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Parental embodied mentalizing: how the nonverbal dance between parents and infants predicts children's socio-emotional functioning

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ABSTRACT

Parental mentalizing – the parent's ability to envision the child's mental states (such as desires, thoughts, or wishes) – has been argued to underlie a parent's ability to respond sensitively to their child's emotional needs, and thereby promote advantageous cognitive and socio-emotional development. Mentalizing is typically operationalized in terms of how parents *talk* to or about their infants. This work extends research on mentalizing by operationalizing parental mentalizing exclusively in terms of nonverbal, bodily based, interactive behavior, namely *parental embodied mentalizing*(PEM). The purpose of the current research was twofold: (1) to establish the reliability and validity of the PEM coding system; and (2) to evaluate whether such measurement predicts infant and child cognitive and socio-emotional functioning. Assessing 200 mother–infant dyads at 6 months using the coding of PEM proved both reliable and valid, including predicting child attachment security at 15 and 36 months, and language abilities, academic skills, behavior problems, and social competence at 54 months, in many cases even after taking into consideration traditional measures of parenting, namely maternal sensitivity. Conceptual, empirical, and clinical implications are discussed.

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Mentalizing; parent–infant; nonverbal; maternal sensitivity; attachment security; externalizing

Introduction

> It is through my body that I understand people.
>
> – Merleau-Ponty (1962, p. 186)

Students of child development have long sought to illuminate whether and how parent–infant relational processes shape human development. Toward this end, much attention has been devoted over the past two decades to *parental mentalizing* – the parent's ability to envision the child's mental states (such as desires, thoughts, or wishes) and to *conceive* of the child as a psychological agent whose behavior and actions are motivated by these mental states (e.g., Fonagy & Target, 1997; Shai & Belsky, 2011a; Slade, 2005). A mentalizing parent appreciates that the child's mind is separate and that both parties' minds and actions reciprocally influence one another (Slade, Grienenberger, Bernbach, Levy, & Locker, 2005).

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Developmentalists studying mentalizing theorize that it underlies a parent's ability to respond openly and sensitively to the child's emotional needs, and thereby regulate development, including attachment security. In terms of Belsky's (1984, Belsky & Jaffee, 2006) model of the determinants of parenting, mentalizing can thus be conceptualized as a characteristic of the parent that influences the quality of parenting and ultimately the child's development. Here we (1) introduce a new, *nonverbal* means of measuring parental mentalizing during the course of parent–infant interaction; (2) examine its association with a variety of factors conceptualized as determinants of parenting (e.g., parental education, marital status); and (3) evaluate the extent to which it predicts a variety of features of child functioning just before the transition to school, drawing on data from the NICHD Study of Early Child Care and Youth Development (NICHD Early Child Care Network, 2005).[1] With regard to the last goal outlined, the issue we specifically address is whether this new, nonverbal approach to measuring parental mentalizing adds prediction of child functioning *over and above* that of a well-established measure of maternal sensitivity.

Assessing parental mentalizing

Aiming to capture parents' capacity to envision the child in terms of mental states – what we refer here as parental mentalizing – researchers have developed three main measures, each pertaining to different aspects of parental mentalizing. Despite having unique properties, each operationalization of mentalizing relies exclusively on what parents *say* to the child during the course of their interactions or about the child when interviewed. The first measure, *parental reflective functioning* (PRF), refers to parents'capacity to (1) envision and make sense of their own and their child's mental states (i.e., intentions, feelings, thoughts, desires, and beliefs); (2) appreciate reciprocally influential, dyadic processes; and (c) anticipate one ' s own or another's actions (Slade, 2007). Measurement of PRF is based on what parents say during the parental development interview (PDI; Phelps, Belsky, & Crnic, 1998; Slade, Aber, Berger, Bresgi, & Kaplan, 2004). Recently, a questionnaire measuring PRF has been developed and is showing promising results (e.g., Rutherford, Goldberg, Luyten, Bridgett, & Mayes, 2013).

The second measure – of *insightfulness* – also pertains to parents' "capacity to consider the motives underlying their children's behaviors and emotional experiences in a complete, positive, and child-focused manner while taking into consideration the child's perspectives" (Koren-Karie, Oppenheim, Dolev, Sher, & Etzion-Carasso, 2002, p. 534). Once again, parents' verbal responses during the course of an interview are used to operationalize insightfulness, although this time parents reflect on their child's thoughts and behavior while reviewing a video recording of their parent–child interaction.

The third measure – of *mind-mindedness* (MM) – refers to the parent's proclivity to treat the child as an individual with a mind, rather than merely as an entity with physical needs that must be met (Meins, 1999). The assessment of MM takes into account the accuracy of parental interpretation of the infant's mental states; thus, mind-related comments are classified as either appropriate or nonattuned to the child's current state, such that the parent's mentalizing capacity is based, at least partially, on the degree to which the parental response meets the child's current state (Meins, Fernyhough, Arnott, Turner, & Leekam, 2011; Meins et al., 2003, 2012). MM differs from

insightfulness and PRF in that its assessment is based on comments made by the parent *during the course of ongoing mother–infant interactions* that reference the infant's putative internal state, thereby affording "online" assessment of parental mentalizing.

Effects of mentalizing

Parental mentalizing is presumed to shape parenting: "The parent's capacity to observe the moment to moment changes in the child's mental state … lies at the root of sensitive caregiving" (Fonagy & Target, 1997, p. 691; see also; Meins, 1999 and Slade, 2002). In light of theory and evidence that maternal sensitivity influences the development of attachment security (for review, see Belsky & Fearon, 2008), it should not be surprising that so does parental mentalizing (Arnott & Meins, 2007; Lundy, 2003; Meins, Fernyhough, Fradley, & Tuckey, 2001; Slade et al., 2005). In fact, in some cases it does so over and above traditional measures of maternal care, including of maternal sensitivity (Kelly, Slade, & Grienenberger, 2005; Koren-Karie et al., 2002; Laranjo, Bernier, & Meins, 2008; Meins et al., 2001). But just like maternal sensitivity, it is not just attachment security that mentalizing predicts. Evidence indicates that children whose mothers evince greater mentalizing capacities themselves experience less psychological stress, greater physiological regulatory abilities, better peer relations, reduced likelihood of conduct problems, and reduced risk of psychopathology (Gottman, Katz, & Hooven, 1996; Ha, Sharp, & Goodyer, 2011; Katz & Windecker-Nelson, 2004; Sharp, Fonagy, & Goodyer, 2006).

Limitations of current approaches to mentalizing

The research just summarized clearly indicates that available approaches to measuring mentalizing are valid. But this is not to say they are without limits, both in terms of coneptualizing, and consequently, measuring, this important developmental construct. It is our contention that all three approaches highlighted earlier afford a limited account of how preverbal infants' experience their relationship with their parents and of how parental mentalizing comes to affect child development. Current approaches also fail to consider sufficiently the bidirectional, reciprocal nature of parental mentalizing and child behavior. Finally, mentalizing, as currently assessed generally fails to consider how, during parent–infant interaction, mentalizing capacities are linked to observed behavior. In light of these claims, the work presented herein advances an additional approach to measuring mentalizing – parental embodied mentalizing (PEM; Shai & Belsky, 2011a) – one that addresses these limitations. PEM can be considered as the nonverbal dance – body-based exchanges – that the parent and the infant engage in during the course of social interaction. Before delineating the PEM approach in detail, we address how it addresses each of the limitations of current approaches already highlighted.

To begin with, we need to note, perhaps surprisingly, that all the aforementioned mentalizing assessments (i.e., reflective functioning, MM, or insightfulness) are based on the *semantic content of verbal behavior* – even in the case of nonverbal infants. But as Gallese (2006, p. 16, italics added) insightfully observed:

> Social cognition is not only "social metacognition", that is, explicitly thinking about the contents of someone else's mind by means of abstract representations. There is also an *experiential* dimension of interpersonal relationships, which enables a direct grasping of the sense of the *actions* performed by others, and of the emotions, and *sensations* they experience. This dimension of social cognition is *embodied* in that it mediates between the multimodal experiential knowledge we hold of our lived body and the experience we make of others.

In other words, because current approaches assessing mentalizing are based on language and, in the case of interviews, necessitate explicit reflection and abstract mental representations, they would seem limited in their ability to illuminate *how* this psychological capacity of parents – manifested in spoken language – actually shapes the mind of the *preverbal* infant, as it is theorized to do (e.g., Fonagy & Target, 1997; Slade, 2005). Thus, current approaches fall short in explaining how parental mentalizing is *experienced* by the preverbal infant so as to affect its development (Shai & Belsky, 2011a). This analysis leads to the claim that more attention must be paid in mentalizing research to the infant's perspective when engaged in social interaction; and this claim leads to belief that more attention must be paid, especially in the case of preverbal infants, to nonverbal interactive processes.

There is also a need to appreciate the apparent inconsistency between the concept of mentalizing and its measurement. Slade (2009, p. 11) states that "mentalization is not simply unidirectional but also rather an inherently, reciprocal, dynamic, and mutually rewarding process." After all, without such consideration, how does one come to see the infant as someone with a mind? Nevertheless, two of the three current approaches to measuring parental mentalizing, insightfulness and PRF, fail to take into account the infant's behavior or how the mother modifies her behavior in response to the infant's actions. Consider, for example, the way PRF is evaluated; when a mother is able to demonstrate reflectiveness regarding her mind or that of her infant *in an interview*, she is rated high on mentalizing. In consequence, the infant's behavior and mental world are present only in a mediated form, through the mother's eyes and mind, thereby being vulnerable to biased and inaccurate interpretations. The infant, as a separate subjective being, is absent from such parental-mentalizing measurements, affording them an essentially individualistic perspective (de Jaegher & Di Paolo, 2007).

The final limitation to be considered pertains to the fact that verbal assessments of parental mentalizing give insufficient attention to its impact on behavior. Perhaps the best evidence of this comes from the underappreciated observation that individuals with antisocial personality disorder and psychopathy do *not* exhibit significant deficits in mentalizing, even though these attributes undermine the supportiveness of care provided to the child (Belsky & Jaffee, 2006). The deficits these individuals have are related more to their lack of concern about the impact on potential victims than the inability to take a victim perspective (Decety, Chen, Harenski, & Kiehl, 2013; Dolan & Fullam, 2004), and to the limited generalizability to complex interpersonal situations (Bateman & Fonagy, 2006). Despite being pivotal to consider how mentalizing impacts behavior, current measures do not capture this ecological, real-life value of mentalizing, and more specifically, do not evaluate parental mentalizing in terms of the parent's ability to change her behavior as a result of the mental state the infant is exhibiting nonverbally.

Note that mentalizing does not imply being able to read the minds of others. Instead, advanced mentalizing involves the acknowledgment of the opacity of minds and thus the fundamental impossibility of knowing the mental states of others with certainty, resulting in understanding misunderstandings (Bateman & Fonagy, 2012). Accordingly, people high in mentalizing are speculated to be more likely to repair interactive repairs (Benjamin, 2003; Skowron, Kozlowski, & Pincus, 2010; Tronick, 1989) as they are able to appreciate that their own mental states might conflict with those of the other, and thus try modifying the interactive process. Unfortunately, what we believe to be a central component of mentalizing – the parent's ability to amend interactive ruptures – is not captured in existing measurements of parental mentalizing.

In light of the above, the central question that arises, and which this work addresses, is whether the parent's ability to take the child's perspective and appreciate him or her as a psychological agent can be systematically assessed solely through reliance on verbal, reflective procedures. We think not and thus have developed a measurement approach that relies exclusively on nonverbal behavior – that is, movement – during mother–infant interaction. In this report, we describe it and provide the first evidence documenting its validity. Such a focus is consistent with the views of mentalizing theorists who conceptualize mentalizing as a multifaceted, psychological capacity, one that has verbal and nonverbal, symbolic and behavioral, as well as implicit and explicit aspects (e.g., Fonagy & Luyten, 2009; Slade, 2005), in which "the caregiver's recognition of the child's intentional stance … is communicated nonverbally, beginning at birth" (Fonagy & Target, 1997, p. 682).

Beyond words

Central to PEM is the theoretical claim that the movement of the entire body conveys information about the contents of our minds. For this reason, PEM focuses on analysis of the parent's and the infant's bodily movements during social interaction, that is, movements of the entire body and all its parts, including limbs, torso, *and* head. Such an approach not only complements, then, the three current, verbally based, approaches to measuring parental mentalizing, but also the "head-centric" focus – on head, gaze, or vocal exchanges – of other strategies for characterizing parent–infant interaction that have proven developmentally informative (see Beebe, 2000; Beebe et al., 2011; Boone & Cunningham, 1998; Gergely & Watson, 1996; Kaye & Fogel, 1980).

The empirical dominance of head-centric approaches seems limited in light of psychological and neuroscientific work showing that kinesthetic patterns consistently convey distinct mental states (Atkinson, Tunstall, & Dittrich, 2007; Clarke, Bradshaw, Field, Hampson, & Rose, 2005; Crane & Gross, 2007; de Gelder et al., 2010; Dittrich, Troscianko, Lea, & Morgan, 1996). In fact, it is well established that certain movement qualities are associated with the expression and interpretation of specific emotions. Thus, movements that convey joy, sadness, or anger vary in their velocity, acceleration, and displacement (Boone & Cunningham, 1998; Hertenstein, Holmes, McCullough, & Keltner, 2009; Pollick, Paterson, Bruderlin, & Sanford, 2001). Variation in such movement parameters predict the ability of observers to distinguish between types of emotional expression (Sawada, Suda, & Ishii, 2003). Moreover, neuroimaging studies show that neural networks involved in emotional processing of facial expressions play an

important role in recognizing whole-body expressions of emotion – even when the face is completely blurred (for a review, see de Gelder et al., 2010).

Importantly, studies of infants (Stack & Muir, 1992), children (Boone & Cunningham, 1998), and adults (Montepare, Goldstein, & Clausen, 1987) from a variety of cultures (Hertenstein et al., 2009) make clear that they are sensitive to specific qualities of movement as reflections of specific emotions. Just as importantly, there is evidence that patterns of infant bodily movements influence parent–infant interactions, even independent of head-centric communicative ones such as facial expressions (e.g., Fraiberg, 1979; Stack & Muir, 1992).

In light of these observations and in accordance with Stern's (1985, 2010) notion of vitality forms, the assessment of PEM as outlined herein considers not so much *what*, but rather *how* the movements of one party impact those of the other. Presumably, such a focus can illuminate the interface between the affective and cognitive style of actions within the realm of relational experience (Di Cesare, Di Dio, Marchi, & Rizzolatti, 2015; Di Cesare et al., 2013; Shai & Belsky, 2011a; Shai & Fonagy, 2014). Indeed, the coding of PEM draws on dance theory and movement analysis paradigms (Kestenberg-Amighi, Loman, Lewis, & Sossin, 1999; Laban, 1960; Tortora, 2006), so that movements of both the parent and the infant are examined closely in terms of the *movement patterns* that are displayed (i.e., tempo, use of space, direction of movement in space, muscle tone, and pacing of movement) and the degree to which the parent is able to infer the infant's mental states from movement to adjust her own movement accordingly (Shai, 2010; Shai & Belsky, 2011a, 2011b; Shai & Fonagy, 2014).

Importantly, because the assessment of PEM focuses on dynamic communicative body movements, other forms of nonverbal communication, such as gaze patterns of facial expressions, are excluded from the PEM coding scheme. As stated earlier, previous work has successfully established the usefulness of investigating facial and vocal patterns to shed light on the parent–infant relationship (e.g., Beebe et al., 2011; Malloch, 1999). The aim of the current undertaking is to evaluate whether whole-body movement – as a distinct communicative modality – conveys meaningful information about mental states and interpersonal interactive processes. Note that as adults we rely heavily on facial expressions and on vocal nuances to infer about the mental states of others and to modify our own behavior accordingly. A coding system that combines these very different communicative modalities of body, voice, and face might jeopardize the coders' ability to distinguish communicative signals coming from these different modalities, especially if these are contradictory, and put at risk the possibility of scrutinizing the specific role the whole body plays in the parent–infant dance. Noteworthy in this regard is neuroscientific evidence showing that the brain processes affective information coming from the face and the body differently and somewhat independently (Aviezer, Trope, & Todorov, 2012; Gliga & Dehaene-Lambertz, 2005; Grèzes, Pichon, & de Gelder, 2007; Kret, Pichon, Grèzes, & de Gelder, 2011; Pichon, de Gelder, & Grèzes, 2009; Thierry et al., 2006).

Although resonating with some important concepts such as attunement (Stern, 1985) or maternal sensitivity (de Wolff & van Ijzendoorn, 1997), PEM specifically taps into parents' ability to recognize and respond to the infant's mental states from the child's movement. Thus, the construct and the measurement of PEM do not attempt to capture parental ability to respond sensitively and in an attuned fashion to all of the infant's

needs and states, such as activity, arousal levels, or physical needs. Instead, the assessment of PEM seeks to capture only those interactive exchanges that involve the infant's mental states, namely being supported and held psychically, encouraged to explore, being aided in discovering and maintaining boundaries of the self, and ensuring smooth transitions between experiences and states of being.

In terms of assessing parental mentalizing from a dyadic perspective, note that when coding PEM, the unit of analysis is the dyad; rather than being assessed separately, both the parent and infant's bodily movements – in relation to one another – become the targets of measurement. Specifically, and as shell be seen, the unit of analysis is an embodied communicative chain, a micro embodied narrative, where the focus is not so much on who did what, but on how one responded to the other. This approach affords a truly dyadic and relational approach, where the meaning of one's actions is evaluated only in relation to those of another.

Noteworthy is that this dyadic approach assesses the mother's capacity to mentalize the infant and to modify her movements accordingly. Thus, the PEM coding scheme affords an assessment of a *parental* capacity rather than of a *dyadic* quality, which is captured effectively by other measurements such as synchrony (Feldman, 2012) or attunement (Stern, 1985). Moreover, such concepts seem to concentrate on the degree to which the interactive dance is mutual, enjoyable, or smooth. The focus when assessing PEM, in contrast, is less on how smooth the dance was, and more on how quickly the parent is able to repair the dance once some toes have been stepped on.

This leads to the third limitation current measures of parental mentalizing have and which the assessment of PEM addresses: the necessity to evaluate the impact of mentalizing on behavior. We attest that mentalizing cannot truly be assessed separately or while overlooking its impact on behavior. As a consequence, a parent's ability to repair dyadic miscoordination, or ruptures, is weighed heavily when measuring PEM. Specifically, the assessment of PEM, at least when it concerns differentiating between either very high or very low PEM capacities, centers on the parent's ability to *repair* interactive, dyadic ruptures. It is true that all parents do not always or automatically know what needs or desires the infant is expressing; but those with high PEM capabilities prove capable of modifying their own kinesthetic patterns in response to their failures so that they respond more accurately to the infant's nonverbally manifested mental state. In contrast, parents with poor PEM capabilities are less likely to make appropriate kinesthetic modifications and fail to detect or misinterpret the infant's kinesthetically manifested mental states, resulting in responding to them in ways that contradict the infant's mental state.

Current study

The aim of the current study is to determine (1) whether PEM can be assessed reliably during the course of parent–infant interactions – in which the sound is turned off – by trained coders who focus on bodily movements, but not the head; and (2) whether PEM assessments prove valid in terms of being related in anticipated ways to (a) hypothesized determinants of parenting, including maternal age, education, socioeconomic status (SES), stress, marital status, and sensitive-responsive parenting, but not infant

birth order and temperament; and (b) developmental sequelae, especially once maternal sensitivity is taken into account.

The predicted associations between PEM and selected determinants of parenting are based on conceptual and empirical data showing that the more a mother experiences being supported (marital status, SES, stress), and the more she is engaged in parenting (age, education), the more sensitive and mind-minded she will be to her child's emotional needs (Meins et al., 2011). In contrast, and based on data suggesting that mentalizing is more of a trait than a state (Arnott & Meins, 2008; Fonagy, Steele, Steele, Moran, & Higgitt, 1991), we predict that PEM is less influenced by the mother's prior experience with other children (i.e., birth order). Since PEM coding essentially focuses the mother's ability to adapt herself to the infant's mental states, no matter what their valence or intensity, we hypothesize that it would be less susceptible to the child's temperament.

With regard to the latter predictions, we specifically target diverse "outcome" measurements made in infancy (i.e., attachment security) and around the transition to school, with the latter focused on problematic functioning (e.g., internalizing/externalizing problems), behavioral competencies (e.g., social skills, peer relations), and cognitive performance (i.e., language ability, academic skills). We cast this wide a net when it comes to evaluating the predictive power of PEM because theory and evidence indicate that processes of parent–child interaction prove related to all these aspects of development, most notably in the data set that we draw upon (NICHD Early Child Care Research Network, 1997). Specifically, we hypothesize that mothers rating higher on PEM will have children who develop more competently, beginning in infancy and into childhood, and that this will be the case, at least in some cases, even after taking into consideration maternal sensitivity.

Method

Participants

Participants were 200 selected mother–infant dyads enrolled in the NICHD SECCYD; the NICHD SECCYD included 1,364 families reflecting the demographic diversity (economic, educational, and ethnic) of the catchment area at each site in the USA (for full details of the sample, see NICHD ECCRN, 2005). The sample of the current work was selected from among 1,168 mother–infant dyads that participated in videotaped mother-infant interactions at both 6 months and15 months, and the Strange Situation at 15 months. From the 1,168 dyads meeting these multiple criteria, 200 *random* selections were carried out so that we could implement a quasi-experimental design involving an equal number of children (i.e., 50) previously classified as secure, avoidant, resistant, or disorganized in their 15-month attachment to their mother.

As Table 1 shows, these strategically sampled dyads included mothers who averaged in their late 20s in terms of age, had some college education, tended to be married or otherwise partnered, had incomes that were far above the poverty level, and had verbal IQs in the general population range. Almost half of the infants were girls and first-born. When the 200 randomly selected cases included in this report were compared to the remaining 968 cases, no significant differences emerged with regard to any of the measurements just mentioned.

Table 1. Demographic and background characteristics of analysis and comparison sample.

	NICHD sample			Analysis sample				
Variable	*N*	*M*	*SD*	*N*	*M*	*SD*	Statistic	*p*-Value
Child's sex	966			200			$\chi^2_{(1)} = 0.03$	0.87
Marital status	965			200			$\chi^2_{(1)} = 3.92$	0.69
Maternal age	966	28.45	5.51	200	28.9	5.62	$t_{(1164)} = -0.45$	0.29
Education	919	14.4	2.51	199	14.48	2.13	$t_{(1116)} = -0.08$	0.67
ITN ratio	958	3.6	3.19	200	3.57	2.95	$t_{(1156)} = 0.34$	0.89
Verbal IQ	905	99.24	18.07	192	100.39	18.58	$t_{(1095)} = -1.15$	0.43
Birth order	966	1.83	0.93	200	1.82	0.88	$t_{(1164)} = -0.01$	0.93

Measures

Parents and children participating in the NICHD SECCYD were assessed on numerous measures throughout the course of the study. We first report the measurements used to select the sample of 200 dyads (attachment security classification and Home Observation for Measurement of the Environment Inventory (HOME) maternal sensitivity), followed by a detailed account of the newly developed coding system of PEM, including its interrater reliability analyses. Next, we delineate the background variables conceptualized as potential determinants of parenting. Finally, the developmental outcomes examined in this work are delineated. With the exception of the measurements derived from the new coding system, additional details about all data collection procedures, psychometric properties of the instruments, and descriptions of how composites were derived and constructed can be found in the study's *Manuals of Operation and Instrument Documentation* (http://www.icpsr.umich.edu/icpsrweb/ICPSR/series/233).

Sample selection measures

As noted, the strategic selection of the 200 dyads was based on two separate measurements: 15-month attachment and HOME maternal sensitivity.

HOME maternal sensitivity. HOME (Caldwell & Bradley, 1984) combines a semi-structured interview conducted in the child's home with an observational component, thereby enabling the rating of maternal support, availability, and stimulation. Following the NICHD ECCRN (1997) procedure, a composite HOME sensitivity score assessed at 6 months was computed based on measures of positive maternal involvement (e.g., "parent's voice conveys positive feelings towards the child"; "parent caresses or kisses child at least once") and lack of negativity (e.g., "parent does not shout at child"; "parent is not hostile"). Previous extensive studies (see NICHD ECCRN, 1997) have found HOME maternal sensitivity (described above) to be the most robust predictor of children's development in the NICHD study, and thus was selected to assess maternal sensitivity in the current inquiry. Moreover, aiming to capture the longitudinal quality of maternal care, a composite of the mean HOME maternal sensitivity at 6 and 15 months was used in the current report.

PEM measure. The PEM coding system was developed for the purposes of the current study. Using the PEM coding system does not require any particular skills or experience. Learning and using the measurement of PEM involves undergoing a PEM training course and a reliability process led by the first author. The training takes place over four days,

during which the PEM coding scheme is studied and practiced. The training seminar also includes lengthy discussions focusing on applying PEM in research and clinical practice. Following the seminar, there is a series of five practice coding videos, on which the trainee receives close supervision and guidance. Thereafter, the trainee needs to complete independent coding of PEM on 10 additional videos and achieve an interrater reliability of 80% or more with the first author.[2]

The new measure of mentalizing was used on the first 10 min of the home-based videotapes of the dyads. Importantly, when PEM was coded, the sound was turned off so that the trained observers had only visual information on which to base their measurements. As aforementioned, one of the goals of the current investigation is to explore the unique role of the whole-body dynamic movement within the parent–infant exchange and to move beyond the head-centric scientific and cultural bias (Shai & Belsky, 2011a); therefore, verbal behavior, gaze patterns, and facial expressions are excluded from consideration. Coders are trained to direct their attention to the participants' bodies instead of faces, and videos are observed on mute mode. The recordings run at normal speed, although frequent pausing and frame-by-frame mode view are necessary for careful consideration of the interactive process.

Coding PEM proceeds in four stages. The first task is to identify the occurrence of PEM-related interactions. The second requires the coder to record a series of movement qualities of each PEM exchange so that a quality rating can be made of the overall interactive episode, with a particular emphasis on if and how disruptions of the "interactive dance" are mended. These separate ratings then serve as the basis for a more global PEM evaluation, which is the measurement subject to analysis in this report (see Appendix for a summary of the behaviors coders were trained to identify and evaluate).

Stage 1: identifying embodied circles of communication (ECC). This first stage of coding involves identifying the onset and termination time of ECC sequences, which are the analysis unit of the PEM system. An ECC is a nonverbal, movement-based, interactive communicative exchange between the parent and the infant, and can be thought of as a micro embodied narrative. Each ECC includes at least three consecutive bodily based action–reaction sequences. An ECC can be regarded as a body-based conversation, in which one party expresses kinesthetically her or his mental states, and the other party responds kinesthetically to these manifestations of mental states.

An example of an ECC is (1) the mother presents the infant with a rattle, using rapid and spread-out movements, and brings it very close to the infant's chest; (2) the infant moves back and shrinks his or her body toward its center; (3) the mother slows her movements' tempo, reduces their range, and withdraws the toy slightly away from the infant's chest; and (4) the infant reaches her hand out toward the rattle and moves her torso forward toward the object.

Note that not all interactive behaviors are coded; the PEM coding process focuses on only those communicative sequences in which the content of the mother or infant's mind is evident in the kinesthetic patterns. In the case of a playful interaction where the mother is expected to interact actively with her infant with no distraction, as in this study, most of the interaction is accounted for in terms of sequences of embodied exchanges of intentional mental states. However, moments that are not coded include

absence of interactive exchange between the parent and the infant, or functional interaction (e.g., wiping infant's face).

Identifying ECC events involves coders needing to recognize each step or turn of an ECC and thus its beginning and end. Identifying these temporal boundaries allows calculating the ECC length. Thus, we can determine the *number of ECC events* per 10-min video segment and their *mean length*, two of the PEM variables we used to establish interrater reliability.

Stage 2: delineating movement qualities. The second stage involves describing the kinesthetic sequence of each ECC in terms of movement qualities as a narrative of each segment, as exemplified above. Thus, each ECC is viewed through a kinesthetic lens so that every step comprising the ECC can be described using some, or all, of the following kinesthetic qualities: tempo, space, pathways, pacing, directionality, and tension flow. Note that while these components of each ECC are registered, they do not figure in the statistical analyses reported in the "Results" section. Essentially, considering the kinesthetic qualities serves to discipline the observer so that final, global PEM rating is based on careful observations.

Tempo refers to how fast or how slow the movement is, that is, its velocity. Sleeping states designate the low tempo extreme, whereas fast hand clapping is an example of very high tempo.

Space refers to the spatial location of the movement, when the individual's body is the point of reference. When coding PEM, a distinction is made between personal and interpersonal space. Personal space, otherwise known as kinesphere (Tortora, 2006) or orbit (Brown, Pipp, Martz, & Waring, 1993), is the personal three-dimensional sphere surrounding the body, the periphery of which is reachable by extending one's limbs, and can be thought of as a flexible bubble surrounding the person. It defines the personal boundaries of self and other (Tortora, 2006) and serves as a buffer zone surrounding the body (Knapp & Hall, 2006). Interpersonal space, on the other hand, is the interactive, changing spatial distances between two individuals in a given environment (Davis, 1975; Moore & Yamamoto, 1989; Scheflen & Ashcraft, 1976).[3]

Pathways. Concern goal-directed movements that cut through space and make intentional connections between the individual and an external object (Tortora, 2006). Pathways involve the imaginary line that movement creates in space, which can be straight, linear lines, as in a hand gesture drawing a triangular, or curvy, indirect, or rounded pathways, as in a hand gesture describing the movement of soap bubbles in the wind (North, 1971).

Pacing refers specifically to the velocity of alterations in movement. Pacing ranges from abrupt or jerky to gradual and sustained. In abrupt pacing, there is no clear sequence of fluent connections between movements (Davis, 1975) and is likely to produce a staccato-like sense of fragmentation and unpredictability. In gradual pacing, there is a clear sequence of fluid connection between movements that creates a sense of continuity and predictability.

Directionality concerns the growing or shrinking movement of bodily dimensions in relation to the body center and is associated with varying degrees of pleasure (Kestenberg-Amighi et al., 1999). Directionality defines the individual in relation to

his/her surrounding space (Kestenberg, 1985): growing movements create open bodily shapes as a result of moving away from the body's center, thus exposing the body to the environment; shrinking movements create closed bodily shapes as a result of moving toward the body's center, thus reducing exposure to the external world. An example of a growing movement would be extending the arms sideways to hug someone; a shrinking movement would be curling up when cold or scared.

Tension flow refers to the individual's muscular tone, and more specifically, to sequences of fluidity and restraint in the state of the muscles in various parts of the body. Tension flow involves alterations between free and bound movements (Kestenberg, 1975; Loman & Foley, 1996), reflecting the vitality and flexibility of the movement.

Stage 3: rating the quality of ECC events. Based on the careful observation and coding of kinesthetic qualities just outlined in stage 2, coders move on to rate the quality of each ECC event. An ordinal scale, with scores ranging from "very low" (1) to "very high" (9), is used to evaluate each ECC event in terms of the degree to which it reflects the parent's ability to modify his or her kinesthetic response in light of the infant's kinesthetically manifest mental state. Determining this score requires the observer to pay careful attention to (1) the ECC initiator; (2) whether the ECC was repetitive or evolved into an elaborate interactive sequence; (3) the clarity of the infant's kinesthetic mentalistic signaling; (4) the extent to which the movement was performed with the entire body, incorporating the torso and extremities in a congruent fashion, or executed only with the extremities, with the trunk and the extremities being fragmented or disjointed; and (4) the parent's ability to follow the infant's kinesthetically manifested mental state and lead it to completion without interruption.

Stage 4: rating a global PEM score. The fourth and final stage of coding PEM entails assigning a global PEM score, ranging from very low ("1") to very high ("9"). The PEM global rating is the parent's *overall*, typical, mentalizing capacity, considering all the individually rated ECC events of the dyadic interaction. As with individual ratings of each ECC, the global PEM rating reflects the degree to which the parent typically manifests – through his or her body movements – an acknowledgment of the infant's internal world and an ability to be responsive and thus modify his or her own kinesthetic patterns to better suit the infant's mental states.

Assigning a global PEM score uses the mean and the mode of the individual ECC scores as anchor points, but further consideration of elements capturing aspects of the interaction as a whole is needed in order to determine the final global score. These considerations are (1) interactive syntax – lowering a score in cases where individual ECCs receive a relatively high PEM rating, but the overall transition between one ECC to another is fast or disjointed. (2) Frequency of extremely low PEM manifestations – in cases where there is more than one ECC rated "1," the global PEM rating could not be higher than "3." (3) Dominance of premature termination of ECCs – cases where parents appear to intervene with the infant's activity before the infant shows signs of fatigue or desire to change activity. In such cases where parents seem unable to follow the infant's mental state to fruition, the global PEM score is lowered.

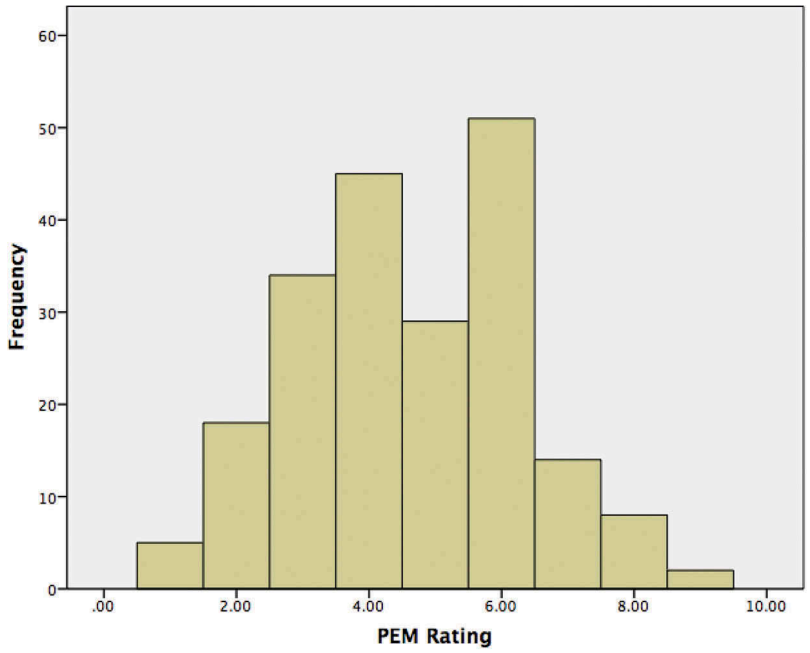

Figure 1. PEM rating distribution.

As shown in Figure 1, in the current study, PEM rating ranged between 1 and 9, with a mean of 4.63 and standard deviation of 1.72. PEM was normally distributed, with skewness of 0.06 (SE = 0.17) and kurtosis of –0.54 (SE = 0.34).

Reliability of PEM

Following extensive training with videotaped mother–infant dyads ($N = 44$) not included in the analysis sample ($N = 200$), we evaluated the inter-rater agreement (IRR) of three postgraduate coders using 44 analyses of sample tapes already scored by the first author, representing 22% of the entire research sample. Interrater reliability was calculated using a two-way random absolute agreement intraclass correlation coefficient model (Shrout & Fleiss, 1979). Details of the results of the reliability assessments are presented in Table 2.

Firstly, we examined whether coders identified the same *number of ECC events per tape* (44 tapes altogether) as the first author. Correlations ranged from 0.77 to 0.97 ($p < 0.01$), with a mean of 0.92. Examining correspondence in the *length* of *ECC* events between the mean ECC length per tape coded by the first author and each of the three raters revealed correlations ranging between 0.96 and 0.97, mean 0.97 ($p < 0.001$).

Table 2. Characteristics of interrater reliability tests.

Variable	Statistic	*N*	Reliability score	Range
ECC frequency	ρ^2	44	0.92***	0.89–0.96
ECC length	ρ^2	44	0.97***	0.96–0.97
Global PEM	ρ^2	44	0.87**	0.84–0.90

** $p < 0.01$; *** $p < 0.001$.

Finally, significant positive correlations for the IRR for the *global PEM rating* ranged from 0.84 to 0.92 ($p < 0.01$), with a mean of $r_{(44)} = 0.87$.

Family, maternal and child determinants-of-parenting measures

Nine variables often included in studies of the determinants of parenting were selected for inclusion in this study, including family factors (SES, marital status, age), maternal measurements (verbal IQ, educational level, parenting stress, maternal sensitivity), and infant variables (temperament and birth order).

A family's SES was derived from the income-to-needs (ITN) ratio, calculated at 6 months. The ITN was created by dividing the total family income by the poverty threshold for family size. The mother's *marital status* was determined by the mother's report of the presence of a husband/partner in the home at 1 month. The mother's *age* and level of *education* in terms of years of schooling were collected at the 1-month interview. At that time, information about the infant's *birth order* (i.e., if and how many siblings the infant has) was also collected. Maternal *verbal IQ* was measured using the Peabody Picture Vocabulary (Dunn & Dunn, 1981), an individually administered test of hearing vocabulary, which includes 175 items arranged in order of increasing difficulty. *Parental stress* was assessed using the Parent Stress Index Short Form (Abidin, 1995), a well-established and researched 36-item self-report questionnaire that yields scores on the following subscales: (1) parental distress, 2) parent–child dysfunctional interaction, and (3) difficult child. As described in detail above, a mean of HOME maternal sensitivity at 6 and 15 months was used to assess maternal sensitivity. *Infant temperament* was assessed by asking mothers to complete a modified version of the Infant Temperament Questionnaire (Carey & McDevitt, 1978) at 6 months. Items were designed to capture infant approach, activity, intensity, mood, and adaptability. Calculating the mean of the nonmissing items with appropriate reflection of items created the composite measure, difficult temperament, so that higher scores consistently reflected a more "difficult" temperament.

Developmental outcomes

Six variables were selected to serve as developmental outcome measures for this report.

Attachment security. Infant–mother attachment security was assessed at 15 months using the strange situation procedure (SSP; Ainsworth, Blehar, Waters, & Wall, 1978). The SSP involves a videotaped, 21-min semi-structured laboratory paradigm involving separations and reunions of the child, the mother, and a friendly but unfamiliar female stranger. Each episode lasts three separation episodes were discontinued if the infant cried strongly for more than 20 s. The procedure was videotaped for subsequent scoring; infants were classified into one of four primary categories (secure, avoidant, or resistant, disorganized; Ainsworth et al., 1978; Main & Solomon, 1990). Classification is based on the infant's behaviors. Infants with secure attachment (B) are affected by the separation, reduce exploratory behavior, are likely to show signs of distress, and at the reunion, seek physical contact with or at least communication across a distance with the mother. Avoidant infants (A) are less affected by the separation, sometimes hardly noticing the absence of the mother; and at the reunion, either do not seek physical contact with mother and in some cases fail to acknowledge or only minimally acknowledge (with a

brief look) mother altogether. Resistant attachment behavior (C) is characterized by distress during the separation, and at the reunion, a deliberate desire for contact combined with a physical resistance of contact when achieved (Ainsworth, Bell, & Stayton, 1971). Disorganized/disoriented behaviors (D) at the reunion include overt displays of fear; contradictory behaviors or affects occurring simultaneously or sequentially; stereotypic, asymmetric, misdirected, or jerky movements; or freezing and apparent dissociation. Each SSP videotape was coded twice at a central location by two of three coders blind to all information about the children. Across all coder pairs, agreement with the five-category classification system was 83% (κ = 0.69) (NICHD ECCRN, 1997).

A modified Strange Situation procedure was used at 36 months to assess the quality of the child's attachment to the mother (Cassidy & Marvin, 1992; NICHD ECCRN, 2001). During the laboratory visit, mother and child were invited to make themselves comfortable in a room. The procedure involved 3 min of play, 3-min separation, 3-min reunion, 5-min separation, and 3 min for the second reunion. Assessments were videotaped for later coding and sent to a central site for coding according to the MacArthur Working Group on Attachment system (Cassidy & Marvin, 1992) by a team of coders blind to any other information about the study. Two coders coded information for the same child. In cases of coding discrepancies, coders discussed the classification in question until reaching a consensus code.

Internalizing and externalizing behavior problems. Behavior problems were assessed at 54 months by having teachers complete the Teacher Report Form (Achenbach, 1991). This form consists of 120 items that address a broad range of children's behavioral and emotional problems, and consists of two subscales: internalizing problems (e.g., "too fearful and anxious") and externalizing problems (e.g., "argues a lot"). For each item, respondents were asked to determine how well that item describes the child within the last two months: 0 = not true (as far as you know), 1 = somewhat or sometimes true, and 2 = very true or often true. Achenbach reports test–retest reliability of 0.89 and stability of 0.71 over two years (NICHD ECCRN, 2003).

Social competence with peers. We assessed this ability at 54 months using a modified teacher-report version of the California Preschool Social Competency Scale (CPSCS; Levine, Elzey, & Lewis, 1969), including four additional items added by the NICHD ECCRN to reflect the child's cooperative play ("Cooperates in games and activities with other children, accepting their ideas"), ability to follow rules ("Follows the rules when playing games with others"), empathy ("When other children are distressed or upset, is concerned and offers help or comfort"), and aggression ("Teases, threatens, argues with, annoys, or bosses other children"). Each item contains four descriptive statements (numbered 1–4) ordered by increasing levels of competence relative to the behavior being measured, with higher scores indicating greater social competency. A composite variable of social competence with peers using 10 items from the modified CPSCS had moderate internal reliability (Cronbach's α = 0.75).

Social skills. This capacity was measured in first grade using the teacher-completed Social Skills Questionnaire from the Social Skills Rating System (Gresham & Elliott, 1990).

This instrument is composed of 38 items describing child behavior, each rated on a three-point scale reflecting how often the child exhibited each behavior. Items are grouped into four areas: cooperation (e.g., "Keeps room neat and clean without being reminded"), assertion (e.g., "Makes friends easily"), responsibility (e.g., "Asks permission before using someone else's property"), and self-control (e.g., "Controls temper when arguing with other children"). The total score used in this report represents the sum of all 38 items, with higher scores reflecting higher levels of perceived social skills (range from 0.86 to 0.94) (NICHD ECCRN, 2005).

Language development. Language competence was assessed using the Preschool Language Scale (Zimmerman, Steiner, & Pond, 1979). It measures a range of language behaviors including vocabulary, morphology, syntax, and integrative thinking that are grouped into two subscales: auditory comprehension and expressive language. The test is standardized having a mean of 100 and standard deviation of 15, with age range of 2 weeks to 6 years, 11 months.

Academic skills. Following the NICHD ECCRN (2002) study, the score for (pre)academic skills is a composite score from two subtests of the Woodcock Johnson Achievement and Cognitive Batteries (Woodcock, Johnson, & Mather, 1990). The Letter-Word Identification test measures skills at identifying letters and words. Standard scores range from 63 to 180, with values above 100 indicating that the raw score was above the mean score of children on whom the test was standardized. The Applied Problems test measures skill in analyzing and solving practical problems in mathematics. Standard scores range from 41 to 157, with values above 100 indicating that the raw score was above the mean score of the standardization sample. Internal consistencies for 4 year olds are 0.92 and 0.91 for the two scales, respectively. The composite score was formed by averaging the standardized scores on the two subtests.

Results

Handling missing data

Overall, 18.1% of the data were missing. Little's Missing Completely At Random (1988) test indicated that the data were missing completely at random, $\chi^2_{(23033)} = 1287.38$, $p = 1.00$. Accordingly, we employed Rubin's (2009) multiple imputation procedure to handle missing data.

Family, maternal and child determinants of parenting related to PEM

In an initial effort to validate PEM, we examined its association with maternal factors: maternal SES, marital status (0 = not married, 1 = married), age, verbal IQ, education, birth order, parenting stress, maternal sensitivity, and with infant characteristics, namely temperament. We predicted that a higher PEM rating would be linked with the mothers' tendency to belong to a higher SES, to be married, older, more educated, with a higher verbal IQ and maternal sensitivity scores, and a lower parenting stress rating. Furthermore, we expected that the PEM rating would be unrelated to birth order or to

Table 3. Zero-order standardized coefficients for associations between PEM and maternal and infant variables.

		1	2	3	4	5	6	7	8	9
1	PEM	–								
2	SES	0.13*	–							
3	Marital status	0.15*	−0.37***	–						
4	Age	0.31***	0.45***	0.30***	–					
5	Education	0.16*	0.46***	−0.25**	0.56***	–				
6	IQ	0.26**	0.33***	−0.19*	0.50***	0.56***	–			
7	Stress	−0.12	0.02	−0.04	−0.17	−0.13	−0.03	–		
8	Birth order	−0.03	−0.25**	−0.11	0.25**	−0.08	−0.01	−0.06	–	
9	Sensitivity	0.39***	0.33***	−0.42***	0.40***	0.46***	0.43***	−0.17*	0.08	–
10	Temperament	−0.01	−0.04	−0.12	0.09	−0.12	−0.15	0.11	0.00	−0.09

$N = 200$. For correlations involving maternal verbal IQ, $N = 199$.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

infant temperament. As Table 3 illustrates, all of the correlational findings but one confirmed these predictions; PEM rating was unrelated to parenting stress.

PEM and infant attachment security

To examine whether PEM was associated with the infants' likelihood of being classified as securely attached at 15 and 36 months, we conducted two multinominal regression analyses. More specifically, security was treated as the referent with respect to insecure-avoidance, insecure-resistance, and disorganized. Results revealed that a higher PEM rating predicted reduced likelihood of 15-month insecure-avoidance [$b = -0.28$, $p = 0.031$, $Exp(b) = 0.76$] and disorganized [$b = -0.52$, $p < 0.001$, $Exp(b) = 0.59$] but not insecure-resistance [$b = -0.10$, $p = 0.44$, $Exp(b) = 0.91$]. PEM rating predicted reduced likelihood of all insecure styles at 36-month [insecure-avoidance, $b = -0.40$, $p < 0.001$, $Exp(b) = 0.67$, insecure-resistance, $b = -0.38$, $p = 0.002$, $Exp(b) = 0.68$, and disorganized, $b = -0.99$, $p < 0.001$, $Exp(b) = 0.37$]. Results remained significant even after controlling for maternal sensitivity.

PEM and competent functioning at 54 months

The final set of analyses evaluated whether the PEM rating predicted children's functioning at age 54 months while taking into account maternal sensitivity. Toward this end, we conducted a series of multiple regression analyses in which PEM rating and maternal sensitivity served as predictors. Standardized coefficients are presented in Table 4.

Results revealed that a higher PEM rating forecast advanced language skills and better academic performance, even when controlling for maternal sensitivity. With regard to behavior problems, a higher PEM rating, but not greater maternal sensitivity, forecasts fewer internalizing problems as well as externalizing problems. Higher maternal sensitivity, after controlling for PEM, was related with more internalizing and externalizing problems. In terms of social functioning, higher PEM rating was associated with enhanced social skills and peer competence.

Table 4. Standardized coefficients for socio-emotional and cognitive functioning by PEM and maternal sensitivity.

	Language	Academic	Internalizing	Externalizing	Social skills	Competence
PEM	0.17*	0.14*	−0.23**	−0.19*	0.15*	0.23**
Maternal sensitivity	0.29***	0.21***	0.16*	0.16*	0.07	0.06
R^2 (%)	14.2	8.2	5.7	4.2	3.2	6.3

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Discussion

The current study was designed to extend the conceptualization and measurement of parental mentalizing beyond the linguistic, declarative domain to include nonverbal, body-based aspects of this parental capacity – "parental *embodied* mentalizing." Our goal was to evaluate whether this new way of conceptualizing mentalizing could yield reliable measurement; whether a global rating based on the careful micro and molar scoring of parent–infant kinesthetic exchanges would covary with commonly studied determinants of parenting in a manner expected; and whether the global PEM rating would predict child functioning in infancy and just before the transition to school, with especial concern for whether such prediction would obtain after taking into account maternal sensitivity.

Results reveal that parental mentalizing can indeed be assessed reliably during the course of mother–infant interactions by trained coders focusing solely on the parent–infant movements, without any consideration of the verbal or tonality unfolding in the interactive exchange. Additionally, as hypothesized, the data indicate that PEM is associated – in an expected manner – with theoretically relevant constructs conceptualized as determinants of parenting, such as maternal education, IQ, age, and SES, as well as with maternal sensitivity, but not with infant temperament or birth order. Finally, and perhaps most importantly, infants of mothers displaying greater PEM during a mother–infant free-play at 6 months (1) were more likely to be classified as securely attached at both 15 and 36 months; and at 54 months evinced (2) greater socio-emotional well-being (i.e., greater peer and social competence, fewer behavior problems) and cognitive functioning (i.e., advanced language comprehension and expressive abilities, and academic skills). In most cases, these predictions held even after accounting for maternal sensitivity, clearly indicating that PEM "adds value" from a measurement perspective.

Results indicate that the quality of parent–infant interactions can be reliably assessed solely on the basis of the nonverbal way the parent's and infant's bodies move and interact on the embodied level, as indicators of their wishes, needs, evaluations, and expectations, rather than relying on an examination of the use of words, intonation, or eye contact. These findings highlight the importance of focusing on the nuanced dance between maternal and infant behavior, a dance that the measurement of PEM is specifically designed to capture. Just as importantly, results indicate that even though variation in PEM overlaps with variation in maternal sensitivity, it adds unique predictive power.

These results underscore that through the mother's ability to treat and respond to her infant as a psychological agent *on an embodied interactive level* that the infant eventually

experiences the caregiver as attentive and trustworthy, scaffolding the representation of a secure attachment figure. These findings corroborate studies emphasizing the significance of moment-to-moment, nonverbal, reciprocal parent–infant interactions for the emergence of a meaningful sense of self and self-with-others, including forming attachment relationships, developing a sense of agency and effectiveness, and self-regulation (e.g., Beebe et al., 2000; Brazelton, Koslowski, & Main, 1974; Stern, 1985; Trevarthen, 1993).

Specifically, we tentatively infer that this somatic translation of the parent's mental capacity is meaningful to the preverbal infant, who is highly sensitive to various kinesthetic stimuli. Through his or her body, the infant experiences how attentive and responsive the parent is to his or her emotional needs, thereby serving as a regulator of the infant's emotional and somatic states. This resonates with Tronick's mutual regulation model (Tronick, 2007; Tronick, Als, & Adamson, 1979), according to which regulation is accomplished through the operation of a communication system in which the infant communicates its regulatory status to the caregiver, who, in turn, responds to the meaning of this communication. This communication unfolds and is expressed in the totality of the infant's and caregiver's bio-psychological processes – subtle, nonverbal, micro-regulatory, and social-emotional processes (Fonagy, 2015; Tronick, 2007).

These early interactive, nonverbal, relational experiences, the shared meaning-making (Tronick, 1989, 2007), are considered to go beyond the infant's attachment representations. Fonagy, Gergely, Jurist, and Target (2002) suggested that the evolutionary function of the dyadic relationship between parent and human infant goes far beyond ensuring the safety of the latter, to furthering the understanding of the nature of subjectivity and the ability to develop social intelligence, skills, and competence (e.g., Feldman, Bamberger, & Kanat-Maymon, 2013). Indeed, our results provide preliminary evidence that the infant's experience of the mother's embodied mentalizing carries over into childhood and expands beyond the parent–infant relationship, seeming to influence (in this observational study) the development of social skills as late as 54 months.

This association can be understood by considering that when an infant repeatedly and continuously encounters a mother who is responsive to the somatic signaling of mental states and treats the infant as a mental agent, the child's sense of agency is fostered, as the infant experiences oneself capable of affecting the world (i.e., the mother). Unfortunately, there are cases in which a parent might ignore, misunderstand, or distort the infant's embodied communicative signals, manifested in low PEM. According to Fonagy (2015), such repetitive and continuous violations of the interactive process are toxic because they not only teach inappropriate content but also undermine the mechanisms for the social acquisition of knowledge and the emergence of an agentive sense of self. Such violations may indeed be reflected in the child's compromised ability to develop emotional and behavioral regulatory control, manifested in many ways, including in internalizing and externalizing problems.

While clearly requiring further inquiry, we dare to speculate that infants who experienced interactions with a mother who was insensitive or unresponsive to their mental states would gradually develop one of two embodied ways of being: (1) needing to defend against the misattuned nature of the interactive encounter, later manifesting itself in externalizing problems – movements directed outwardly, difficulty in regulating and containing emotions, and a general tendency to act outwardly, as if reenacting the

need to fend off the bombarding and overwhelming nonverbal interactions with the parent; or (2) withdrawing from the interactive space to protect themselves, later manifested in internalizing problems – the tendency to direct themselves and the mental world inwardly, thereby isolating themselves from the distorted, disappointing, or the absence of a meaningful encounter with the parent.

We further found that PEM was predictive also of children's cognitive development, namely academic and language performance at 54 months, above and beyond maternal sensitivity. These findings can be understood in two ways; one is that the parent's ability to be attentive and responsive to the infant's emotional and mental needs affords the child the safety to inquisitively explore the world. Secondly, when mentalizing, the parent demonstrates the action of symbolism – appreciating that the infant's infant's body movements represents his or her mental world. Through experience, the infant learns what a symbolic activity is and how to implement it in additional domains of being – cognitively and linguistically.

Lastly, these findings support the important distinction that can and should be made between online, real-time assessments of parenting and offline ones. With the exception of MM (Meins et al., 2012), existing measures of parental mentalizing are *offline* measures, that is, assessed after the actual parent–infant interaction has taken place, and thus may be considered more suitable for determining the parent's reflective capacity (Oppenheim, Goldsmith, & Koren-Karie, 2004; Slade, 2005). Such assessments might fall short in fully elucidating either the parent's ability to mentalize the infant in real time while interacting with him or with her, or the infant's experience of the parent and him or herself in this relationship. PEM provides exactly this possibility, and thus could be considered a measure well-suited to measuring online mentalizing.

It is also important to consider the current findings while keeping in mind that mentalizing can involve automatic, spontaneous, and implicit or controlled, and explicit processes, each subserved by distinct patterns of neural activation (Fonagy & Luyten, 2009; Shai & Belsky, 2011b). Explicit mentalizing is typically interpreted, conscious, verbal, and reflective; it is a slow process that necessitates awareness and involves brain processing linguistic and symbolic material (Fonagy & Luyten, 2009). Implicit mentalizing, in contrast, is perceived, nonconscious, nonverbal, and unreflective; it involves much faster processing and activates older brain circuits that rely heavily on sensory information (Satpute & Lieberman, 2006).

We maintain that PEM is an implicit process that does not involve parents' controlled awareness – not when considering the process of interpreting the infant's movement as manifestations of mental states nor in the process of the parents' decision-making determining their embodied responses to their infant. The significance of this is that unlike verbal measures of parental mentalizing that tap into more controlled processes, PEM advances a more accurate evaluation of parenting behavior – one which is less biased by social desirability – because parents are unlikely to know which movements are more or less socially accepted, and even if they would, have far less control over his or her bodily movements than the words they utter.

Limitations and future research

Our results are encouraging as they begin to provide a possible, even if partial, experiential mechanism by which parents' internal representations shape infants' internal world and developmental capabilities. The results begin to suggest that whole body, interpersonal experiences, may have long-lasting effects on the child's well-being. The fact that the research's design included no effort to promote PEM means, of course, that it cannot confidently determine causal processes.

Despite the numerous advantages of using the NICHD SECCYD, one significant limitation in the context of the current investigation is that it did not include assessments of the parents' *verbal mentalizing* capacities, nor were they interviewed so that such information could be obtained. Mentalizing research would benefit from a direct comparison of the parents' embodied and verbal mentalizing capacities. Such a comparison might answer some intriguing questions. Do verbal and nonverbal mentalizing measurements co-vary or are they orthogonal? Do they differentially predict children's future functioning? Are there sensitive time windows in which the impact of one form of parental mentalizing – verbal or embodied – carries more weight in terms of predicting the child's development? It will also be important to consider *paternal* PEM capacities and examine if and how these may differ from maternal PEM patterns, and whether paternal and maternal PEM capacities differentially predict children's future development.

Although the primary purpose of this study was to evaluate the utility of analyzing nonverbal and whole-body movement to shed light on the parent–infant relationship, it would be of great interest to examine if and how the approach of PEM, and its focus on movement qualities, could be applied not only to the interactive patterns of the body but also to those of the voice. We speculate that the very same movement qualities that central to coding PEM (e.g., fast versus slow tempo or gradual versus abrupt pacing) could be applied to describe vocal patterns. Thus, future research could certainly benefit from examining the degree to which the PEM framework could be applied to other communicative modalities and further explore the degree to which human interpersonal communication, especially those of parents and infants, is based on intermodal emotional processes (Walker-Andrews, 2008).

Clinical implications

This parental mentalizing assessment presented herein seems to have enormous face validity for clinicians and might well have important implications for early intervention. In the clinical setting, PEM can be a useful diagnostic tool assessing parent–infant interactions, allowing the detection of moments of both functioning parental mentalizing, as well as lapses in mentalizing. When shared with the parent watching the recorded interaction, this information could be used to empower the parent, while also exploring why, when, and how lapses in mentalizing occurred. As in the PEM coding process, the parent and clinician can examine step by step, ECC by ECC, what the movement of one member elicited in the other, how each movement could have been perceived, (mis)interpreted, and experienced. Such an approach could help parents explore how their own views, expectations, fears, and desires color the

interpretation of their infant's movements (Underdown & Shai, 2014). This practice of PEM in the clinical setting thus allows the parent to explore what works for this unique parent–infant dyad, and equally important, what might work even better.

Conclusions and implications

On the basis of the results reported here, it seems justified to conceptualize and treat parental mentalizing as a multilayered construct that extends beyond verbal expressions and involves whole-body, nonverbal interactive processes between the parent and the infant –PEM. This approach, which extends current work on parental mentalizing, yields not only a reliable and valid measurement, but also one that relates to putative determinants and consequences of parenting in just the manner expected, including in the latter case, over and above maternal sensitivity. Thus, it appears that future research on mentalizing would benefit from extending the measurement tools beyond verbal behavior to nonverbal behavior. From a translational perspective, the current work also suggests new ways of redirecting parent–infant interactive processes when the goal is to prevent the development of problems or promote the child's well-being.

Notes

1. Although it would be ideal to compare multiple approaches to the measurement of mentalizing, the NICHD data set does not include parental mentalizing measures.
2. For a manual describing the PEM coding system in greater detail, as well as for information about training on the instrument, please contact the first author, Dana Shai, sdana@idc.ac.il
3. A further spatial distinction used when coding PEM involves three planes that refer to the orientation of movement in relation to the ground: horizontal (movement appearing sideward), vertical (movements are directed up or down), and sagittal (movements directed forward and backward) (Bartenieff & Lewis, 1980; Kestenberg, 1975; Laban, 1960; Lamb & Watson, 1999).

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Appendix

Global PEM rating summary ("anchor points")

Score 1

- Parent presents grave difficulty to acknowledge the infant has a mind; infant seems to be an inanimate object rather than a subjective person.
- Infant's mental state is expressed kinesthetically clearly and over an extended amount of time.
- Parent does not repair ruptures and lets own mind lead the interaction.
- Parent's movement threatens to place the infant in physical danger.

- Parent holds or moves the infant in a bizarre manner.
- There is evidence of a physical, muscular conflict between parent and infant, where the parent actively overrides the infant's mental state.

Score 3

- Benignly, the parent does not seem to keep the baby's mind in their mind.
- The parent repairs their kinesthetic response only after a substantial time and the infant's clear kinesthetic communication.
- Parental responsiveness to infant's mental states is functional or concrete.
- The infant's engagement of the parent is functional or concrete.
- Their minds seem to operate on parallel paths.

Score 5

- Parent perceives and treats the infant as a mentalistic entity.
- Basic appreciation of infant's mental state.
- The parent and the infant are connected; their minds are meeting.
- Greater ability to respond to infant's positive, rather than negative, states.
- Infant's mental states tend to be kinesthetically clear.
- Short and nonelaborate interactions.

Score 7

- Complex recognition and appreciate of infant's mental state.
- Parent acknowledges their mental state influences that of the infant's.
- When there is a rupture, there is a quick repair.
- Parent responds to both positive and negative mental states.
- Parent modifies a negative interaction into a positive one.
- Parent's mental states enrich the infant's interactive engagement.
- Parent can modify their mental state in real time – while they are executing it – when taking into account the infant's kinesthetic signaling.

Score 9

- Parent detects the infant's subtle and sophisticated mental states, which can also be conflictual and ambivalent.
- Ruptures are repaired quickly.
- The parent presents a wide range of movement qualities and ECC themes.
- The minds of both parties contribute and enrich that of the other, such that the evolving kinesthetic interaction progressively becomes more and more sophisticated and multifaceted.
- Parent is able to take a negative interaction and turn it into a positive one.