non-depressed mothers (Goldsmith & Rogoff, 1997).

Furthermore, highly sensitive mothers spend significantly more time focused on their infants' object of interest than less sensitive mothers (Raver & Leadbeater, 1995). Also, mothers who use more constructive verbal strategies and support during problem solving maintain higher levels of joint engagement with their children (Hustedt & Raver, 2002). These studies strongly suggest a relationship between maternal interactive style and children's joint attention abilities.

The empirical findings revealing the influence of maternal style support theoretical accounts suggesting that joint attention is embedded in interpersonal relationships (e.g., Bruner, 1999; Fogel, 1993; Legerstee, 2005; Stern, 1985; Trevarthen, 1979; Tronick, 1981). These theorists argue that infants are biologically prepared to perceive people's communicative behavior as purposeful and goal-directed, and that developmental changes of this construct occur from a basic awareness, as exhibited during dyadic interactions, to a more comprehensive understanding of the communicative goals of others, as revealed during triadic interactions.

There is evidence that from birth, infants are not only sensitive to the eyes of people and prefer to monitor people's gazes over other facial features (Mauer & Salapatek, 1976), but infants reveal that they are aware of the attention of others because they use it as a cue to infer communicative intent (Bruner, 1999; Fernald, 1989; Reddy, 1999; Stern, 1985; Trevarthen, 1979). They react with social and emotional behaviors when adults establish eye contact (Bruner, 1999; Reddy, 1999; Stern, 1985), and engage in conversational turn-taking through alternating their gazes (Cohn & Tronick, 1987; Kaye & Fogel, 1980). Through monitoring others' gazes infants are informed about a person's interest and what the person is likely to act upon next. Thus, gaze monitoring is essential for an understanding of mental processes of others (Phillips et al., 1992). These findings suggest that from birth infants show signs of intersubjectivity and social attunement (Stern, 1985; Trevarthen, 1979), and that secondary intersubjectivity derives from, and is continuous with primary intersubjectivity.

It is conceivable that the controversy surrounding the ontogenetic pathway of meaningful communication is a function of the different theoretical arguments and corresponding methodologies that are used to assess this question. The problem is that theorists who propose that infants do not engage in triadic engagement until 9 months of age seldom investigate infants below these ages (Carpenter et al., 1998; Tomasello, 1995), whereas those who argue for a relationship between dyadic and triadic communication seldom venture beyond the age of 3 months (Murray & Trevarthen, 1985; Tronick, 1981; Tronick, Als, Wise, & Brazelton, 1978).

The aim of the present study was to examine these opposing theoretical predictions on the development of meaningful communication during the first year of life, and the role maternal interactive style plays in scaffolding the progression from dyadic to triadic interactions. We expected that (1) gaze monitoring at 3 months predicts CA at a later age, and (2) maternal affect attunement is a mechanism that solidifies the relationship between dyadic and triadic abilities. If these predictions are supported they will shed light on the *continuity* of early mental state awareness as expressed in dyadic and triadic relationships, and the environmental factors that influence this process.

1. Method

1.1. Participants

Sixty-three mother–infant dyads were recruited for the present study. Ten dyads were excluded because they did not complete all four visits. The final sample consisted of 53 mother–infant dyads (24 male and 29 female). They were seen at 3 months of age ($M = 97.6$ days, S.D. = 11 days), 5 months of age ($M = 167.8$ days, S.D. = 9 days), 7 months of age ($M = 228.4$ days, S.D. = 8.3 days), and 10 months of age ($M = 304.7$ days, S.D. = 6.4 days). All infants were healthy ($M = 3540$ g at birth), and achieved a 1- and 5-min APGAR score of at least 7, indicating they were in normal physical condition at birth. All participants were of European decent and came from low to middle class families, based on parental education. Mothers were given a small gift for their participation.

1.2. Procedure and materials

Visits took place in an Infancy Laboratory playroom. To prevent possible distractions, white curtains enclosed the play area. Four digital cameras focused on various angles of the procedure: one on the adult's face, one on the infant's face, and two on the interaction from the left and the right side. Images were fed into a split-screen generator to produce a combined view of the interaction. These images were recorded onto a video tape.

At all ages, infants participated in a 3-min free–play interaction with their mothers, who were asked to interact with the infants as they naturally would at home. Interactions began when infants were in a calm and alert state (stage 4; Wolff, 1966).

1.3. Visit at 3 months

During the visit at 3 months, infants were placed approximately 30 cm from their mother in an appropriate infant seat and engaged with her in a dyadic face-to-face interaction.

1.4. Visit at 5, 7, and 10 months

During the visits at 5, 7 and 10 months, infants engaged in triadic interactions. Infants were seated on a mat facing their mother, while an experimenter sat behind the infants, gently supporting them by the waist. Infants were provided with age appropriate toys that included: a rattle mirror, a transparent plastic toy with small popping balls inside, a soft picture book, and a dumbbell rattle. The structure of this joint play situation provided ideal conditions for infants to coordinate attention between mothers and object (Bakeman & Adamson, 1984; Landry, Smith, Miller-Loncar, & Swank, 1998; Leyendecker, Lamb, Schölmerich, & Fricke, 1997).

1.5. Measures

1.5.1. Maternal attunement

Maternal attunement was defined as maternal maintaining attention and warm sensitivity (Landry et al., 1998; Legerstee & Varghese, 2001; Markova & Legerstee, 2006). *Maintaining attention* was coded whenever mothers followed or maintained infants' focus of attention by making a verbal or nonverbal remark about the infants' object of attention. If, for example, an infant looked at a particular toy and the mother asked "Would you like that toy over there?" maintaining attention was coded from the second the mother glanced at the object until either partner shifted attention. Maintaining attention was coded on a second-by-second basis, and the proportion of time spent maintaining during each 3-min episode was calculated. *Warm sensitivity* was coded when mothers were perceptive of their infant's verbal and nonverbal cues. Maternal warm sensitivity was rated on a 5-point scale for every minute of the 3-min interaction for each of the following components: (1) positive affect, (2) warm concern and acceptance, and (3) social responsiveness (Landry et al., 1998; Legerstee & Varghese, 2001; Markova & Legerstee, 2006). *Positive affect* was defined as the intensity and duration of mothers' affective behavior (e.g., smiles), tone of voice, and use of affective words. *Warm concern* referred to mothers' acceptance of infant activities, gentleness during play, and concern for comfort and safety. *Social responsiveness* was defined as mothers' contingent responses to their infants' positive behavior or vocalizations, as well as modulation of any negative infant behavior or vocalizations. The average of the above three behavioral ratings was calculated to compose a final score of warm sensitivity.

Previous research indicated that depression may affect maternal interactive style independently of her attunement (Field et al., 1988). In order to control for postpartum depression, mothers were asked to fill out the Beck Depression Inventory (BDI; Beck, 1961). This questionnaire provides information about the presence of depressed feelings and behaviors. A score of 0–9 is indicative of no or minimal depression, where as core of 10–16 points to the experience of a mild depression. Mothers with a score of 17–29 are assumed to be experiencing moderate depression.

1.5.2. Infant behavior

1.5.2.1. Gaze monitoring. At the 3 months visit, infant gazes directed towards the social partner's face and eyes were recorded. Gazes at anything other than the adult's face were excluded. Gaze monitoring was only documented when infants looked towards the adult's face for at least 2 s.

1.5.2.2. Coordinated attention. At 5, 7 and 10 months, infant CA was coded, as instances where mother and infant were engaged with the same object, and during which infants looked from the object to the adult's face and back to the same object (Bakeman & Adamson, 1984; Carpenter et al., 1998; Fisher, Legerstee, & Perucchini, 2006; Legerstee & Weintraub, 1997). Each episode of CA was required to last at least 3 s. To account for infant looking at mother's face

Table 1
Intercorrelations between subscales of affect attunement ($N = 53$)

Subscale	3 months		5 months		7 months		10 months	
	1	2	1	2	1	2	1	2
1. Maintaining attention	–	.308*	–	.480**	–	.794**	–	.693**
2. Warm sensitivity		–		–		–		–

* $p < .05$.
** $p < .001$.

as a result of mothers drawing attention to their faces, rather than the infant initiating these looks, instance in which adult behavior (e.g., vocalizations) triggered infants' gaze switches were excluded.

Competence in CA has been linked to cognitive development (Murray, Fiory-Cowley, Hooper, & Cooper, 1996; Murray, Kempton, Woolgar, & Hooper, 1993). To control for their mental age, infants were tested with the Bayley Scales of Infant Development (2nd ed.; Bayley, 1993) at 3 and 5 months of age. Infants could receive scores that classified them as either normal developing, mildly delayed, or significantly delayed.

1.5.3. Inter-rater reliability

Two research assistants blind to the hypotheses coded maternal attunement and infant behaviors independently. The first assistant coded all the data, while the second coded 30% of the data. Coders were not familiar with the theoretical hypotheses and therefore could not influence the data one way or another. Inter-rater agreement reached $\kappa = .83$ for maintaining attention, $\kappa = .80$ for warm sensitivity, $\kappa = .82$ for gaze monitoring, and $\kappa = .79$ for CA.

2. Results

2.1. Control measures

Results showed that all infants were normally developing, as measured by the Bayley scales of infant development, and none of the mothers were depressed, as measured by the BDI.

2.2. Maternal attunement

A correlational analysis between maintaining attention and warm sensitivity was performed at each age (see Table 1). At all ages, mothers who ranked high on maintaining attention also ranked high on warm sensitivity. Thus, maintaining attention was used for all subsequent analyses as a measure of maternal attunement.

To reveal age effects, maternal attunement was submitted to a repeated-measures ANOVA with age (3, 5, 7, 10 months) as the within-subjects factor. Results showed a significant main effect of age, $F(3, 156) = 39.942$, $p < .001$, $\eta^2 = .434$. Post-hoc tests[1] demonstrated that maternal attunement increased significantly from 3 months ($M = 38.12$, S.D. = 15.22) to 5 months ($M = 56.61$, S.D. = 22.35) ($p < .001$), from 5 to 7 months ($M = 65.84$, S.D. = 21.42) ($p < .001$), but not from 7 to 10 months ($M = 68.82$, S.D. = 17.71). The increase in attunement across age followed a significant linear trend, $F(1, 52) = 104.461$, $p < .001$, $\eta^2 = .668$ (see Fig. 1).

2.3. Coordinated attention

Table 2 shows the number of infants who engaged in at least one episode of CA with their mother, as well as the frequency of CA at 5, 7, and 10 months of age. A Cochran's Q test was calculated to assess the age effects for CA occurrence, and revealed that there were no significant differences in the number of infants who displayed CA at 5, 7, and 10 months, $Q(2) = 4.667$, $p = .097$. As can be seen in Table 2, more than 50% of infants at all ages engaged in at least one episode of CA with their mother. This pattern did not change systematically with age.

[1] All post-hoc tests were calculated with a Bonferroni correction.

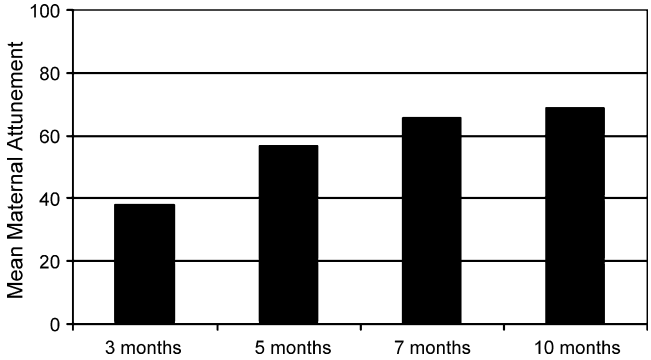

Fig. 1. Mean proportion of maternal attunement at 5, 7 and 10 months of age.

Table 2
Number (and percentage) of infants engaging in CA, and mean frequency (S.D.) of CA at 5, 7, and 10 months

Age	Number of infants (%)[a]	Mean frequency (S.D.)
5 months	32 (60.4%)	.79 (.87)
7 months	41 (77.4%)	1.04 (.69)
10 months	35 (66%)	1.47 (1.5)

[a] $N = 53$ infants.

Additionally, a repeated-measures analysis of variance (ANOVA) was calculated to compare the frequency of CA across the three ages. Results showed a significant main effect for age, $F(2, 104) = 6.822$, $p = .002$, $\eta^2 = .116$. Post-hoc test revealed that the frequency of CA increased significantly from 5 to 7 months ($p = .039$), and from 7 to 10 months ($p = .047$). The developmental progression of CA across the three ages showed a significant linear trend, $F(1, 52) = 10.099$, $p = .002$, $\eta^2 = .163$ (see Fig. 2).

In summary, although the frequency of CA increased for each infant, there was no increase in the amount of infants who produced CA at each age. This finding suggests that in this sample CA has its onset at 5 months, rather than between 9 and 12 months, as suggested in previous reports (Carpenter et al., 1998).

2.4. Relationship between gaze and CA

All infants monitored their mothers' gazes at 3 months ($M = 79.13$, S.D. = 19). To examine the link between infant gaze monitoring at 3 months and subsequent CA at 5, 7 and 10 months, and to investigate the role of maternal attunement in this relationship, standard multiple regressions were computed between CA at each 5, 7 and 10 months as the dependent variables, and gaze monitoring at 3 months, maternal attunement at each 5, 7, and 10 months, respectively, and their interaction as the predictor variables. To account for the problem of multicollinearity caused by

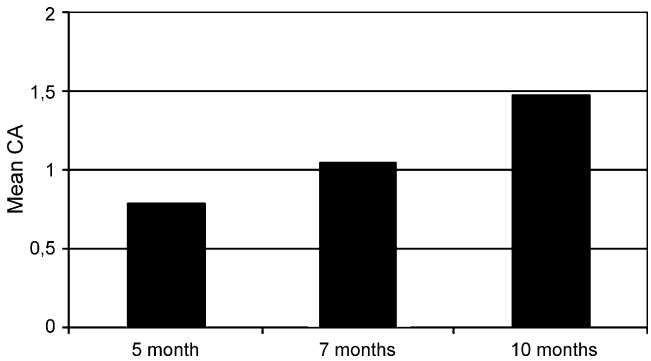

Fig. 2. Mean frequency of CA at 5, 7 and 10 months of age.

Table 3
Summary of a standard multiple regression for variables predicting CA at 10 months ($N = 53$)

Variable	*B*	S.E. *B*
Gaze 3 months	.035**	.008
Maternal attunement	.037**	.009
Gaze 3 months × maternal attunement	.001*	.001

Note. $R = .708$, $F(3, 49) = 16.448$, $p < .001$.
* $p < .05$.
** $p < .001$.

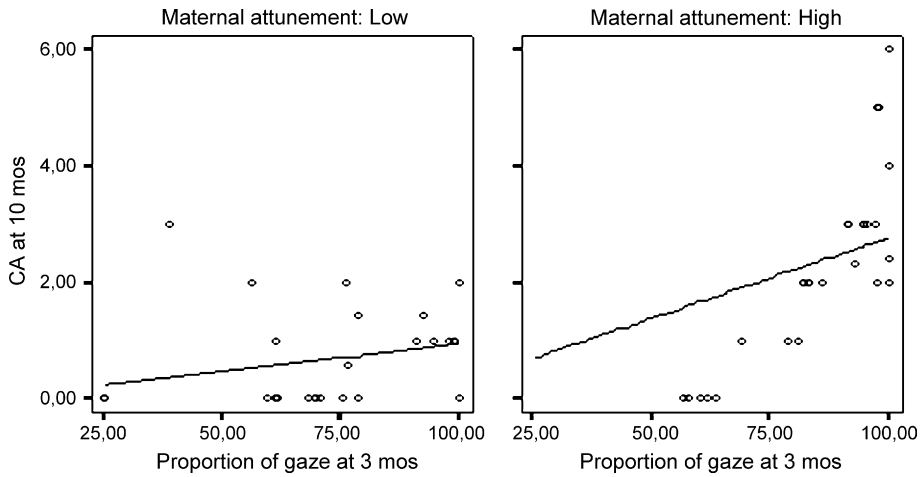

Fig. 3. Gaze monitoring at 3 months predicting CA at 10 months as a function of maternal attunement.

the interaction term, all predictor variables were centered. At both 5 and 7 months of age, gaze monitoring, maternal attunement, or their interaction did not account for significant variance in CA.

For the prediction of CA at 10 months, the interaction between gaze monitoring at 3 months and maternal attunement at 10 months proved significant, $t(50) = 2.116$, $p = .039$, $sr^2 = .213$ (see Table 3 for unstandardized regressions coefficients, *B*, their standard errors, and *R* for regression). Consequently, maternal attunement at 10 months was used to create two groups, low maternal attunement (−1 S.D.) and high maternal attunement (+1 S.D.). To examine simple slopes, two standard regression analyses were performed, with CA at 10 months as the dependent variable, and gaze monitoring at 3 months, low or high maternal attunement at 10 months, respectively, and their interaction as the predictor variables. Results indicated that gaze monitoring at 3 months significantly predicted CA at 10 months, but only within the high maternal attunement group, $B = .055$, S.E. $B = .013$, $p < .001$, $sr^2 = .42$ (see Fig. 3).

In summary, although there was an increase in the overall production of CA, there was no change in the amount of infants who produced CA at 5, 7 and 10 months. Maternal attunement was found influential in the link between dyadic and triadic abilities. Namely, gaze monitoring at 3 months accounted for a significant amount of variance in CA at 10 months, but only when maternal attunement was high. Overall, these findings suggest that gaze monitoring during dyadic and CA during triadic interactions are related, and that maternal attunement is a mechanism that fosters this link.

3. Discussion

Recent theories and empirical data have suggested that the emergence of triadic interactions between 9 and 12 months of age constitutes infants' first attempts to simultaneously integrate object interest and person engagement within their focus of attention (Carpenter et al., 1998). In particular, it is argued that only triadic communication is meaningful, because sharing experiences over objects is dependent on cognitive abilities which allow for mental state awareness, such as an understanding of goal-directed actions (Carpenter et al., 1998). This theoretical orientation

proposes that although prior to this age infants interact with other people in dyadic interactions, expressing emotions in a turn-taking sequence, these interactions are not meaningful for the reason that they do not involve an awareness of the mental states of others; rather infants' information transfer, such as the sharing of emotions during the first 9 months of life are closer to perception than to reasoning.

In contrast to such discontinuous accounts of the development of mental state awareness, some theorists argue for continuity between pre-linguistic and linguistic forms of communication and mentalism, and predict that maternal interactive skills foster this relationship. Consequently, they claim that coordinated attention has its roots in gaze monitoring during the dyadic period. In particular, it is argued that from early on, infants communicate reciprocally with conspecifics, showing a strong desire to connect with the social world (Stern, 1985; Trevarthen, 1977, 1979). These dyadic interactions are evidence of intersubjectivity (Stern, 1985; Trevarthen, 1979; Tronick et al., 1978), and like triadic interactions, enable infants to engage in meaningful communication with others where subjective experiences, such as affect and attention, are shared (Stern, 1985; Trevarthen, 1977, 1979).

Although much work has focused on the infant's earliest awareness of people as goal-directed agents, many questions remain about the ontogenetic pathway of meaningful communication. The developmental origin of such ability is important for our appreciation of human development, because it marks the onset of mental state awareness, and the development of a Theory of Mind (Wellman, 1990). In particular, little is known about the relationship between dyadic and triadic interactions, and the mechanisms that may promote the emergence of triadic interactions. These questions were addressed in the present study. Our primary focus was to determine whether gaze monitoring of people's faces during dyadic interactions was linked to gaze monitoring of people's faces during interactions with objects, and, furthermore, to investigate the role of maternal attunement in this development.

We found that gaze monitoring at 3 months strongly predicted CA at 10 months, but only when maternal attunement was high. These findings are revealing because they support the continuous theory of meaningful communication suggesting a relationship between dyadic and triadic communication that is dependent on a supportive maternal interactive style. For instance, Bruner (1999) has put forth a powerful argument for the continuity between dyadic and triadic communications. He contends that already at 3 months, "there is something particular at the focus of infant attention that they wish to bring to the attention of others" (Bruner, 1999, p. 336). However, instead of a third object, as in triadic communication, during dyadic communication the infant is the object. Bruner (1999) calls this type of intentional behavior epistemic intention. Both epistemic (present during dyadic interactions) and instrumental intentions (present during triadic interactions) are acts of indicating "that provide the means for extending individual human attention to an interpersonal, intersubjective level" (Bruner, 1999, p. 337). Infants are aware that they are the object of attention of their interlocutors, because they know that attention is always external, always referential (Bruner, 1999). Empirical data shows that infants interpret people's attention as about something, because they respond to people's gaze with smiles and vocalizations (Kay & Fogel, 1980; Reddy, 1999), and become upset if people refrain from communication with them (i.e. Still face; Field, Vega-Lahr, Godlstein, & Scafidi, 1986; Tronick et al., 1978).

Not only was there a relationship between gaze monitoring during dyadic interactions and CA during triadic communication, but the number of infants who produced CA at 5, 7 and 10 months of age did not increase significantly. Bakeman and Adamson (1984) did not find a significant difference in CA episodes between 6 and 9 months either. Together, these findings do not support the view that infant socio-cognitive abilities such as CA are part of other joint attentional skills that are a manifestation of a unitary socio-cognitive capacity that allow infants to understand people as intentional agents between 9 and 12 months of age, but not before (see Carpenter et al., 1998; Charman et al., 2000; Tomasello, 1995). The present research used well-established definitions and coding criteria (e.g., Bakeman & Adamson, 1984; Carpenter et al., 1998) and showed that infants as young as 5 months reliably shared attention with adults over toys. If, as suggested by Carpenter et al. (1998), CA is evidence of mental state awareness in others then our findings indicate that such awareness is already evident somewhere between 3 and 5 months, if not before.

To our knowledge, the present study is the first to show that joint attentional skills such as CA are founded in dyadic interpersonal relationships, and that the relationship between dyadic and triadic interactions are fostered through attuned interactions. The idea, that the quality of social interaction maybe a key element in promoting a link between dyadic and triadic interpersonal relationships has remained, until now, unexplored territory. The positive results of the present research allow us to shed light on the controversy between the discontinuous (e.g., Carpenter et al., 1998) and continuous theorists (e.g., Bruner, 1999; Fogel, 1993; Trevarthen, 1977; Tronick, 1981), who propose divergent ontogenetic pathways for the development of meaningful communication. According to both theoretical approaches, mental state awareness as revealed during meaningful communication is the result of specific biological adaptation to

perceive others to be 'like me'. In particular, when infants become aware that they are mental or goal-directed agents, the 'like me' principle enables them to perceive others that have these attributes. However, whereas traditionally the discontinuous theorists have put infant awareness of others' intentions toward the end of the first year of life based on joint attention behaviors, the continuous theorists place this ability at the beginning based on particular infant communicative responses, and argue that dyadic interactions where caregivers tune in to the emotions and affective states of their infants and allow infants to tune into theirs, allows for mental state awareness and meaning making (Bruner, 1999; Tronick, 1981).

By examining infants longitudinally, using both age appropriate methodologies and behavioral measures in experiments spanning the first year of life, we found that if the quality of maternal attunement was high, infants younger than 9 months engaged in triadic interactions, and that triadic sharing was founded in dyadic sharing. In a recent study, Markova and Legerstee (2006) demonstrated that 5- and 13-week-old infants showed a clear difference in social understanding as a function of the quality of maternal attunement. Attuned mothers not only provide relationships to their infants that are more supportive and creative than less affectively attuned mothers, but attuned mothers provide emotional signals that contain information about people's mental life (Stern, 1985). These signals may be indicative of or directive for the infants' own intentional communicative behaviors (Bruner, 1999). Consequently, social partners who provide more information about their own internal states are more likely to be reciprocated. Accordingly, during affective interactions infants recognize the social partner as being 'with me', rather than 'like me", which is the essence for identification to take place (Markova & Legerstee, 2006). Our finding that gaze monitoring at 3 months predicted coordinated attention at 10 month, but only if mothers were highly attuned, provides strong evidence about the impact of social factors on the development of meaningful communication during the first year of life, and the relation between mother–child interaction and socio-cognitive abilities.

In summary, the present study provides new data regarding the ontogeny of meaningful communication. It appears that the developing ability to engage in coordinated attention is first rooted in a social context (i.e., the dyadic state), and that the progression from dyadic to triadic interpersonal relations is influenced by the degree to which mothers are affectively attuned to their infants. Affect attunement, the ability to know what the other person is experiencing subjectively, underlies not only emphatic understanding, but is also the basis for early meaningful communication and, most importantly, provides a way for mutual appreciation of the other's mental state (Stern, 1985). As the present research has revealed, highly attuned mothers foster infant progression from being skilled dyadic partners to being skilled triadic partners, who communicate readily about shared experiences in the world.

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