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Mother–infant Interaction Quality and Infants' Ability to Encode Actions as Goal-directed

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Abstract

*The current study investigated the relationship between mother–child interaction quality and infants' ability to interpret actions as goal-directed at 7 months in a sample of 37 dyads. Interaction quality was assessed in a free play interaction using two distinct methods: one assessed the overall affective quality (*emotional availability*), and one focused on the mother's proclivity to treat her infant as an intentional agent (*mind-mindedness*). Furthermore, infants' ability to interpret human actions as goal-directed was assessed. Analyses revealed that only maternal emotional availability, and not maternal mind-mindedness, was related to infants' goal-encoding ability. This link remained stable even when controlling for child temperament, working memory, and maternal education. These findings provide first evidence that emotionally available caregiving promotes social-cognitive development in preverbal infants.*

Keywords: mother–infant interaction; mind-mindedness; emotional availability; goal encoding

Introduction

The development of social understanding has been a topic of great interest. One hallmark of social understanding is the acquisition of a theory of mind (ToM) between 3 and 5 years of age, which is the ability to predict and explain social behavior on the basis of mental states (Astington, 1993; Barresi & Moore, 1996; Perner, 1991; Wellman, 1990). However, already in infancy, children acquire certain social-cognitive abilities that are predictive of their later social understanding (for reviews, see Rakoczy, 2012; Sodian, 2011). Such an early competence is the ability to encode human actions as goal-directed (e.g., Falck-Ytter, Gredebäck, & von Hofsten, 2006; Király, Jovanovic, Prinz, Aschersleben, & Gergely, 2003; Paulus et al., 2011;

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Woodward, 1998, 1999). Woodward (1998) showed 6-month-old infants events in which a person reached for one of two toys. After habituation to this event, infants looked significantly longer on test trials in which a person grasped the other toy (new goal trials) than when the person reached for the old toy, but the path of the grasping was changed (old goal trials). Because infants show this preference only for human goal-directed action, and not for the motion paths of a mechanical claw, the looking-time patterns indicate that infants encode actions in terms of agent–goal relations. The ability to explain behavior by ascribing goals to an agent, which infants develop during the second half of their first year of life (Cannon & Woodward, 2012; Falck-Ytter et al., 2006; Paulus et al., 2011; Woodward, 1998, 2012), has turned out to be an important early precursor of later mental state understanding (Aschersleben, Hofer, & Jovanovic, 2008; Wellman & Brandone, 2009; Wellman, Lopez-Duran, LaBounty, & Hamilton, 2008). For example, Aschersleben et al. (2008) found a positive correlation between 6-month-old infants' decrement of attention to goal-directed action and their false belief understanding at 4 years of age.

Although the development of social understanding from infancy to preschool age has been investigated in depth, little research has addressed the effects of the caregiving environment on children's ToM development. In contrast to the large number of studies showing that sensitive caregiving is positively related to socioemotional development from infancy to adulthood (e.g., Mäntymaa, Puura, Luoma, Salmelin, & Tamminen, 2004; Zayas, Mischel, Shoda, & Aber, 2011; Ziv, Aviezer, Gini, Sagi, & Koren-Karie, 2000), almost no research has related socialization factors to infants' social-cognitive abilities (for an exception, see Mcquaid, Bibok, & Carpendale, 2009).

Investigating environmental effects on the development of social understanding in preschoolers, studies found different aspects of maternal interaction style to be related to ToM. Some authors found that a warm and sensitive interaction style was positively related to preschoolers' ToM competence (Cahill, Deater-Deckard, Pike, & Hughes, 2007; Hughes, Deater-Deckard, & Cutting, 1999; Symons & Clark, 2000). Moreover, Meins et al. (2002) found that children's ToM was predicted through a specific facet of maternal behavior, namely maternal mind-mindedness (MM). This construct refers to a mother's tendency to view her infant as an intentional agent with autonomous thoughts, intentions, emotions, and desires (Meins, 1997). Meins et al. (2002), who assessed mothers' MM as well as their sensitivity following Ainsworth, Bell, and Stayton (1971), found that children who had mind-minded mothers at the age of 6 months were better at solving false belief tasks at 4 years of age than were children whose mothers were less mind-minded. Interestingly, maternal sensitivity was not an independent predictor of children's ToM. In general, these findings provide support for theoretical accounts that assume an impact of social interaction on the development of social understanding (e.g., Barresi & Moore, 1996; Carpendale & Lewis, 2004, 2010; Nelson, 2007).

Hofer, Hohenberger, Hauf, and Aschersleben (2008) studied the impact of mother–child interaction quality on infants' social-cognitive abilities. They examined maternal interaction quality in a free play interaction by applying the CARE-Index (Crittenden, 2004), and assessed infant's goal-encoding ability at 6 months using a modified version of the paradigm used by Woodward (1998). The CARE-Index assesses maternal sensitivity, control, and unresponsiveness on a 0–14 scale by looking at seven aspects of interaction behavior, such as facial and vocal expression, body contact, affection, turn-taking contingencies, control, and choice of activity. A cluster analysis

resulted in three distinct styles: (1) predominantly sensitive (N = 28), (2) unresponsive (N = 16), and (3) moderately controlling (N = 12). The study showed that infants of moderately controlling mothers, and not, as previously expected, infants of predominantly sensitive mothers, were better able to encode actions as goal-directed. The authors explained their findings by supposing that moderately controlling mothers have a more pedagogical interactional style and expect their infants to read their intentions, which makes these infants more attentive to what happens in their social environment.

Yet, besides the study by Hofer et al. (2008), little is known about environmental factors that foster infants' action understanding. This is particularly remarkable, as a number of influential theories have argued that social interaction plays a crucial role in the development of social cognition (Barresi & Moore, 1996; Carpendale & Lewis, 2004; Reddy, 2010). According to Fonagy (2002), the development of social understanding has its roots in the actual interactions and experiences infants have with their parents. If the parent behaves in a predictable, non-frightening, and sensitive way, the behavior of other people becomes meaningful, which helps the child, for example, to predict others' action goals (see also Barresi & Moore, 1996).

As theoretical accounts lead to the notion that infants acquire social-cognitive competencies in the context of interaction with their caregivers, the aim of the present study was to shed more light on the impact of maternal interaction style on infants' social-cognitive development, in particular infants' goal understanding (Woodward, 1998). As mentioned before, infants' goal-encoding ability has been shown predictive of children's ToM (e.g., Aschersleben et al., 2008), and different facets of maternal interaction style have also been shown to be beneficial for children's ToM (Hughes et al., 1999; Meins et al., 2002; Symons & Clark, 2000). Nonetheless, it is an unresolved question whether and how different facets of maternal interaction relate to *infants*' social-cognitive development. In the present study, we aimed at a more differentiated exploration of the relationship between mother–child interaction and infants' goal-encoding ability by using two different assessment measures of interaction quality: the *Emotional Availability Scales* (Biringen, 2008) and *maternal mind-mindedness* (Meins & Fernyhough, 2010).

The Emotional Availability Scales (EAS) is a method that does not quantify distinct behaviors, but analyzes the interactional *style* of the dyad. It is an emotion-focused measure that refers to the overall affective quality of the relationship. The construct of emotional availability (EA) is multidimensional, as it comprises different dimensions of caregiving: four dimensions on the mother's side (sensitivity, structuring, non-intrusiveness, and non-hostility) and two dimensions on the child's side (responsiveness and involvement). We chose this type of measurement, as, in contrast to the CARE-Index (Crittenden, 2004), the EAS differentiates between maternal structuring and intrusiveness. This is important, as these constructs focus on different aspects of maternal behavior: Whereas maternal intrusiveness is about control and interference, structuring refers to the mother's ability to set rules in a positive and proactive way. Thus, by applying the EAS, it is possible to investigate whether a moderately intrusive interactional style is beneficial for infants' goal sensitivity, or whether it is maternal structuring that supports infants' goal-encoding ability.

In contrast to maternal EA, which is viewed as characteristic of the mother–child dyad, maternal MM taps a social-cognitive trait of the mother and refers to verbal comments about the infant's internal states. There are good reasons to expect a positive association between both EA and MM and infants' understanding of intentional action.

Maternal EA might be beneficial for infants' goal encoding, as learning especially is promoted in a warm and sensitive environment, in which a child can explore his or her environment while being supported by the mother. This assumption is supported by several findings that an emotionally responsive caregiving is beneficial for a variety of competencies on the child side (e.g., Hammond, Müller, Carpendale, Bibok, & Libermann-Finestone, 2012; Mäntymaa et al., 2009; Ziv et al., 2000). In particular, referring to Hofer et al. (2008), we suppose that maternal structuring is more beneficial for infants' goal-encoding skills than a moderately controlling interaction style because structuring in the zone of proximal development should enable the child to learn something about the environment (e.g., Rogoff, 1990). However, a mother with a rather controlling interaction style does not give the child enough autonomy, which has been shown to hinder infants' cognitive development (e.g., Feldman & Eidelman, 2006).

Additionally, we assume that maternal MM could also be related to infant's goal encoding, as mind-minded mothers may have infants who are better at interpreting human actions as goal-directed because these mothers allow their infants to experience themselves as self-efficient by verbally commenting on their mental states and appropriately responding to them. Furthermore, maternal MM has been shown to be correlated with children's ToM whereas maternal sensitivity did not explain further variance (Meins et al., 2002).

Examining the literature, it is not possible to conclude whether maternal EA or MM might be more beneficial for infants developing an understanding of human actions as being goal-directed. Thus, as an exploratory question, we examined which type of interaction style and which dimensions of each assessment measure are more important for the infant's acquisition of goal-encoding skills. In order to make sure that the relationship between interaction quality and infants' goal encoding would not be mediated by intra-individual factors of the child, we assessed measures of infants' temperament (Infant Behavior Questionnaire; Rothbart, 1981), as well as their working memory skills (Reznick, Morrow, Goldman, & Snyder, 2004) as control variables. We chose to control for child temperament, as an infant who is able to focus on one object and has good emotion regulation might do better at the goal-encoding task, simply because he or she has a better duration of orienting. Infants' working memory was assessed, as we wanted to control for more general cognitive competencies that have shown to correlate with social-cognitive development (e.g., Henning, Spinath, & Aschersleben, 2011). Furthermore, on the adult side, we controlled for maternal education, as children with higher educated mothers tend to have better social-cognitive abilities than children of mothers with low education (e.g., Pears & Moses, 2003).

Method

Participants

The present study was part of a longitudinal study on *ToM in infancy* (e.g., Paulus, Kühn-Popp, Licata, Sodian, & Meinhardt, 2013).The local ethics committee approved of this work. The final sample consisted of 37 German-speaking mother–infant dyads (25 females and 12 males). Six additionally tested children were excluded because of low inter-observer agreement ($r < .90$) in the goal-encoding task. Another eight children were fussy or cried during the testing, and were therefore also excluded. Children's mean age was 7.0 months [standard deviation (*SD*) = .23], ranging from 6.53 to 7.67 months. The families were recruited from public birth records and mainly

came from the lower to upper middle class. All infants were healthy, full-term and did not have any pre- or perinatal complications. The average age of the mothers was 33 years, ranging from 20 to 41 years. Ten mothers had a not college-bound high-school degree (secondary school up to grade 10), six mothers had a college-bound high-school degree (secondary school up to grade 13), and twenty-one mothers had a college degree. Mothers' educational level was coded according to the following system: No secondary school = 0, secondary school up to grade 9/not college-bound ('Hauptschule') = 1, secondary school up to grade 10/not college-bound ('Realschule') = 2, secondary school up to grade 12/college-bound ('Gymnasium') = 3, Bachelor/Master = 4, and PhD = 5.

Procedure and Measures

The tasks were conducted in the following order: After a warm-up phase during which mothers completed the sociodemographic and temperament questionnaires, the goal-encoding task was conducted. Afterwards, the play interaction took place. The mothers were told to play with their infant as they usually would at home. The working memory task was conducted last.

Child Temperament (Rothbart, 1981)

The questionnaire consisted of 94 items, which were categorized into six subscales. There were 17 items regarding the infants' reactions to new situations and persons ('distress and latency to approach sudden or novel stimuli'), 15 items regarding the infants' 'smiling and laughter', 17 items referring to the babies' activity level, 20 referring to distress to limitations, 11 items referring to ability to concentrate on one object ('duration of orienting'), and 11 items refer to 'soothability'. Subscale scores were computed by summing the item scores and dividing by the number of valid items. Reliability of the different subscales was high, ranging from .73 for 'smiling and laughter' and .84 for 'distress and latency to approach sudden or novel stimuli' (Rothbart, 1981).

Goal-encoding Task (Woodward, 1998)

Infants sat in a tabletop seat or on the parent's lap in front of a puppet stage. On the stage, a white teddy and a multi-colored ball were placed on pedestals. In each trial, a stage curtain opened, and a human hand and arm moved in from the side and grasped one of the objects. It remained still in this position until the trial ended and the curtain closed. A trial lasted until the baby had looked away from the stage for two consecutive seconds. During habituation, for half of the infants, the toy on the right was the target; for the other half, the toy on the left was the target. The habituation criterion was established by summing up looking times over the first three consecutive trials that summed up to at least 12 seconds. An infant reached the habituation criterion when three trials totaled less than half of the sum of these trials. If an infant did not reach this criterion, the test trials were begun after 14 trials. Six infants did not reach the habituation criterion. The mean number of habituation trials was $M = 9.59$ ($SD = 3.25$, range 6–14). After habituation was complete, the toys' positions were switched, and the baby saw one familiarization trial with the toys in their new positions. After that, the baby saw two alternating test events with three trials of each type. In the old goal/new

path event, the actor grasped the same toy as during habituation. The toy was in a new position, so the actor moved his arm through a new path to grasp the toy whereas in the new goal/old path event, the actor moved his arm through the same path as in habituation, grasping a new toy.

The infants' looking was coded by an observer who pressed a key on a computer keyboard when the infant looked at the stage. From that, looking times and habituation criteria were calculated by a computer program (Pinto, 1994). To assess reliability, a second observer coded each video again from the videotaped record. Only infants for whom an inter-observer correlation of .9 or more was achieved were included (N = 37 of 43).

The Emotional Availability Scales (Biringen, 2008, 4th edition)

Relationship quality was assessed at 7 months, based on a videotaped, 10-minute mother–child free play interaction in a laboratory setting. The EA scales consist of six dimensions, four of them addressing the mother's' side of EA and two the child's side of EA, which are all rated on a 1–7 scale. EA is a dyadic measurement, in so far as maternal behavior cannot be assessed independently of child behavior and vice versa. It is a global assessment of emotional openness and communication between mother and child. Maternal sensitivity particularly focuses on genuine affect and emotional responsiveness to the child, but also comprises aspects like timing and flexibility in play. A highly sensitive mother displays genuine interest and affect toward her child, and is able to read the child's signals appropriately. The structuring dimension assesses the mother's ability to structure the interaction in the zone of proximal development by guiding the child and giving him or her consistent clues without overpowering the interaction, but also setting limits when necessary. A mother scoring high on structuring is an active member of the interaction and breaks down the steps so that the child is able to complete the exercise. Maternal non-intrusiveness refers to the mother's tendency to follow the child's lead and offer the child the opportunity to explore the environment. A mother high on non-intrusiveness would wait for optimal breaks to enter the interaction rather than interrupting the child. Non-hostility is characterized by an overall lack of negativity in face and voice. Thus, a mother scoring high on non-hostility is able to regulate her emotions and does not show overt or covert forms (e.g., boredom or impatience) of disrespectful behavior. Child responsiveness is about whether the child is willing to respond to the mother's suggestions and demands, as well as whether the child enjoys interacting with her. A highly responsive child would show a good emotional regulation, as well as an optimal balance between responsiveness to the mother and autonomous exploration. Child involvement assesses the child's attempts to engage the mother in the interaction in a non-urgent and relaxed way. A child scoring high on involvement engages the mother in the interaction in a positive way by, for example, looking at or talking to the mother.

Additionally, the overall affective quality of the relationship is assessed by the clinical screener (1–100 scale). Scores from 1 to 40 refer to a very problematic, possibly traumatized relationship; the zone from 41 to 60 is marked by a detached, distant, and avoidant relationship; scores ranging from 61 to 80 refer to a complicated relationship, marked by pseudo-sensitivity; and dyads that score above 81 are marked as healthy, emotionally available relationships. In a dyad scoring high on the clinical screener, both mother and child are highly emotionally recruitable. The mother is sensitive to the child's cues and shows genuine, positive affect toward the child,

structures the interaction appropriately without being intrusive or hostile, and the child is emotionally responsive and involves the mother in an appropriate way.

The coding was done by two coders who had completed a training program conducted by Zeynep Biringen. In order to assure reliability, 35 percent of the videos (N = 13) were rated by a second observer. Cohen's kappa were as follows: $\kappa = .80$ for the clinical screener, $\kappa = .91$ for maternal sensitivity, $\kappa = .82$ for maternal structuring, $\kappa = .73$ for non-intrusiveness, $\kappa = .79$ for non-hostility, $\kappa = .82$ for child responsiveness, and $\kappa = .72$ for child involvement.

Maternal Mind-mindedness (Meins & Fernyhough, 2010)

Maternal MM was also assessed using the same videotaped free play interactions as for the EAS, coding only the first 7 minutes, as the play interaction varied between 6 and 10 minutes, which could create a confound when analyzing frequency scores. Everything the mother said during the interaction was transcribed in order to identify all comments focusing on the infant's internal states.

Mind-related Comments. Mind-related comments were defined as any comment that (1) uses an explicit internal state term to comment on the infant's mental states, or (2) any utterance that is meant to be a dialogue said/thought by the infant. Mind-related comments were placed into the following subcategories: (1) desires and preferences (e.g., like, dislike), (2) emotions (e.g., fed up, solemn), (3) cognitions (e.g., think, remember), (4) epistemic states (e.g., teasing), (5) talking on the infant's behalf (e.g., 'I want to hide this from mommy!'), and (6) physiological states (e.g., tired, hungry). Physiological states were coded as mind-related if mothers stated them in the absence of any accompanying signs of such states from the infant. Further, the term 'funny' was coded as mind-related if the mother used the term in response to the child finding something funny (e.g., 'You find that amusing, don't you?'). However, if the mother commented on an activity (e.g., 'That's funny!'), the term was not coded as mind-related. Further, 'clever' was coded as mind-related if the mother referred to the fact that the child had performed a task skillfully (e.g., 'That's clever!'). However, if the term was used for general praise (e.g., 'Oh, clever boy!'), it was not coded as mind-related. Also, intentions were only coded as mind-related if the mother specified the goal the child tried to achieve (e.g., 'Do you want to put the ball in the basket?'). However, general uses of 'trying' (e.g., 'What are you trying to do?') were not coded as mind-related.

Comments That Are Not Mind-related. Comments about a child's perception states (e.g., watching, listening, touching, tasting) were not coded as mind-related. Comments about the infant saying something or talking (e.g., 'Are you talking to me?') were not coded as mind-related either. Further, non-specific references to the infant's internal states (e.g., 'Are you alright?') were not coded as mind-related.

Appropriate Mind-related Comments. Mind-related comments were coded as appropriate if the coder agreed with the mother's reading of the infant's current internal state. For instance, the mother might have said 'You want the ball?' while the infant was reaching toward the ball. Further, if the mother clarified how to proceed after a pause in the interaction, her comment was also rated as appropriate, provided the child was not already focusing on something else. For instance, if the infant was not focusing on

any particular object, the mother might have said: 'Do you want to play with x?' Further, comments linking a current activity with similar events in the past or future were also coded as appropriate. For instance, while the infant was playing with a toy car, the mother might have said: 'Do you remember our car?'

Non-attuned, Mind-related Comments. Following Meins and Fernyhough (2010), mind-related comments were coded as non-attuned if the mother was not able to read the infant's mental state appropriately, and thus commented upon it in a non-attuned manner. In the coding manual, five possible cases in which a mental state comment is coded as non-attuned are described: (1) If the researcher disagreed with the mother's reading of the infant's internal state. For instance, the mother might have said 'You are bored with the ball' while the infant was actively playing with it. In this case, 'bored' was coded as non-attuned, mind-related comment. Further, (2) if the mother commented on past and future events that were unrelated to the infant's current activity, these comments were also rated as non-attuned. For instance, without having talked about the grandmother before, the mother might have remarked all of a sudden: 'Do you want to visit granny tomorrow?' If (3) the mother tried to engage the child in a new activity while the child was already actively engaged in something else, this behavior was likewise rated as non-attuned. For instance, the mother might have said 'Let's play with the ball' while the infant was still attending to a flower. If (4) the mother attributed internal states to the infant which were not implied by the infant's behavior, but appeared to be projections of her own internal states, this comment would also be rated as non-attuned. For instance, the mother might have said: 'You think about your dad whom you love so much, don't you?' Finally, (5) maternal comments in which the referent was not quite clear such as 'You like that!' when the infant was not attending to any particular object or event were also rated as non-attuned.

Indices of 7-month MM in Analyses

To control for overall verbosity, in all inferential analyses, scores for appropriate as well as non-attuned, mind-related comments were expressed as a proportion of the total number of words (Meins & Fernyhough, 2010). Thirty-five percent of the data (N = 11) were coded by a second observer, using the verbal transcripts of the first coder, but watching the videos again. Cohen's kappa was $\kappa = .83$ for appropriate mind-related comments and $\kappa = .85$ for non-attuned, mind-related comments.

Working Memory (Reznick et al., 2004)

The infants sat on their caregiver's lap facing a frame containing two openings that were side by side, 42 cm apart from center to center. Two curtains were attached to the back of the frame, designed to cover the windows. At the beginning of each trial, the experimenter pulled aside two curtains, put her face in one of the windows, and engaged the infant's attention. Then, the experimenter withdrew her face, replaced the two curtains, and wiggled her fingers at the top center of the frame. As soon as the infant looked toward the fingers, the experimenter reopened the curtains, and after a 2- to 3-second pause, she reappeared in her previous location. The curtains were then closed again. After a short pause, the curtains were reopened to initiate the next trial. The experimenter's location of appearance was counterbalanced across trials between the left and right windows, and the procedure lasted for six trials (in contrast to 12 trials in the original procedure).

Videotapes were coded by two independent coders who assessed the direction of the infant's first gaze after the reopening of the curtain. Children were given a score of 1 if they looked toward the cued direction, and a score of 0 if their gaze was directed toward some other location. Scores, thus, ranged from 0 to 6. A random sample of 25 percent children was coded by a second observer. Cohen's kappa was .72.

Results

Before describing the correlational analyses as well as the regression analysis, the descriptive statistics of all variables are reported, beginning with infants' goal-encoding ability as outcome variable, and continuing with the descriptives of the interactive measures (EA and MM) as well as the control variables.

Descriptive Statistics

Infants looked, on average, 21.3 seconds at the new goal (*SD* = 14.6, range 2.5–69.1) whereas they looked 17.0 seconds at the new path (*SD* = 18.5, range 3.3–117). As the primary dependent measure for the main analyses, a score was determined for each infant. Percentage scores were calculated, dividing the total amount of looking time at the new goal event by the sum of the looking times at the new goal event plus the new path event (*M* = 56 percent, *SD* = 12 percent, range 20–86 percent).

Table 1 lists the descriptive statistics for maternal emotional availability and mind-mindedness. Within a possible range from 1 to 7, the scores on the different dimensions ranged from 2.5 (sensitivity and structuring) to 7 in our sample. Regarding the means, mothers scored in the upper mid-range in the different dimensions, with the highest mean of 6.0 on non-hostility. The number of maternal appropriate mind-related comments was much higher than the number of non-attuned, mind-related comments. Table 2 lists the descriptive statistics of all assessed control variables. All variables were checked for normal distribution and influential outliers. No outliers (*SD* ≥ or ≤3) could be identified, and all variables were normally distributed, except the number of

Table 1. Means, Standard Deviations, and Range for EA and MM

	M	*SD*	Range
Clinical screener	74.05	16.58	50.00–100.00
M-sensitivity	4.47	1.26	2.50–7.00
M-structuring	4.51	1.30	2.50–7.00
M-non-intrusiveness	5.51	.98	3.50–7.00
M-non-hostility	5.97	1.06	4.00–7.00
C-responsiveness	4.70	1.29	3.00–7.00
C-involvement	4.28	1.08	3.00–6.50
EA (sum)	**29.46**	**6.11**	**21.00–41.50**
Appropriate comments (MM)	5.78	16.58	0.00–21.00
Non-attuned comments (MM)	.85	1.56	0.00–7.00
Number of words	267.41	147.88	59–539

Note: EA = emotional availability; MM = mind-mindedness.

Table 2. Means, Standard Deviations, and Range for the Assessed Control Variables

	M	*SD*	Range
Child temperament:			
Activity level	4.38	.98	1.70–6.71
Distress to limitations	3.66	.97	2.11–5.89
Distress with new stimuli	2.92	1.00	1.33–5.82
Duration of orienting	3.17	.98	1.75–6.36
Positive affect	4.55	.85	3.29–6.23
Soothability	4.89	.84	3.29–6.40
Working memory	3.31	1.28	1.00–6.00
Maternal education	3.43	1.04	2.00–5.00

non-attuned, mind-related comments. Because of a skewed distribution of this variable, prior to inferential analyses, a square root transformation was conducted.

Inferential Analyses

t-tests revealed that infants looked longer on new goal/old path trials than on old goal/new path trials [$t(36) = 1.93$, $p = .03$, one-tailed]. That is, they looked longer when the actor moved in the same way as in habituation, grasping a different toy. An individual-level analysis showed that 29 of the 37 infants looked longer to the new-goal than the new-path event. A chi-square test against 50 percent (chance level) revealed that this pattern was significantly different from chance, χ^2 (N = 37, $df = 1$) = 11.919, $p = .00$.

All EA dimensions were significantly inter-correlated, with maternal sensitivity and child responsiveness showing the highest correlation ($r = .93$, $p = .00$), and maternal structuring and maternal intrusiveness showing the lowest correlation ($r = .37$, $p = .01$). As also can be seen in Table 3, the two interaction variables were highly correlated. Mothers' appropriate mind-related comments were significantly correlated with nearly all EA dimensions whereas non-attuned, mind-related comments were not. The highest correlation was found between child responsiveness and mothers' appropriate mind-related comments ($r = .52$). The sum score of EA was also highly correlated with appropriate mind-related comments ($r = .49$).

Nearly all EA dimensions were significantly correlated with infants' goal encoding, with maternal non-hostility showing the highest correlation ($r = .41$). The sum score of EA showed the highest correlation with infants' goal encoding ($r = .43$). Neither the mothers' appropriate mind-related comments nor the non-attuned, mind-related comments were correlated with infants' goal-encoding ability.

Regarding the different temperament dimensions, only infants' activity level was marginally negatively related to infants' goal encoding ($r = -.33$, $p = .07$). Neither maternal education nor infants' working memory was related to the infants' ability to encode actions as goal-directed. Further correlational analysis showed that maternal EA was neither related to infants' working, memory, and temperament, nor to maternal education. Maternal MM was not correlated with any of the control variables either (see Table 3).

Table 3. Correlations between All Assessed Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Clinical screener	1																		
2. M-Sensitivity	.95***	1																	
3. M-Structuring	.77***	.80***	1																
4. M-Non-intrusiveness	.67***	.62***	.37**	1															
5. M-Non-hostility	.79***	.79***	.63***	.57***	1														
6. C-Responsiveness	.94***	.93***	.74***	.69***	.75***	1													
7. C-Involvement	.88***	.89***	.71***	.64***	.69***	.89***	1												
8. EA (sum)	.96***	.96***	.83***	.73***	.84***	.96***	.92***	1											
9. Appr. comments (MM)	.44**	.48**	.46**	.38*	.26	.52***	.36*	.49***	1										
10. Non-att. comments (MM)	−.18	−.20	−.08	−.23	−.26	−.22	−.22	−.23	−.01	1									
11. Goal encoding	.31*	.39**	.35**	.33**	.41**	.37**	.39**	.43**	−.01	−.11	1								
12. Activity level	.15	.16	.27	.06	−.21	−.17	−.14	−.18	−.11	−.02	−.33**	1							
13. Distress to limitations	−.19	−.22	−.42**	−.16	−.23	−.14	−.05	−.24	−.30	.07	.05	.23	1						
14. Distress with new stimuli	.16	.14	−.09	.20	.13	.34	.12	.16	−.13	.06	.05	.10	.47**	1					
15. Duration of orienting	−.02	.00	.20	−.15	.06	−.03	−.06	.02	−.06	−.24	.03	−.29	−.53***	−.15	1				
16. Positive affect	−.01	−.02	.21	−.15	.09	−.07	−.01	.02	.17	.14	.17	.21	−.20	−.32	.34	1			
17. Soothability	.07	.07	.02	−.17	−.03	−.05	−.08	−.04	−.15	.21	.20	.35	−.14	−.14	.25	.21	1		
18. Working memory	.11	.18	.17	−.13	.20	.06	.06	.11	.09	−.07	.09	−.04	−.13	−.19	−.05	−.12	−.12	1	
19. Maternal education	.15	.09	.05	.08	−.08	.10	.04	.06	.00	−.23	.03	−.16	−.16	−.03	.13	−.40**	.11	−.11	1

Note: EA = emotional availability; MM = mind-mindedness.
*** $p < .01$, ** $p < .05$, * $p < .10$, two-tailed.

Table 4. Hierarchical Regression Analysis to Predict Infants' Goal-encoding Ability

N = 31	ß	R^2	ΔR^2	*F* value
Step 1				
Activity level	−.33	.11	.11	3.63*
Step 2				
Activity level	−.26			
Emotional availability (sum)	.44***			
		.30	.19	6.06***

*** $p < .01$, ** $p < .05$, * $p < .10$, two-tailed.

To investigate relative contributions of predictor variables to explained variance in infants' goal encoding, a hierarchical linear regression analysis using the enter method was conducted. As the proportion of predictors and number of participants is recommended to be 1:10 (Harris, 1985), only those variables that had shown a significant or marginally significant correlation with the outcome variable were entered into the model. Missing data were excluded using the listwise option. The variables were entered in two steps: In the first step, the control variable (child activity level) was entered. Children's activity level turned out to be a marginally significant predictor of infants' goal-encoding ability, and explained 11.1 percent of the variance. In the second step, maternal EA was added (due to multicollinearity of the different EA dimensions, only the sum score of EA was entered). The analysis revealed that maternal EA was the only significant predictor of infants' ability to interpret human actions as goal-directed, whereby little but further variance could be explained by infants' activity level. The model with child temperament and maternal EA resulted as highly significant and explained a total of 30.2 percent of the variance of infants' goal encoding (see Table 4).

Discussion

This study investigated the relation between mother–child interaction quality and a task designed to assess infants' ability to encode actions as goal-directed (Woodward, 1998). Results showed that maternal EA significantly predicted 7-month-old infants' goal-encoding ability. Infants with emotionally available mothers were better at encoding human actions as goal-directed than were infants with less emotionally available mothers. Maternal education, infant temperament, and working memory were not predictive of infants' goal encoding. This study provides the first evidence that an emotionally available caregiving style promotes infants' social-cognitive development, and thus points to the importance of the mother–child relationship for the development of social understanding. Importantly, we showed that only the overall affective quality assessed through the *Emotional Availability Scales* (Biringen, 2008) was related to infants' goal encoding. By contrast, maternal MM, although correlated with EA, was not predictive of infants' goal encoding.

However, our study has some limitations. As our sample size is rather small, the study should be replicated with more participants. Furthermore, our sample mainly consists of middle-class families. Thus, we cannot conclude that our results can be

generalized to a sample with a low socioeconomic status. Moreover, it would be interesting to investigate whether maternal EA also has an impact on other social-cognitive abilities of the child, such as gaze-following and imitation. Another limitation of our study refers to the issue that all data were collected at the same measurement point. Thus, strictly speaking, we are not allowed to draw conclusions about the causality of the relationship between maternal interaction style and infants' goal-encoding ability. However, as maternal EA seems to be rather stable over time (e.g., Biringen, Matheny, Bretherton, Renouf, & Sherman, 2000; Bornstein et al., 2006), we could conclude that the mothers were emotionally available from the time that the infant had been born. Furthermore, the inverse direction, an influence of infants' goal-encoding ability on maternal EA, is rather improbable, as this social-cognitive competence emerges only around the age of 6 months (Woodward, 1998). Nevertheless, causal relations can only be investigated longitudinally. Thus, it would be very interesting to see if our results also hold in a longitudinal design.

This is the first study that compared two different assessment measures of mother–child interaction and linked them to a specific social-cognitive competence in infancy, namely the ability to encode human actions as goal-directed. Our results provide empirical support for the theoretical notion that the relationship quality between mother and child is related to infants' social-cognitive development, in particular their action understanding, as frequently hypothesized (e.g., Carpendale & Lewis, 2004; Fonagy, 2002). Furthermore, our study extends previous findings showing a link between mother–child interaction and children's social-cognitive skills, such as the results by Meins et al. (2002), who found a link between maternal MM and children's ToM at 4 years, as well as the results by Hughes et al. (1999) and Cahill et al. (2007), who demonstrated a link between maternal warmth, respectively warm responsiveness, and children's ToM.

The fostering role of maternal emotional availability for infants' goal-encoding skills can be explained as follows. Infants with emotionally available mothers are able to concentrate on their environment, as they do not have to cope as much with their own emotion regulation because their emotions get well regulated by a sensitive mother (e.g., Davidov & Grusec, 2006). Thus, the infants have capacities left to focus on other persons' desires, emotions, and intentions, and more generally speaking, on other people's actions. Furthermore, emotionally available mothers are also able to read their infant's signals appropriately and to respond to them in a sensitive way. This promotes infants' experience of self-efficacy and also might sensitize infants to other peoples' goals and intentions behind their behavior, as their own behavior is also read and interpreted in an accurate way.

Additionally, the link between EA and infants' goal-encoding ability could be mediated by a concept called 'motionese'. Specifically, Brand, Baldwin, and Ashburn (2002; see also Brand & Shallcross, 2008) found that when mothers demonstrate objects to 6- to 8- and 11- to 13-month-old infants, their actions are characterized by distinct features, such as closer proximity to the child, higher expression of enthusiasm, a greater amount of repetitiveness, higher interactiveness (more turn-taking and more gazes to the infant's face), as well as a higher amount of joint action on objects with their children. These characteristics might enhance infants' learning about action, as they facilitate infants' attention to action, and thus enhance learning about action. This explanation is supported by the findings of Koterba and Iverson (2009), who examined whether infant-directed action affected 8- to 10-month-old infants' attention to objects as well as their object exploration. They showed that varying levels of repetition and

amplitude were related to differences in infant attention, and variations in repetition were linked to differences in infants' object exploration. Infant-directed action may also directly help infants to get access to the meaning of action by helping them to recognize goals and intentions that motivate action. We suggest that an emotionally available mother also has several attributes that characterize motionese: An emotionally available mother shows much positive affect and interacts with her child, showing turn-taking, eye contact, and joint attention. If this line of reasoning is true, it is possible that maternal EA also enhances infants' attention, and helps them learn to recognize goals and intentions that motivate action. One reason for this relation could be that magnified emotions amplify information about intentionality and help infants recognize goal achievement (Brand et al., 2002), which is necessary to encode human actions as goal-directed.

To sum up, the relation between maternal EA and infants' goal encoding could be attributed to two different pathways that are not necessarily mutually exclusive: Maternal EA could directly affect infants' goal encoding, or it might be mediated through specific ways of the mother engaging in goal-directed behavior with her infant (e.g., motionese), which in turn could support infants' goal sensitivity.

Furthermore, it should be noted that, in contrast to Hofer et al. (2008), who found a positive correlation between moderate maternal intrusiveness and infants' goal encoding, we found a negative correlation between the EA dimension maternal intrusiveness, and a positive correlation between structuring and infants' goal encoding. One possible explanation for the seemingly divergent findings could be ascribed to the different assessment measures of interaction quality. Hofer et al. applied the CARE-Index, which assesses the dimensions sensitivity, control, and non-responsiveness on the mother's side. In contrast to the EAS, the mother's tendency to appropriately structure the interaction is not looked at separately in the CARE-Index. Thus, it is possible that the link that Hofer et al. found between maternal intrusiveness and infants' goal-encoding ability is due to maternal structuring, which can easily be confounded with intrusiveness.

In our study, maternal MM was not related to infants' goal-encoding ability. One possible explanation could be that MM, which refers to a mother's explicit, verbal conceptualization of her child, only is important at a later age of the child and is not related to early competencies in the first year of life. Longitudinal studies have provided compelling evidence for a link between maternal MM and social-cognitive abilities (ToM) at preschool age (Meins et al., 2002). Thus, we suppose that for preverbal children, the mother's behavior, and in particular her affect, might be more important than her verbal references to the infants' mental states. Another reason for the missing link between maternal MM and infants' goal encoding could be that the relation is transmitted through maternal EA, as MM and EA are significantly correlated with each other. Our results show that mind-minded mothers tend to be more emotionally available, but that MM *per se* does not promote infants' goal encoding. These results are in line with the hypothesis of maternal MM being a part of sensitivity (Lundy, 2003). Our findings lead to the conclusion that the mother's mere tendency to appropriately attribute mental states to her infant without being *emotionally* available is not enough for promoting specific competencies on the child side, and that learning can especially occur in an emotionally available environment. Furthermore, they support Biringen's (2000) assumption that the overall affective quality is more indicative of the relationship and is more important for positive outcomes on the child side than quantitative measurements (like maternal MM) focusing on specific maternal behaviors.

In conclusion, our findings support the theoretical assumption that the mother–child relationship is the cradle for infants' social cognition (Fonagy, 2002). Furthermore, our results are in line with the view that the development of social understanding is rooted in the early interactions between infants and their caregivers (Barresi & Moore, 1996; Carpendale & Lewis, 2004; Reddy, 2010).

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