Empirical Article

Maternal Affect Attunement: Refinement and Internal Validation of a Coding Scheme

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The concept of maternal affect attunement has evoked considerable theoretical interest, but attempts at empirical validation have been scarce. The aim of this study was to refine the coding scheme for assessment of maternal affect attunement and to establish the internal validity of the measure. Forty dyads with seven-month-old infants and their mothers were recorded in two face-to-face play situations. Mother-child interactions were coded by four raters on the dimensions of Maintaining Attention and Warm Sensitivity, the latter comprising the subscales of Positive Affect, Social Responsiveness, and Warm Concern. Inter-rater agreements for all scales and subscales were high. Scale reliabilities and construct stabilities as estimated by test-retest correlations were satisfactory. We conclude that the Maternal Affect Attunement Scale (MAAS) reliably captures individual differences in Maintaining Attention and Warm Sensitivity.

Keywords: Maternal Affect Attunement Scale (MAAS), parent-child interaction, coding dyadic interaction, maintaining attention, warm sensitivity

Infants are social creatures. They engage in active, dialogue-like communication and tend to match their emotional states to those of the interaction partner (Brazelton, Koslowski, & Main, 1974; Tronick & Cohn, 1989). A key component of this exchange, presumably with positive proximal and distal developmental consequences, is the contingency of the maternal response (Carpenter, Nagell, & Tomasello, 1998; Stern, 1977; Striano & Reid, 2006; Tronick, 2005) leading to interactional synchrony within the mother-infant dyad. According to Seligman (1975), infants are more likely to develop a sense of control, which is essential to future social, emotional, and cognitive health, if they experience affectively contingent outcomes during turn-taking episodes with their caregiver. Through repeated occurrences, infants perceive a contingency between a particular behavior and a rewarding response in their environment (Watson, 1979). Gergely and Watson (1996) argued that infants initially become sensitized to their own emotional states through the mother's distinctive reflections of the infant's emotional displays. Typically, infants respond to such contingencies with smiles and vocalizations. Non-contingent stimuli on the other hand may elicit little attention and neutral affect.

When studying early mother-infant interactions, various contingency-related constructs have been defined and used, including social contingency (Dunham & Dunham, 1990, 1995), interactional or dyadic synchrony (Feldman & Greenbaum, 1997; Harrist, 1994; Isabella & Belsky, 1991), or affect attunement (Haft & Slade, 1989; Stern, Hofer, Haft, & Dore, 1985; see Harrist & Waugh, 2002, for a detailed review). The present research is in line with the latter construct. Stern was the first to refer to affectively contingent interactions between mother and infant as "affect attuning" (Stern,

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Barnett, & Spieker, 1983). In 1985, he further defined affect attunement as "… expressing the quality of a shared affect state but without imitating the exact behavioral expression of the inner state" (Stern, 1985, p.251). Rather than matching the infant's negative state, parents seem to modulate this state through sensitive emotional expression, thereby providing the infant with a sense of social awareness (Stern, 1985).

It is crucial to distinguish between the research on early mother-child interaction that describes it in terms of mutual contributions and the research that characterizes it in terms of maternal dimensions such as sensitivity or responsiveness (Fogel, 1993). Typically, instances of social contingency have been assumed to be mutual, including the assumption that both interaction partners perceive, and adapt to, the actions of the other person. But, as already assumed by Cairns in 1979, it is in fact very reasonable to expect that this type of synchrony is quite limited early in development. Today many developmentalists consider infants' caregiver's behavior to be critical for coordinating and maintaining interaction, even though contingency is a dyadic construct (Biringen, 1990; Smith & Pederson, 1988). In a recent review, Feldman (2007) summarized the ontogeny of early synchrony between parent and infant, starting in the last trimester of pregnancy going up to about one year of age. Not before nine months of age, social interactions are considered to develop in a "true give-and-take mutuality" (Feldman, 2007, p. 330). Before that, matching and coordination of parent and infant interactive behavior can be observed, mainly with maternal adaptation to the infant's cues. Within this line of research, maternal behaviors comprising reactions to the infant's signals are observed and described (Murray & Trevarthen, 1986). Affect attunement in this context explicitly focuses on the mother's attunement to the infant's affect and will be referred to as maternal affect attunement. Harrist and Waugh (2002) concluded that high attunement on the part of the mother maximizes maintained engagement, allows coordinated interaction, and promotes attunement on the part of the infant, thereby facilitating the occurrence of dyadic synchrony.

Despite great theoretical interest in developmental consequences of maternal affect attunement, there are almost no empirical investigations of its reliability and internal validity. In 1989, Haft and collaborators made an attempt to study affect attunement systematically (Haft, 1989; Haft & Slade, 1989; Stern, 1985). According to the Affect Attunement Protocol (AAP), previously recorded mother-child interactions were analyzed to identify sequences in which the mother's and the infant's behavior matched along dimensions such as modality, intensity, rhythm, shape, and duration (Stern, 1985). For the selected sequences, maternal responses were then rated along a continuum from negative attunements to comments to positive attunements. Maternal behavior was considered as attuned if the infant's initial behavior was matched by the mother's response. Results of that pilot study revealed that the proposed coding scheme did not capture the diversity of maternal attuning behavior, especially not the misattuning behavior, as also introduced by Stern in 1985. Furthermore, several methodological constraints including a very small and age-diverse sample, limited the interpretability of that data.

In 1998, Landry and colleagues evaluated maternal interactive behaviors and their relation to children's social development (Landry, Smith, Miller-Loncar, & Swank, 1998). They reported three maternal behaviors that seem to be especially important to children's learning of contingency in social interactions and that differ considerably between mothers: Maintaining Attention, Redirecting Attention, and Warm Sensitivity. These three dimensions have been used by other researchers to describe and establish the degree of maternal affect attunement. For instance, Legerstee and Varghese (2001) found that, in comparison to less affect-attuned mothers, highly affect-attuned mothers had higher scores on Maintaining Attention and Warm Sensitivity. Redirecting Attention, on the other hand, seemed to be characteristic of less affect-attuned mothers (Legerstee & Varghese, 2001; Varghese, 1999).

This approach to the investigation of maternal affect attunement seems promising for the assessment of maternal attuning behavior in different age samples (Legerstee, Markova, & Fisher, 2007) and within the laboratory setting. In contrast to the AAP, these constructs seem to give a better account of misattuning behavior, which may be considered a conceptual part of Redirecting Attention (for detailed discussion see below). Therefore, the present study made a first attempt to refine and specify the assessment of maternal affect attunement in the Maternal Affect Attunement Scale (MAAS), based on the scales and subscales first introduced by Landry et al. (1998). The focus of this article is on the internal rather than the external validity of the measure. In particular, we investigated inter-rater agreement, correlations among scales and subscales as well as reliabilities and relative stabilities as inferred on the basis of test-retest correlations. Furthermore, we included various sociodemographic data and correlated these with the maternal affect attunement.

Methods

Participants

A total of 46 infants and their mothers participated in this study. Mothers were recruited from several maternity clinics and baby courses in Berlin, Germany. Dyads with infants whose gestational age was under 38 weeks were excluded from the study.

Of the initial sample, six mother-child dyads were excluded from the study either due to inability to return to or complete the second visit or because they did not speak German to their infants.[1] A final sample of 40 mothers (M = 35 years) and their seven-month-old

[1] There were significant differences in the degree of Maintaining Attention ($t = 13.48$, $p < .05$) between the six excluded dyads and the dyads in the final sample. The mothers of these six dyads that were excluded from further analysis maintained attention reliably less frequently than mothers in the final sample. To increase the homogeneity of the final sample, three of the six mothers were excluded because they did not speak German to their infants. This study aimed to exclude differences due to linguistic (e.g., motherese) as well as cultural-specific features. The remaining three mothers were excluded because of missing data.

infants (52.5% female; 47.5% male) ranging from 6.14 to 7.18 months (M = 6.5 months) were included in the analyses. A complete overview of the sample can be found in Table 1. Seventy percent of the infants were first-born, 22.5% second-born, and 7.5% had two to four siblings. Ninety-five percent of the mothers and 97.5% of the fathers participating in the study had German nationality. At the time of data acquisition only one of the mothers was not living together with the father of the infant. All of the participating mothers were primary caregivers. All except one father were either currently employed in skilled or semiskilled professions full-time or were still studying. Before the child's birth, the mothers were full-time employment (65%), part-time employment (12.5%), in educational training (12.5%), unemployed (5%) or homemakers (5%).

Table 1. Participants' Descriptive Information.

	Min	Max	Mean	SD
Mother's age (years)	21	44	35	5.365
Father's age (years)	26	48	39	5.468
Child's age at T1 (months)	6.14	7.15	6.45	.413
Child's age at T2 (months)	6.19	7.18	6.63	.430
Child's birth weight child (g)	2690	4080	3430.63	331.512
Week of gestation	38	42	39.74	1.032

The study was approved by the institute's Ethics Committee. All participants gave their written informed consent. The parents received a compensation of 10 Euro per session after the second test session of the study.

Procedure

Mother-infant dyads were seen during two visits to the Baby Laboratory at seven months of age. Prerequisites for successful testing were that the baby was not tired, hungry, thirsty, or ill, and had had a recent diaper change. The testing room was soundproof and had white curtains. To avoid the child being distracted, no objects other than a table, a baby seat, a chair for the mother and two cameras were in the room.

Infants were placed in a baby seat upon a table opposite the mother (approximately 30 cm between the mother and her child). This procedure allowed comfortable eye and body contact between the two (face-to-face situation). The entire testing was videotaped with two cameras, which were located opposite each other. One of the cameras was videotaping the child, the other was recording the mother. The two recordings were combined, leading to a time-synchronized split-screen picture of mother and child, in which the mother's and the child's gaze met at an angle of about 45° (see Figure 1). The video recording enabled the examiner to evaluate and code the interaction later.

Mother-child interactions were recorded following several different instructions. During the first four minutes, the mother was instructed to interact with her child as she normally would. The following standardized instruction was given to the mother:

"First I would like to ask you to interact with your baby so both of you feel comfortable and have a good time with each other. Try to do this in a way you would do it at home. Take as much time as you would normally take. The main experiment will start after this episode. These first four minutes are important for you but especially for the child to get used to the new environment. Furthermore, we need this time to adjust some final technical settings. After this period you will receive instructions for the main part of the experiment." (translated from German into English). During these first four minutes the use of any toys was prohibited. The instruction during the free-play sequences was intentionally open. The first and last 30 seconds of the sequence were excluded from coding. A total of three minutes of free-play (FP) mother-child interaction was used to code maternal affect attunement. Thus, the purpose of this first part of the testing was withheld from the mothers prior to the study. They were informed after the second session of the study.

Figure 1. Split-screen Picture of Mother and Child During the Interaction.

Following the first four minutes of free play, the mother was given further instructions. The next six minutes of the mother-child interaction included a partly structured play situation. The mother was instructed to play the Peek-a-boo game with her child for one minute. A four-minute-sequence of free play followed. The same instruction as during the first four minutes was given, but this time the use of one age-appropriate toy (i.e., rattle) was permitted. This time, the mothers knew that this sequence was part of the main study. Then, a one-minute-sequence of an age-appropriate German child's game followed. This involved the mother walking her fingers over the child's belly. The transitions between the different parts of the interaction were signalized to the mother by a knock at the door. From this second interaction sequence only the free-play-with-toy (FPT) part was used for later coding. Again the first and last 30 seconds of this sequence were excluded from coding and hence a total of three minutes of mother-child interaction was used. The two interspersed one-minute-sequences were included to make mothers feel more comfortable and to get a more accurate impression of the free-play interaction sequences. In the test

sessions, mothers wore a white/gray t-shirt to avoid any confound due to differences in the attractiveness of the mother's clothes. The same complete procedure was repeated within the next one to ten days.

Coding Maternal Affect Attunement

Two dimensions of maternal behavior were coded for the two interaction sessions: Attention and Warm Sensitivity. Scales were adapted from descriptions by Landry, Legerstee, and their respective colleagues (Landry et al., 1998; Legerstee et al., 2007; Legerstee, Varghese, & van Beek, 2002). The Attention code included two maternal attention-directing styles: The time in which mothers maintained their infant's attention and the time in which mothers used directive strategies to change the child's focus of attention either verbally or nonverbally. *Maintaining Attention* was coded every time the mother followed or maintained the infant's focus of attention by making a verbal or nonverbal response about the infant's object of attention. Thus, the mother had to be engaged with the child to be coded as *Maintaining Attention. Redirecting Attention* was coded whenever the mother's request was more demanding and left less choice for the child. The mother could induce the infant to change his/her focus of attention by making comments, suggestions, or requests (Ainsworth, Bell, & Stayton, 1971; Landry et al., 1998; Legerstee et al., 2007). Thus, *Redirecting Attention* was coded when the child's focus of attention was changed directly by the mother (Legerstee, personal communication, February 2, 2007). The two attention codes, Maintaining and Redirecting Attention are mutually exclusive, but there might be sequences in which the mother is not attending at all. In this case no code is given for Attention. Attention was coded on a frame-by-frame basis for both three-minute interactions.[2]

Warm Sensitivity was defined as the degree of sensitivity the mother displayed to the child's cues, including the promptness and appropriateness of reaction, acceptance of the infant's interests, amount of physical affection, positive affect, and tone of voice. It was coded when the mother showed perceptiveness towards the infant's verbal and nonverbal cues and included the following three components: Positive Affect, Warm Concern, and Social Responsiveness. *Positive Affect* was defined as the intensity and duration of mother's affective behavior, tone of voice, and use of affective words. *Warm Concern* described the mother's acceptance of infant activities, gentleness during play, and concern for comfort and safety. *Social Responsiveness* referred to the mother's contingent responses to her infant's positive behavior or vocalizations, as well as modulation of any negative infant behavior or vocalizations (Legerstee et al., 2007). A five-

[2] While coders first watched the video in real time to scan for transitions in maternal attention behavior, they marked the exact starting and end point of a maternal behavior indicating Maintaining or Redirecting Attention only thereafter. This procedure allowed the coding of verbal comments and the identification of their semantic context.

point rating scale was used for the three subscales, as proposed by Landry et al. (1998). Three consecutive ratings were made for each of the subscales Positive Affect, Warm Concern, and Social Responsiveness in both conditions (FP and FPT). These ratings summarized the coders' judgment on the corresponding subscale for the first, second, and third minute of interaction respectively. This procedure guaranteed that the coders would focus on one of the behavioral sub-aspects of Warm Sensitivity at a time. To obtain a score for each subscale, the average score over the three consecutive ratings was computed. Finally, the three subscales were averaged again to obtain a total score of Warm Sensitivity. The full manual for coding Maintaining and Redirecting Attention and the three subscales of Warm Sensitivity can be found under http://library.mpib-berlin.mpg.de/ft/kb/KB_Maternal_2008.pdf.

To increase coding accuracy, behavior was coded in multiple passes of each video sequence by each coder. The four video sequences of each subject were coded consecutively. Coding was carried out by four separate coders by means of the Interact® software, a program that helps to observe and code behavior (Mangold, 2007). In advance, all coders received a substantial training on the MAAS before the present data were coded. Besides an introductory session in which the concept of each construct was discussed, the coder training included a joint coding of three practice video sequences and a separate coding of ten practice video sequences, each followed by extensive discussion. Only after that the experimental data was coded. Of the four coders, two did not have any contact with the participants before and while coding the interaction sequences. Two coders each coded 100% of the videos, whereas the other two coded a random subset of the videos, resulting in 30% of the total amount of recorded sequences. One main coder and one coder coding a subset of videos did not have any contact with the participants at any point in time prior or during the time period when they were coding the sequences.

Results

The two attention scales, Maintaining Attention and Redirecting Attention, showed an almost perfect negative correlation ($r = -.99$, $p < .05$). For this reason, only results for Maintaining Attention will be reported here. Note that the codes for Maintaining Attention and Redirecting Attention were mutually exclusive, and that the mothers were asked in the instructions to interact with their children, so that some form of attention-relevant behavior towards the child, be it of a maintaining or redirecting kind, was to be expected.

Inter-rater Reliabilities

To test the reliability of Warm Sensitivity and Maintaining Attention, the inter-rater reliabilities were established separately for the three subscales of Warm Sensitivity, Warm Sensitivity as a whole, and for Maintaining Attention (see Table 2 for details).

Cohen's Kappa was calculated for the duration code Attention with a one-frame accuracy interval using a computerized program (Mangold, 2007). The Kappa for Attention between the two main raters was $\kappa = .93$ in the various conditions. Furthermore, Kappas between the remaining pairs of raters were between .62 and .85. A two-way mixed model Intraclass Correlation (ICC) was used to test the inter-rater reliability for the scales of Warm Sensitivity as data is ordinal. Intraclass Correlations (ICC) for the Warm Sensitivity scales showed moderate to outstanding interrater agreement ranging from .56 to .83. The means of the scores for Maintaining Attention, Redirecting Attention, and Warm Sensitivity of rater 1 and rater 2 were used for further analysis.

Table 2. Inter-rater Agreement (Kappa; Intraclass Correlation (ICC)) for all Scales and Raters.

Rater Pairs	Attention (Kappa)	Positive Affect (ICC)	Social Responsiveness (ICC)	Warm Concern (ICC)	**Warm Sensitivity[a] (ICC)**
Rater 1 vs. Rater 2*	**0.93**	**.56**	**.68**	**.60**	**.64**
Rater 1 vs. Rater 3**	0.77	.86	.80	.78	.85
Rater 1 vs. Rater 4**	0.63	.69	.82	.74	.78
Rater 2 vs. Rater 3**	0.85	.56	.73	.65	.75
Rater 2 vs. Rater 4**	0.67	.83	.64	.72	.67
Rater 3 vs. Rater 4**	0.62	.63	.62	.56	.64

Note. Values for the main rater pair are displayed in boldface. * For 100% of the interactions; ** for 30% of the interactions; [a]composed of the mean of Positive Affect, Warm Concern and Social Responsiveness

Correlations Among Maternal Affect Attunement Scales

Earlier studies collapsed the ratings of Positive Affect, Social Responsiveness, and Warm Concern into a construct of overall Warm Sensitivity (Landry et al., 1998; Legerstee & Varghese, 2001). Before doing so, we inspected the correlations among the three subscales within and between the FP and FPT conditions for each of the two sessions (Table 3). Correlations among the three scales were substantial within each condition and session (range of *r*s: .80 – .97, $p < .05$), and also were reliable between conditions (range of rs: .70 – .89, $p < .05$). These results support the practice of aggregating the three Warm Sensitivity subscales (Warm Concern, Positive Affect, and Social Responsiveness) into a total scale of Warm Sensitivity. Given that the three subscales were assessed in the same metric, a simple way to achieve this, also used here, is to compute the mean of the three subscales.

Table 3 also shows the correlations between Maintaining Attention and the three Warm Sensitivity subscales within and between both conditions. Of the total number of 24 correlations between the Warm Sensitivity subscales and Maintaining Attention, seven were positive, and the rest did not differ reliably from zero. Moderate but significant correlations were found between Warm Concern and Maintaining Attention for both conditions in Session A (FPT: $r = .44$, $p < .05$; FP: $r = .34$, $p < .05$) and in Session B in the FP condition ($r = .32$, $p < .05$). Furthermore, a correlation between Maintaining

Attention in the Free Play Conditions and Warm Concern in the FPT condition was found within each session as well (session A: $r = .31$, $p < .05$; session B: $r = .33$, $p < .05$). Additionally, a moderate correlation could be established in session A within each condition between Social Responsiveness and Maintaining Attention (FPT: $r = .38$, $p < .05$; FP: $r = .33$, $p < .05$). In session B this was only found within the FP condition ($r = .42$, $p < .05$). Positive Affect did not correlate reliably with Maintaining Attention (Table 3). The aggregated Warm Sensitivity score and Maintaining Attention did not correlate between or within conditions or sessions. Clearly these results do not support the practice of aggregating Maintaining Attention and Warm Sensitivity into a unitary maternal affect attunement score. Note also that only in Session A was Maintaining Attention moderately correlated with itself across FP and FPT conditions ($r = .44$, $p < .05$).

Table 3. Correlations Among the Three Subscales of Warm Sensitivity, Warm Concern (WC), Positive Affect (PA), and Social Responsiveness (SR), the Warm Sensitivity Aggregate Score (WS), and Maintaining Attention (MA) Within and Between the two Experimental Conditions, Free Play (FP) and Free Play With Toy (FPT), Separately for Sessions A and B.

		FP					FPT				
		WC	PA	SR	WS	MA	WC	PA	SR	WS	MA
FP	WC		**.82**	**.86**	**.94**	**.32**	**.89**	**.86**	**.82**	**.90**	.22
	PA	**.85**		**.80**	**.93**	.14	**.73**	**.84**	**.74**	**.82**	-.08
	SR	**.89**	**.86**		**.94**	**.42**	**.80**	**.78**	**.85**	**.85**	.20
	WS	**.96**	**.95**	**.96**		.31	**.85**	**.88**	**.85**	**.91**	.11
FPT	MA	**.34**	.19	**.33**	.30		**.33**	.15	.25	.25	.26
	WC	**.84**	**.70**	**.76**	**.80**	**.31**		**.83**	**.88**	**.95**	.25
	PA	**.73**	**.80**	**.74**	**.79**	.16	**.80**		**.85**	**.94**	.06
	SR	**.75**	**.74**	**.75**	**.78**	.15	**.89**	**.87**		**.96**	.29
	WS	**.81**	**.78**	**.79**	**.83**	.22	**.94**	**.94**	**.97**		.21
	MA	.15	-.02	.09	.10	**.44**	**.44**	.30	**.38**	.39	

Note. Correlations in boldface are significant ($p < .05$). Correlations for Session A are shown below the main diagonal, correlations for Session B above the main diagonal.

Mean Differences

A comparison of the FP and FPT conditions for Session A revealed a trend for the mean differences in Maintaining Attention (t (158) = 1.92, $p = .06$), with mothers tending to maintain attention more in the FPT than in the FP condition. In Session B, this trend was statistically reliable (t (158) = 2.57, $p < .05$). Means of Warm Concern, Positive Affect, and Social Responsiveness did not differ between the two conditions in either session (see Table 4). Mean differences between identical scales across sessions did not differ reliably from zero.

Table 4. Paired t-tests Between the Conditions Free Play (FP) and Free Play With Toy (FPT) for the Three Subscales of Warm Sensitivity, Warm Concern (WC), Positive Affect (PA), and Social Responsiveness (SR), the Warm Sensitivity Aggregate Score (WS), and Maintaining Attention (MA, in Seconds).

	Scale	Condition	Mean	SD	t-value	p-value
Session A	Warm Concern	FP	4.00	.62	-1.287	.206
		FPT	3.93	.61		
	Positive Affect	FP	3.94	.68	.701	.488
		FPT	3.98	.62		
	Social Responsiveness	FP	3.70	.67	.517	.608
		FPT	3.73	.65		
	Warm Sensitivity	FP	3.88	.63	.067	.947
		FPT	3.88	.59		
	Maintaining Attention	FP	166.90	13.45	1.922	.062
		FPT	170.98	11.45		
	Scale	Condition	Mean	SD	t-value	p-value
Session B	Warm Concern	FP	4.00	.59	-.735	.467
		FPT	3.97	.61		
	Positive Affect	FP	3.99	.67	.781	.439
		FPT	4.03	.66		
	Social Responsiveness	FP	3.75	.66	.532	.597
		FPT	3.78	.64		
	Warm Sensitivity	FP	3.91	.60	.337	.738
		FPT	3.93	.61		
	Maintaining Attention	FP	165.28	18.04	2.567	**.014**
		FPT	172.62	9.35		

Note. p-values in boldface are significant ($p < .05$)

Test-retest Correlations

To obtain information about test-retest reliabilities and relative stabilities for both the FP and the FPT conditions, test-retest correlations across the two sessions were computed for the Warm Sensitivity total score, the three Warm Sensitivity subscales, and Maintaining Attention (Table 5). Within each condition, the total score and the subscales of Warm Sensitivity all correlated statistically reliably, ranging from $r = .72$ to $r = .91$. Also, Maintaining Attention in Session A correlated positively with Maintaining Attention in Session B within each condition (FP: $r = .67$, $p < .05$; FPT: $r = .40$, $p < .05$). Test-retest correlations between the two conditions were also of similar magnitude. For the total score and the subscales of Warm Sensitivity, all correlations were statistically reliable, ranging from $r = .68$ to $r = .90$. Maintaining Attention in Session A of condition FP correlated positively with Maintaining Attention in Session B of condition FPT ($r = .36$, $p < .05$) and vice versa ($r = .66$, $p < .05$).

Table 5. Test-retest Correlations for the Three Subscales of Warm Sensitivity, Warm Concern (WC), Positive Affect (PA), and Social Responsiveness (SR), the Warm Sensitivity Aggregate Score (WS), and Maintaining Attention (MA), for Free Play (FP) and Free Play with Toy (FPT).

		Session A									
		Free Play (FP)					Free Play with Toy (FPT)				
Session B		WC	PA	SR	WS	MA	WC	PA	SR	WS	MA
	WC	***.90***	**.81**	**.84**	**.89**	.23	**.84**	**.74**	**.76**	**.82**	.14
	PA	**.74**	***.85***	**.82**	**.84**	.13	**.69**	**.79**	**.71**	**.77**	-.08
FP	SR	**.84**	**.80**	***.90***	**.89**	.27	**.72**	**.68**	**.75**	**.76**	.16
	WS	**.88**	**.87**	**.91**	***.93***	.22	**.80**	**.78**	**.79**	**.83**	.08
	MA	.30	.12	.30	.25	***.67***	**.38**	.25	.26	.31	**.66**
	WC	**.86**	**.75**	**.81**	**.84**	.25	***.81***	**.75**	**.72**	**.80**	.24
	PA	**.80**	**.87**	**.79**	**.86**	.13	**.72**	***.84***	**.77**	**.82**	.07
FPT	SR	**.82**	**.78**	**.85**	**.86**	.25	**.80**	**.77**	***.83***	**.84**	.24
	WS	**.87**	**.85**	**.86**	**.90**	.22	**.82**	**.83**	**.81**	***.86***	.19
	MA	.18	-.06	.16	.10	***.36***	.29	.07	.24	.21	***.40***

Note. Correlations in boldface are significant ($p < .05$). Test-retest correlations for identical measures are in italics.

Exploration of Covariates

The exploration of covariates in the sense of establishing the convergent and divergent validity of the MAAS was beyond the scope of this study. Nevertheless, possible relations to other variables were explored post-hoc for Session A. We found that the age of the mother correlated negatively with the degree of Maintaining Attention ($r = -.45$, $p < .05$) in the FP condition. Thus, the older the mother, the less likely she was to maintain attention. Moreover, in the FPT condition, children's birth weight correlated negatively with Warm Sensitivity ($r = -.33$, $p < .05$).

Discussion

The aim of the present study was to examine the internal validity of the MAAS. Mothers and their seven-month-old infants were observed in two sessions during which a sequence of mother-child interactions was recorded. The rating of the video sequences was carried out by four coders. Initially, the MAAS included a total of six scales for coding maternal behavior: Maintaining Attention, Redirecting Attention, and Warm Sensitivity, which was further subdivided into three subscales: Warm Concern, Positive Affect, and Social Responsiveness (adapted from Landry et al., 1998). Because Maintaining Attention and Redirecting Attention showed a close-to-perfect negative correlation, only results for Maintaining Attention were reported.

Inter-rater reliabilities between the different rater pairs were high for all of the scales. Higher scores on Warm Sensitivity in Session A were associated with higher scores on Warm Sensitivity in Session B, indicating satisfactory test-retest reliabilities and high relative stabilities of the construct. The same result was found for the three subscales of Warm Sensitivity, Warm Concern, Positive Affect, and Social Responsiveness. Test-retest correlations for the total scale and the three subscales ranged from $r = .75$ to $r = .90$, with a median value of $r = .85$. Thus, interindividual differences in mother's interaction behavior on the dimension of Warm Sensitivity could be reliably assessed and showed a substantial degree of short-term relative stability over a period of ten days. Furthermore, Maintaining Attention in Session A was reliably correlated with Maintaining Attention in Session B (for the FP condition, $r = .67$; for the FPT condition, $r = .40$). Overall, the MAAS showed moderate to high test-retest reliabilities, and, by implication, relative stabilities.

With respect to relations between Warm Sensitivity and Maintaining Attention, we could not replicate earlier results by Legerstee and Varghese (2001; Varghese, 1999), as Maintaining Attention and Warm Sensitivity did not correlate significantly in the present study. In contrast, Legerstee and Varghese found a positive correlation between Maintaining Attention and Warm Sensitivity and accordingly a negative correlation between Redirecting Attention and Warm Sensitivity. It is likely that the instructions and the experimental setup reinforced maternal attention behavior, as mothers were explicitly instructed to interact with their children. For the same reason, Maintaining Attention and Redirecting Attention were ipsatively related in this sample, showing a negative correlation that did not differ from $r = -1$. With different experimental procedures (e.g., longer sequences) and other experimental settings (e.g., observations at home) that allow for longer stretches of no attention on the part of the mother, the ipsative relation may be attenuated so that the two constructs could vary more independently.

Average levels of Maintaining Attention behavior were lower in the FP than in the FPT condition. The observed difference may be due to one or more of several factors that might have been confounded in this study. First, mothers were aware of being recorded in the FPT condition but learned only afterwards that they had also been recorded in the FP condition. Therefore, they may have felt more social pressure to display highly attuned behavior during the FPT condition than during the FP condition. Second, the FP condition always preceded the FPT condition, so the observed difference may also reflect increasing familiarity with the experimental setup. Third, the presence of an object that is of interest to the child may create less need to redirect attention, as the child's positive affective state is easily maintained when the mother shares the child's interest in the toy.

At the same time, test-retest correlations within and across the FP and FPT settings did not differ reliably from each other (Table 4). In other words, mothers' affect attunement in the FP condition predicted mothers' affect attunement in the FP condition assessed one to ten days later about as well as their attunement in the FPT condition, and vice versa. Thus, individual differences on MAAS were consistent across the two conditions.

A closer look at the episodes in which mothers attempted to redirect the attention of their children evokes the question whether it may be useful to distinguish between "supportive" and "intrusive" forms of redirecting attention, for example. Supportive redirecting would refer to attempts to calm the child or distract it after a frustrating event. Intrusive redirecting would refer to instances in which the child's actions are being disrupted. Examples of either way of Redirecting Attention were frequently found in the present study. This idea is supported by a notion of Stern (1985) who put forward the concept of misattunements. He referred to misattunements as maternal attempts to attune to the child but without achieving a good match. Within this concept he specified "successful" misattunements, which include a successful altering of the infant's behavior in direction of the mother that may correspond to the present idea of a "supportive" form of Redirecting Attention. Future coding schemes aimed at capturing the functional valence of redirecting attention should incorporate these distinctions and relate them to infants' behavior, as they might have different developmental antecedents, correlates, and consequences. Finally, one could think of a "neglecting" form of redirecting attention that points to maternal efforts to redirect the infant's attention away from her. In this particular experimental setting, this kind of redirecting might be especially present in interactions within clinical or subclinical populations.

In post-hoc exploratory analyses restricted to the first session, we also found that younger mothers maintained attention for longer periods of time, which is in line with Holditch-Davis, Schwartz, Black, and Scher (2007), who found that maternal positive involvement behaviors in interactions decreased with maternal age. Furthermore, mothers of children with lower birth weight showed higher degrees of Warm Sensitivity, which may reflect differences in mothers' perceptions of need for care. This result replicates earlier findings by DeWitt and colleagues (1997). However, the results of the previous studies are quite inconsistent and findings are contradictory. Most of these compared infants with very low birth weight with children with normal birth weight, while the present study excluded infants with a birth weight less than 2600g in advance.

In sum, this study describes two standardized experimental procedures to observe and assess maternal affect attunement in infancy. First, one may record mother and child in a face-to-face situation without any toy (FP condition). Second, one may introduce an age-appropriate toy that is likely to evoke the child's interest (FPT condition). In either case, three minutes of interaction are used for coding maternal affect attunement. In the present sample we found high levels of inter-rater agreement for Maintaining Attention and the three Warm Sensitivity subscales, Positive Affect, Social Responsiveness, and Warm Concern. The three subscales were highly correlated and can be combined into an aggregate score of Warm Sensitivity. In contrast, correlations between Warm Sensitivity and Maintaining Attention were generally low. Therefore, we recommend that the two constructs, Warm Sensitivity and Maintaining Attention, are kept separate, as they may indicate different dimensions of interaction quality. Finally, scale reliabilities and construct stabilities as estimated by test-retest correlations were satisfactory throughout. Overall, the present version of the MAAS

reliably captures individual differences in mothers' degrees of affective attuning in a laboratory setup. Note, however, that reliable use of the coding scheme requires an in-depth training period of about two to three weeks.

In comparison to the AAP by Haft and Slade (1989), the MAAS tries to overcome conceptual problems of the first approach by including maternal misattuning behavior, implemented in the subscale Redirecting Attention. As opposed to the AAP, the MAAS coding of the degree of maternal affect attunement is based on short recorded standardized face-to-face interactions of mother and infant in the laboratory. This procedure makes it possible to assess the degree of maternal affect attunement next to other data within one session, which is especially valuable when conducting research with very young infants. Nevertheless direct comparisons between this standardized approach and approaches studying maternal affect attunement in natural home settings are lacking and should be addressed by prospective research. Furthermore, in the MAAS the entire three-minute sequence is coded whereas the AAP proposes to code only events that match in terms of modality, intensity, rhythm, shape, and duration of mother and infant interaction. The latter procedure might already in advance cause selection errors. Besides, in contrast to the study by Haft and Slade (1989), the present study included a larger and more homogenous sample in terms of age.

A limitation of the proposed coding scheme is that the infant behavior is not assessed and therefore the number of opportunities that the infant provided for the mother to show certain types of behavior was not controlled for. Jonsson and Clinton (2006) identified six clusters of infant behavior that particularly elicited attunement behavior in mothers (e.g., pleasurable motoric behavior, displeasure, etc.). In order to find out how the degree of maternal affect attunement established with the MAAS relates to the infant's behavior within this very short and standardized sequence, future research should assess the infant's behavior as well. Finally, a constraint of this study is the restricted age group of seven months. As a next step, the age range for which the MAAS coding scheme yields a reliable index of individual differences in maternal affect attunement needs to be explored. To the extent that the present coding scheme may be applicable to a wider age range in infancy, it could form the basis for longitudinal studies on the development of maternal affect attunement. This will help to elucidate the stability of individual differences in maternal affect attunement over longer periods of time, and the importance of it for the child's social, affective, and cognitive development. For instance one could imagine using the MAAS to study the influence of the degree of maternal affect attunement on the infant's social interaction behavior.

In sum, this study shows that, as well as displaying high inter-rater agreement for all scales, scale reliability and construct stabilities of the MAAS are very satisfactory. The present work underlines the importance of conducting experimental research to systematically validate a measure to study maternal affect attunement before focusing on its implications.

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Maternal Affect Attunement

A Refined Coding Scheme

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Coding Maternal Affect Attunement: Maintaining Attention

	Definition	Examples	Analyses
Maintaining Attention (MA)	Coded whenever *mother follows or maintains infant's focus of attention* by making a verbal or nonverbal remark about the infant's object of attention. Coded when a *maternal comment, request, or question relates to or elaborates on the activity the infant is currently engaged in visually or physically.* The *mother must be engaged with the child* in order to be coded as MA. There are instances where the mother looks on as the child plays which are still coded as MA, *as long as the mother does not have a glazed look on her face.*	Infant looks at a particular toy and the mother asks, "Would you like that toy over there?" → MA is coded from the second the mother glanced at the object until either partner shifts attention Child looks away but mother follows gaze or continues looking at the child (not following the gaze) but being engaged → Code MA Mother picks up the toy in order to continue playing with it; she continues focusing on the child right after picking up the toy → Continue coding MA While the mother starts a new game, the child's focus of attention remains with the mother or shared object of attention → Code MA Child cries and mother takes it out of the seat in order to calm it → Code MA Mother changes the focus of attention for less than two seconds → Code MA	Coded on a frame-by-frame basis MA has to last for at least two seconds in order to be coded. Each time the child changes attention, pause and see what the mother is doing Whenever a mother stops MA for more than two seconds (either redirecting attention [RA] or attending to something else), there should be an empty space in the MA column For analyses: The duration of MA over time is calculated

Coding Maternal Affect Attunement: Redirecting Attention

	Definition	Examples	Analyses
Redirecting Attention (RA)	*Mother induces* infant to change focus of attention by making comments, suggestions, or requests. RA is coded when the *child's focus of attention is changed directly or the mother tries to change its focus of attention.* RA is coded when the maternal request *is rather demanding and leaves less choice* for the infant. RA can be *verbal* (e.g., "Look up at mommy!") *or nonverbal* (e.g., clapping hands to make infant look up)	Mother calms the child by distracting it → Code RA Mother initiates new play as the child starts to get bored/to distract child from crying → Code RA Mother picks up the toy in order to RA (e.g., child cries) and then continues to look at the child and play with the toy → Code RA Mother tries to RA but child does not change focus of attention → Code RA from second mother starts RA until she stops (Attempt has to last for at least two seconds → otherwise code MA) Mother initiates a new game although the child seems content with the current focus of attention → Code RA	Coded on a frame-by-frame basis RA has to last for at least two seconds in order to be coded. RA can be a supportive/ encouraging as well as intrusive behavior Whenever a mother stops RA for more than 2 seconds (either by MA or by attending to something else), there should be an empty space in the RA column For analyses: The duration of RA over time is calculated MA and RA are mutually exclusive

Coding Maternal Affect Attunement: Warm Sensitivity

Positive Affect	**Def.**	**The intensity and duration of the mother's affective behavior (e.g., smiles), tone of voice, amount of physical affection, and use of affective words (e.g., "Are you happy?")**	
	Characteristics	Mother expresses warmth and emotional openness throughout the interaction. Positive affect is expressed by *relaxed body posture, warm tone of voice*, frequent smiles and laughter, and happy facial expressions. Mother uses *appropriate tone of voice* and level of repetition to *match the child's age and linguistic capacity*. Mother employs "motherese" (high pitched repetitive vocalizations, "infant talk") for infants in the first 6–9 months of life. Mother changes her *emotional expression in accordance with the child's activity, condition, and emotionality*.	
	Code Def.	**1**	Very little or no parental positive affect is expressed throughout the interaction. Very little or no smiling is observed. No or few modulations are observed in the mother's affective intensity. The range of affect is limited and unsynchronized with modulations in the infant's state.
		2	Positive affect is expressed less than half of the time of the interaction. Mother may smile infrequently, and her voice may be unadapted to the child's developmental level or behavioral state most of the time.
		3	Positive affect is expressed irregularly but at least half of the time. Mother's voice is relatively warm and variable but may often be unadapted to the child's developmental level (e.g., adult speech to an infant) or behavioral state (e.g., warm, loud speech to a tired infant). Mother shows medium intensity of smiling and shows moderate modulations in her affect.
		4	Mother is positive most of the time (smiles frequently and uses a warm and age-appropriate voice) and is warm to the child. Nevertheless, one can imagine a more optimal state of positive affect towards the child. Mother may not express optimal range of affect.
		5	Mother is consistently positive and warm towards the child. Maternal vocalization is warm, appropriate, and adapted to the child's age and state. Mother may smile with great intensity and possibly laugh. Mother expresses a large range of affect and fitting levels of arousal in response to the child's communicative signals.
Warm Concern	**Def.**	**Mother's acceptance of the infant's activities, gentleness during play, and concern for comfort and safety (e.g., "Are you okay?")**	
	Characteristics	Degree to which the mother's presence as a whole provides a "*secure base*" for the child in terms of warmth, security, closeness, and empathy. The *mother's response* to the child is *appropriate, receptive*, and provides an *external regulatory framework* to the child's activities and emotions. Mother *touches the child affectionately* and spontaneously. Mother and child remain in *close proximity* (within arms' reach) throughout the observation. Touch expresses warmth and love and includes kissing, hugging, fondling, loving pokes, caressing, etc. <u>Important:</u> Do not include touch that aims to get the child's attention or instrumental touch (e.g., shifting the child in its seat; cleaning its mouth).	
	Code Def.	**1**	Mother's presence does not provide a "secure base". Mother and infant are not in close proximity and non-instrumental touch is not observed (e.g., child may remain disorganized and uninvolved).

		2	Mother may try to provide a "secure base" for the child (e.g., she tries to touch the child affectionately), but this state is not achieved. Child may feel uncomfortable and mother cannot comfort the child. No or little non-instrumental touch is observed.
		3	There are indications that the maternal presence may have a "secure base" function, but this is not observed consistently. Mother may touch the child infrequently.
		4	Little less than the highest level of warm concern is achieved. Mother's presence may provide an overall structure for the child, but, e.g., overt affection and warmth may not be so obvious or genuine. Mother may touch her child affectionately.
		5	Maternal presence provides an overall structure for the child that regulates the child's states, affect, interest, learning, and emerging social skills. She clearly provides a "secure base" for the child. Mother and child remain in close proximity and mother may touch the child often with overt affection and warmth.
Social Responsiveness	**Def.**	**Mother's contingent and imitative responses to their infant's positive behavior and vocalizations (including promptness and appropriateness of reaction), as well as modulation of any negative infant behavior or vocalizations**	
	Characteristics	Mother demonstrates through vocalization, gaze, facial expressions, and body movements that she is *aware of the infant's social signals* and is *receptive to the communication*. For instance, during a dyadic activity the baby begins to look at something else and the mother follows his/her gaze, asking, "Are you looking at …? Do you like it?" Or the infant changes facial expression to a brighter, more greeting expression and the parent responds using "motherese" vocalization (baby talk). Or the infant shows signs of fatigue or loss of interest and the mother responds by reducing the level of activity. Look at the mother's *response to the child's social initiations*. Mother may *imitate* the child's actions, facial expressions, body movements or vocalizations. Furthermore, the mother expands and *elaborates* the imitated actions by adding variations and by increasing the level of complexity of the child's communicative message (e.g., the infant may utter "Ba" and the mother responds by "Ba ba bu," changing posture and expression and adding something like, "Now you are telling me how much you like that game"). *Praising* may be part of a highly socially responsive mother's repertoire. <u>Important:</u> (a) The mother does not need to respond in the same modality as the child's signals (e.g., the child vocalizes and the parent responds by changing expression and body posture). (b) The mother may add interpretations to the child's actions.	
	Code Def.	**1**	Mother does not show any awareness or response to the child's social signals. No imitation and elaboration is observed. Mother constantly interrupts child, e.g., by introducing new games even though the child seems happy with current activity. No praising at all may be observed.
		2	Little responsiveness of the mother is observed. Mother may overlook many of the child's signals and use only one or two instances of imitation or elaboration. Little or no praising may be observed. Mother may overstimulate the child and he/she may seem uncomfortable.

		3	Medium level of social responsiveness is observed. Some of the infant's signals are recognized, while others may be overlooked. Imitation may be part of a give-and-take interaction but it is not very frequent or consistent. Few instances of maternal expansion may show that elaboration is within the mother's repertoire. A medium level of praising may be observed. Mother may exaggerate playing with the child and the child may have no room to explore the world on its own. Mother may over-stimulate the child, but child seems comfortable.
		4	Mother is responsive to the child's signals in a non-intrusive and sensitive manner most of the time. She may elaborate, imitate, and praise frequently but not consistently. Mother may seem to overstimulate the child, but child is happy and may start to cry every time the mother stops.
		5	Mother is consistently responsive to the child's signals. Mother is able to transmit her responsiveness to the child in a non-intrusive, sensitive manner. Mother may imitate the infant's actions frequently throughout the interaction. By using elaboration the mother may raise the level of the child's interest in the joint activity. Mother may let the child explore while ensuring that the child is fine. Mother may praise her child frequently. In some cases, mother may frequently introduce modulations in the interaction if she thereby modulates the child's negative behavior and vocalizations successfully.