Infant Behavior and Development 61 (2020) 101486

Contents lists available at ScienceDirect

Infant Behavior and Development

journal homepage: www.elsevier.com/locate/inbede

Full length article

Does Postpartum Depression Affect Parental Embodied Mentalizing in Mothers With 4-Months old Infants?

Sofie Garset-Zamani [a], Katharina Cordes [a], Dana Shai [b], Rose Spencer [c], Anne Christine Stuart [a], Simo Køppe [a], Mette Skovgaard Væver [a,*]

[a] Department of Psychology, University of Copenhagen, Denmark
[b] School of Behavioral Science, The Academic College of Tel Aviv Yaffo, Israel
[c] Coombe Wood, Mother and Baby Unit, Perinatal Mental Health Service, Central North West London, National Health Service, England, United Kingdom

ARTICLE INFO

Keywords:
Mother-infant interaction
Postpartum Depression
Parental Embodied Mentalizing
Embodiment

ABSTRACT

Parental Embodied Mentalizing (PEM) regards parents' nonverbal capacity to understand the infant's bodily manifested mental states and adjust his or her own movements accordingly. Little is known about how mothers suffering from postpartum depression (PPD) mentalize the infant on an embodied level. The aims of the present study were to investigate whether mothers meeting criteria for a PPD diagnosis differ from non-clinical mothers in regard to their PEM capacities and whether the severity of depressive symptoms was associated with PEM in mothers meeting criteria for a PPD diagnosis compared to non-clinical mothers.

10-minute long lab-based face-to-face interactions were coded with the PEM coding scheme at 4-months postpartum in mother-infant dyads with mothers meeting criteria for a PPD diagnosis (n = 29) and non-clinical mothers (n = 51).

Results showed that mothers with and without a PPD diagnosis differ in their capacity to mentalize on an embodied level, but only when controlling for scores on the Edinburgh Postnatal Depression Scale (EPDS). However, more depressive symptoms as measured with the EPDS was not in itself associated with lower PEM in either group. This finding may indicate the presence of a threshold effect, i.e. that maternal PEM may be affected only when a certain degree of severity and duration in depressive symptoms is beyond a certain threshold. The importance of the findings in regard to the assessment of depression as well as more clinical perspectives are discussed.

1. Introduction

Maternal postpartum depression (PPD), also known as postnatal depression, is common, affecting approximately 13% to 18% of all women within the first year after childbirth (Gavin et al., 2005; O'hara & Swain, 1996). In general, depressive disorders are characterized by sad, empty, or irritable mood, which is accompanied by somatic and cognitive changes that interfere with the individual's functioning and behavior (American Psychiatric Association, 2013). Depressive disorders can also be understood via theories regarding the concept of embodiment, inspired by e.g. Merleau-Ponty's philosophy. Merleau-Ponty emphasizes the body as a

* Corresponding author at: Department of Psychology, University of Copenhagen, Øster Farimagsgade 2A, 1353, Copenhagen K, Denmark.
E-mail address: mette.vaever@psy.ku.dk (M.S. Væver).

https://doi.org/10.1016/j.infbeh.2020.101486
Received 3 January 2019; Received in revised form 18 August 2020; Accepted 27 August 2020
Available online 10 September 2020

mediating link between the object of perception and the subject of perception and the body has an intentional orientation towards the world (Merleau-Ponty, 2002). According to body phenomenology, the body is the foundation of being in and acknowledging the world.

Previous research has identified effects of depression on an embodied level. For example, Fuchs and Schlimme (2009) have described the effect of depression as a disturbance of embodiment, in which the depressed individuals' body can be characterized as solid and heavy in comparison to an otherwise fluid, transparent and unhindering medium for expressing intentions and impulses. Also, Michalak et al. (2009) found that depressed participants had a slower gait compared to non-depressed control participants and had significantly more crouched postures than a non-clinical group. Moreover, previous research has identified two different predominant activity levels that affect the movement-patterns in individuals experiencing depressive symptoms: a slow and diminished activity level (psychomotor retardation), e.g., slow walking patterns and gestures; and an increased but ineffective activity level (psychomotor agitation), e.g. fidgeting aimlessly, struggling with sitting still and feeling physically agitated (Avery & Silverman, 1984; Buyukdura, McClintock, & Croarkin, 2011).

The findings that depression might affect the embodied level is particularly important in depressive episodes in the postpartum period. Mother infant-interactions are primarily nonverbal and therefore effects of depression on an embodied level might also affect the nonverbal communication of the mother and her child. Already Bowlby (1969) focused in his attachment theory on how the infant's emotional development is created by a physical and exploratory approach to the world. Developmental research demonstrates that infants early experience is basically relational, and in particular infants are oriented towards the people they rely on to survive (Rochat, 2013). In the first months of their lives, infants communicate with their caregivers predominantly nonverbally, using body movements, facial expressions, and sounds (Fonagy & Target, 1997). Bowlby (1969) emphasized that the mother's primary role is to offer herself as a "safe container" for the infant through spontaneous and dynamic nonverbal interactions. Detailed studies of mother–infant interaction have shown that mother and infant read the intentions inherent in each other's actions, and that they time and coordinate their activity and expressions, which forms the basis of what has been conceptualized as "embodied communication" (Brazelton, 1979; Stern, 1985; Trevarthen & Aitken, 2001). The infants' constant sensorimotor and bodily interactional experiences are "embodied" (stored in the body) as pre-symbolic mental representations - also described as "expectancies of action sequences" (Beebe & Lachmann, 2002, p. 212). Through the parents' reliable and repetitive response to the infant's nonverbal cues, the infant has the experience of being met in his or her emotional needs, understood, and cared for. The quality of such interactive experiences has been found to predict children's socioemotional, cognitive, and behavioral functioning as late at 54 months (Beebe et al., 2010; Shai & Belsky, 2017; Shai & Meins, 2018). Thus, due to the embodied, nonverbal nature of early mother-child interaction, potential effects of a PPD diagnosis on the embodied level of the mother, might also have consequences for the socio-emotional development of the child.

In line with this notion, and in accordance with the finding of two different behavioral activity levels in depression (i.e. psychomotor retardation and agitation (Avery & Silverman, 1984)), studies have demonstrated that mothers with a PPD diagnosis often show either a withdrawn or an intrusive interactional style (Cohn, Matias, Tronick, Connell, & Lyons-Ruth, 1986; Field, Healy, Goldstein, & Guthertz, 1990; Lovejoy, Graczyk, O'hare, & Neuman, 2000). Both interactional styles are characterized by diminished maternal sensitivity and responsiveness to the infant's social and emotional signals (Murray, Halligan, & Cooper, 2010), which can be a risk factor for socio-emotional child development (Feldman, 2015). Research shows that individuals with more depressive symptoms have difficulties in recognizing and understanding the infant's mental states from the infant's whole-body movements or have difficulties in modifying their own kinesthetic patterns according to the infant. For example, studies have found that mothers suffering from depressive symptoms are engaged in less touching with their infant and touch in a more negative-affectionate manner compared to non-clinical mothers (Herrera, Reissland, & Shepherd, 2004; Mantis, Mercuri, Stack, & Field, 2018). Also Taubner, Kessler, Buchheim, Kächele, and Staun (2011) found that more severe depressive symptoms in a high-risk inpatient sample was associated with low Reflective Functioning (RF; Fonagy, Steele, Steele, Moran, & Higgitt, 1991) - a measure for verbally expressed mentalizing capacity, whereas this association was not identified in outpatients with less severe symptoms. However, to the best of our knowledge, no prior research has included whole-body dynamic movement expressions in the investigation of mother-infant interactions in mothers meeting criteria for a PPD diagnosis.

Parental Embodied Mentalizing (PEM; Shai & Belsky, 2011, 2017) is a recently validated measure used to capture the parental mentalizing ability to understand the infant's kinesthetic manifested mental states and adjust their own kinesthetics accordingly, with no consideration of the verbal or vocal exchanges (i.e., volume is turned off when coding) (Shai & Belsky, 2017). The basic theoretical concepts of PEM are: 1) mental states are expressed through movement qualities, 2) human beings relate to each other on a kinesthetic embodied level, 3) human beings adjust their own kinesthetic movement in social interaction to react to others' kinesthetically manifested mental states (Shai & Fonagy, 2014). This is true for all humans, but is pivotal when considering infants, as they do not have to their disposal the verbal realm to express themselves through. Moreover, and in line with Stern's thinking (1985), the approach of PEM is based on the premise that infants are immersed in and experience the world through these movement qualities, and that the degree to which the infant experiences that his or her mental states are responded to in the interpersonal realm has a significant impact on the child's developmental trajectory.

Indeed, in two large-scale longitudinal studies with community-based families (N = 200, and N = 208), mothers' PEM at six and eight months predicted infant attachment in infancy and toddlerhood (Shai & Belsky, 2017; Shai & Meins, 2018). Shai and Belsky (2017) further found that PEM at six months predicted cognitive, academic, social, and behavioral functioning as late as 54 months. In terms of parental caregiving behaviors, PEM at six and eight months was found to be related with maternal sensitivity and verbal measures of parental mentalizing (Shai & Belsky, 2017; Shai & Meins, 2018). It was further found that PEM at four months was associated with coparental alliance, which in turn predicted parental stress (Shai, Dollberg, & Szepsenwol, 2017).

The assessment of PEM focuses on how dynamic whole-body kinesthetics are performed in the mother-infant interaction rather than focusing what movements are performed, i.e. it refers to movement typology characterizing movement and giving it its tone or

quality (Shai & Belsky, 2011). Examples of the movement qualities examined are velocity, shape, direction in space, distance from the body, etc. Research has demonstrated that different movement qualities are related to both the expression and interpretation of distinct emotions. For example, there is a variation of acceleration and velocity in movements that convey sadness, joy, or anger (Boone, Cunningham, Tucker, Watson, & Boyatzis, 1998; Hertenstein, Holmes, McCullough, & Keltner, 2009; Pollick, Paterson, Bruderlin, & Sanford, 2001). Hence, PPD may influence a mother's whole-body kinesthetic expression and affect the way a mother behaves on an overall embodied level in regard to her young child.

To date, no previous study has examined PEM in mothers suffering from a PPD diagnosis compared to nonclinical mothers when interacting with their infants.

2. The Current Study

The aim of the present study is to examine whether mothers with a PPD diagnosis differ from non-depressed mothers in regard to their PEM capacities when interacting with their 4-months old infants. Based on the literature, we expect that mothers meeting criteria for a PPD diagnosis (i.e. the clinical group) will demonstrate lower PEM capacities compared to non-clinical mothers as measured by the PEM coding system (Shai, 2017). Furthermore, we also investigate the association between depressive symptoms and PEM capacities. We expect that mothers in the clinical group with more severe depressive symptoms will demonstrate lower PEM capacities compared to the group of non-clinical mothers.

3. Methods

3.1. Participants

The present study is part of a larger, longitudinal study investigating the parent-infant relationship and child development. The sample of the present study consists of 80 mother-infant dyads ($N = 80$). Of these 80 dyads, 29 mothers were diagnosed with PPD, and the remaining 51 were non-clinical mothers, who did not suffer from depression or any other form of psychopathology. The nonclinical mothers were recruited via web pages and by advertising at local obstetricians. PPD mothers fulfilling inclusion criteria were referred to the study by community health visitors in routine home visits (Væver, Krogh, Smith-nielsen, & Harder, 2013). The study was approved by the local Institutional Ethical Review Board.

All women were Caucasian, first-time mothers from urban Copenhagen and gave their written informed consent to participate before they were enrolled in the study. All mothers were on maternity leave at the time points of the study variables being collected. All infants were 4-months old (M = 4.00, SD = .22), Caucasian, full-term and had unremarkable pre- and postnatal medical histories. Sample characteristics are presented in Table 1 and show the low-risk nature of the sample. The clinical and non-clinical groups did not differ significantly in regard to standard demographic variables (education, age, single-parent status, nationality, sex of child, child's birth weight, and gestational age) apart from psychopathology in the clinical group. The inclusion-criteria for the clinical group were primiparous, singleton pregnancy, somatically healthy, and score of 10 or more on the Edinburgh Postnatal Depression Scale (EPDS; Cox, Holden, & Sagovsky, 1987). The inclusion criteria for the non-clinical group were singleton pregnancy, primiparous, mentally and somatically healthy. If a mother was interested in participating in the project, she was referred to the study. Exclusion criteria for both groups were indications of psychotic symptoms, premature birth, drug or alcohol abuse, and major mental or physical disabilities in the child.

Due to ethical reasons, all mothers with a PPD diagnosis included in the research project were offered a brief intervention. The intervention took place between 4 and 10 months postpartum, i.e. after observation of infant-mother interactions and consisted of six-sessions weekly cognitive behavioral therapy in a group context. The focus of the intervention was not the mother-child relationship,

Table 1
Sample Characteristics.

Variable	Nonclinical group ($n = 51$)	Clinical group ($n = 29$)	p
Mean age, infant *(SD)*	4.01 (.19)	3,98 (.26)	.57
Mean age, mother *(SD)*	30.49 (4.15)	30.76 (3.81)	.77
Single mother, *n* (%)	1 (2)	1 (3.4)	.60
Years of education, *n* (%)			.48
9-12 (ISCED level 3)	4 (7.8)	2 (7.1)	
14 (ISCED level 4)	3 (5.9)	2 (7.1)	
15 (ISCED level 5-6)	17 (33.3)	14 (50)	
17 or more (ISCED level 7-8)	27 (52.9)	10 (35.7)	
Unemployed, *n* (%)	4 (7.8)	4 (14.3)	.30
Child Sex, *n* (%)			.75
Male	23 (45.1)	16 (55.2)	
Female	28 (54.9)	13 (44.8)	
Mean child gestational age (*SD*)	40.57 (1.21)	40.18 (1.65)	.25
Mean child birth weight, grams (*SD*)	3560.61 (535.71)	3447.26 (437.96)	.35
Mean EPDS score (*SD*)	4.11 (2.71)	15.28 (4.11)	.00

Note: ISCED = International Standard Classification of Education by UNESCO.

but primarily the reduction of maternal depressive symptoms. Two mothers did not participate in the intervention as one mother was abroad, and the other mother did not wish to participate due to the group format. Two mothers received antidepressant medication.

3.2. Procedure

The 80 mothers and their 4-months old infants visited the university lab and were videotaped for ten-minutes during face-to-face interactions. The lab visit was scheduled to accommodate into the infants' sleeping and eating patterns. For the face-to face interactions, the infants were placed in a baby seat on a table opposite the mother, who was seated in a chair in front of the infant. The distance between mother's and infant's heads was approximately 830 mm when the mother was sitting upright. Two video cameras (25 frames/second filming) enabled simultaneous monitoring of the mother and her infant. The cameras recorded two different perspectives of the interaction: a lateral- and frontal view. All the mothers were instructed to interact with their infant as they normally would do. No toys were provided so that the interaction and embodied communication could be the focal point of examination. The mothers would have physical contact with their infant by touching the infant. The overall mean of spatial proximity in the interaction (the distance between the mother and her infant) in the non-clinical group was 579.6 mm (SD = 134.6 mm; range: 153–967 mm). In the clinical group the mean of spatial proximity in the interaction was 583.2 mm (SD = 122.9 mm; range: 168–1125 mm) (Væver et al., 2013).

4. Measures

4.1. Maternal Postpartum Depression

The Danish version of the Edinburgh Postnatal Depression Scale (EPDS; Cox et al., 1987; Smith-Nielsen, Matthey, Lange, & Væver, 2018) was administered to screen for maternal PPD (Nielsen, Videbech, Hedegaard, Dalby Salvig, & Secher, 2000). The EPDS is a 10-item self-report questionnaire assessing presence and severity of depressive symptoms in the postpartum period. The internal consistency for this sample was excellent (Cronbach's $\alpha = .93$). Following the recommendation of Cox et al. (1987), the cut-off score used in the present study was 10.

The standardized psychiatric interview Present State Examination (PSE; Wing, Cooper, & Sartorius, 1974) is a semi-structured interview for clinicians widely used for diagnosing psychopathology, which was administered after intake in both groups. In the nonclinical group, PSE was administered to assess symptoms of Axis I psychopathology and the PSE confirmed that none of the clinical mothers presented Axis-I psychopathology at enrollment. In the PPD-group, a PSE interview was performed after referral in order to validate the diagnosis of depression according to the DSM-IV TR, as well as to rule out that the mother's heightened EPDS-score was not better accounted for by another Axis I disorder which, as previously has been documented, can be the case. All PSE interviews were vocally recorded and administered by trained clinical psychologists. Based on the interview, they made an initial diagnostic evaluation. Subsequently, all interviews from the PPD group and 30% (randomly selected) from the non-clinical were coded by another trained clinical psychologist with no previous knowledge of the women. Agreement for depressed/not depressed classification was 100% (Smith-Nielsen et al., 2016).

4.2. Parental Embodied Mentalizing

PEM capacities were assessed using the PEM Coding System (Shai & Belsky, 2017). The videos of the mother-infant interactions were muted for the purpose of focusing only on the nonverbal communication of the mother and her child and avoiding bias by verbal inputs.

To assess PEM, the 10-minute interactions were divided into Embodied Circles of Communications (ECCs). An ECC is a kinesthetic-manifested communicative exchange between infant and parent. The ECCs are described in terms of the kinesthetic qualities such as: directionality (concerns the growing or shrinking movement of bodily dimensions in relation to the body center), pacing (refers to the velocity of alterations in movements), pathway (concerns the imaginary line that movements create in space e.g. a straight or a rounded movement pathway), tension-flow (refers to the individual's muscular tone), tempo (refers to how fast and slow the movement is) and space (refers to where in space the movement is taking place when the infant's body serves as a point of reference) (Shai & Belsky, 2017). A score was assigned to each of the ECC (using a seven-point scale), reflecting the mother's capacity to respond and adjust her kinesthetic qualities in regard to the infant's kinesthetic-manifested mental states. A score of one reflects very low PEM capacity, i.e. the parent demonstrates considerable difficulty in acknowledging the infant as a mental entity and does not repair any ruptures. A score of four reflects moderate PEM capacity, i.e. the parent perceives the infant as a mentalistic entity and is a basic appreciation of infant's mental state. A score of seven reflects very high PEM capacity, i.e. the parent detects the infant's subtle mental states and repairs any ruptures in an appropriate and timely manner.

Based on the individual PEM ratings, a global PEM rating was assigned to the entire interaction (using a seven-point scale), reflecting the mother's typical PEM capacity throughout the 10-minutes. The global PEM score denotes the degree to which the parent in general demonstrates a kinesthetic appreciation of the infant as a mental entity and implicitly uses this appreciation to constantly modify her own kinesthetic qualities to better suit those of the infant.

The primary coder of the PEM coding was the first author. The reliability-coder was the fourth author, who had vast experience in coding PEM. Both coders were trained by Dr. Shai, the developer of the PEM measure, and in the present study they were blinded regarding group status. 20% of the mother-infant dyads were randomly selected and rated independently by both coders. The inter-rater reliability of the global PEM score was high with ICC = .85.

5. Statistical Analyses

All statistical analyses were conducted in the software program "IBM SPSS Statistics" (version 20). First, we conducted descriptive analyses for PEM global score in the overall sample and each group respectively. Second, we conducted a hierarchical linear moderation analysis to investigate the two hypotheses. Prior to analysis, we checked the data for normality and found that the data was not normally distributed. Thus, we log-transformed the PEM scores before analyzing the data and conducted linear regression analysis. The dependent variable was the log-transformed PEM scores with group status (clinical vs. non-clinical) being the independent variable in the first model, and in the second model, group status, EPDS scores, and the interaction between group status and EPDS scores were the independent variables.

6. Results

Table 2 shows the descriptive statistics. The linear analyses showed that group status in itself did not predict PEM scores ($b = .01$, $t(74) = 0.32$, $p = .75$, 95% CI [-0.06; 0.08]). However, when EPDS was controlled for, group status was significant in predicting PEM scores ($b = 0.18$, $t(72) = 2.82$, $p = .01$, 95% CI [0.05; 0.30]). EPDS scores in itself did not significantly predict PEM scores ($b = -0.01$, $t(72) = -0.79$, $p = .43$, 95% CI [-0.02; 0.01]). Moreover, our results revealed that the interaction term was not significant, indicating that the association between EPDS score and PEM score did not differ significantly in mothers with and without PPD ($b = -0.01$, $t(72) = -1.52$, $p = .13$, 95% CI [-0.03; 0.00]). Fig. 1 shows the negative relationship between EPDS and PEM scores in the clinical and non-clinical groups.

7. Discussion

The aim of the present study was to examine whether mothers with a PPD diagnosis and non-clinical mothers differ in their embodied mentalizing capacities assessed by PEM (Shai & Belsky, 2017) and further whether the severity of depressive symptoms was associated with PEM in mothers meeting criteria for a PPD diagnosis compared to non-clinical mothers.

Our results support the first of our hypotheses, that mothers fulfilling criteria for a PPD diagnosis have difficulties in recognizing and understanding the infant's mental states from the infant's whole-body movements or have difficulties in modifying their own kinesthetic patterns according to the infant. However, this is only when controlling for EPDS scores, i.e. taking the individual variability in concurrent depressive symptoms into consideration. Thus, including EPDS scores helps to explain the error variance of the data. Fulfilling criteria for a diagnosis of depression includes that the maternal depressive state is of a more persistent character. The PSE is a semi-structured clinical interview where you ask the mother about her current mental state as well as her mental state in the previous month (Wing & Stuart, 1978). EPDS is a 10-item self-rating questionnaire on which the mother rates her mental state in the previous week (Cox et al., 1987). This finding may indicate the presence of a threshold effect, i.e. that maternal PEM may be affected only when a certain degree of severity and duration in depressive symptoms is beyond a certain threshold. In the current study, to be included in the PPD group, the mothers had fulfilled criteria for a diagnosis as well as score of 10 or more on the EPDS. However, based on the current study we are not able to define the threshold in regard to degree of depression severity and duration. This finding may also point to the importance of how depression is measured. When studying PPD's impact on maternal mentalizing capacity, there has been a tradition of either measuring the presence or absence of a clinical diagnosis based on a psychiatric interview, such as for example the PSE, or by measuring PPD based on the severity of depressive symptoms, assessed for example with a self-report questionnaire such as the EPDS. But our findings indicate that both a clinical diagnostic interview and assessment of concurrent depressive symptoms based on self-report are important to identify the negative impact of PPD in an otherwise low-risk population.

We did not find a significant relationship between EPDS scores and global PEM scores in either group. Also, the interaction between group status and EPDS in regard to PEM was not significant, meaning that we did not find support for our second hypothesis, i.e. that mothers in the clinical group with more severe depressive symptoms would demonstrate lower PEM capacities compared to the group of non-clinical mothers. These two non-significant findings suggest that the severity of symptoms in itself do not have a significant impact on mothers' ability to mentalize on an embodied level. Previous studies have found a relationship between severity of depressive symptoms and the ability to mentalize, but these studies either investigated verbalized mentalizing (Taubner et al., 2011) or an aspect of the interaction like touch (Herrera et al., 2004; Mantis et al., 2018). The PEM measurement, however, is an embodied mentalizing measurement, meaning that it measures the mother's ability to understand the infant's kinesthetically manifested mental states that encompasses many aspects of the movements such as tempo, directionality, the use of space, etc.

The present study has several limitations. First, the participating infants were only 4-months old. Usually it is recommended that PEM is used from the age of six months up to two years, because the children's embodied signals become more clearly expressed and distinct around six months of age. Infant's kinesthetic expression at 4-months may be less clear and varied than older infants, however

Table 2
PEM Descriptive Statistics (in the whole sample and each group respectively).

	N	Minimum Score	Maximum Score	Mean	Std. Deviation
Overall Sample	80	1	6	3.66	1.067
Non-clinical Group	51	2	6	3.65	1.055
Clinical Group	29	1	5	3.69	1.105

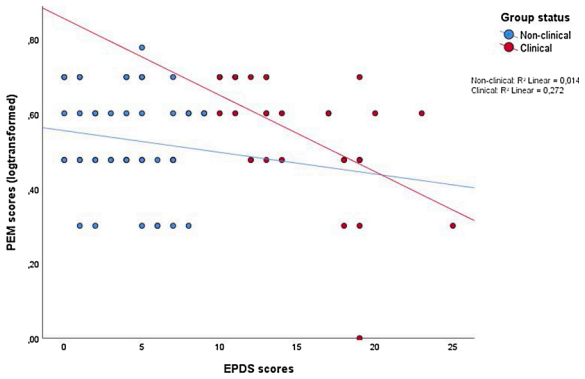

Fig. 1. Relationship between EPDS scores and mothers' logtransformed PEM scores.

it has been demonstrated that PEM can be accurately assessed with young infants at three months (see Shai et al., 2017). Second, infants were seated and fixated in an infant-chair during the interaction with the mothers, which limited the infants' exploration of the environment. Generally, it is recommended to use PEM in free-play interactions (Shai, 2017). However, we consulted with Dr. Shai (the developer of PEM and co-author), who confirmed the design of our research and approved the study. Third, due to the relatively small and homogeneous low-risk sample, findings of our study might not be generalizable.

Nonetheless, this study also has several strengths. It is the first study to examine PEM in mothers diagnosed with PPD compared to nonclinical mothers. Second, with the PEM measure, we assessed the parents' implicit embodied mentalizing abilities in real-time interaction with their infants, focusing on the ongoing bodily-based behavioral patterns, rather than focusing on parents' explicit verbal reflections on their infant's internal experiences, separately from the interaction itself. Third, when assessing PPD in regard to PEM we included both a continuous variable (severity of symptoms) and a binary variable (PPD diagnosis). When including both measures, we were able to identify the potential presence of a threshold effect in regard to maternal PPD.

The present study advances our knowledge on embodied parental mentalizing in low-risk mothers with a PPD diagnosis and also points to future potential clinical and research implications. First, the current study tentatively suggests that PPD might trickle and infiltrate the parent-infant domain and influence the PEM capacity. There is some evidence indicating that the impact of postnatal depression on the child's development is a function of both severity and duration (Krink, Muehlhan, Luyten, Romer, & Ramsauer, 2018; Taubner et al., 2011). Therefore, future research should ensure, by following up on families, whether PPD diagnosis and PEM continue to evolve and/or change. Second, future studies should further investigate the associations between PPD and PEM in larger, more heterogeneous and high-risk samples and could benefit from inclusion of data of PEM capacity in mothers with a PPD diagnosis containing more kinesthetic measures to differentiate and give a greater detailed overview of the mothers' difficulties.

Third, it is important that professionals working with mother-infant dyads, where the mothers suffer from PPD, are aware that these parents may have difficulties in implicit and embodied mentalizing. A video-based systematic coding of the mothers' bodily interactions with their infants can contribute to a more accurate assessment of the mothers mentalizing capacity. The use of video is accessible, and recordings can be captured in the homes of the family, thereby adding to the ecological validity of mentalizing investigations. In the future, it could be relevant to develop an intervention focusing on promotion of the embodied mentalizing abilities in mothers with a PPD diagnosis or other mental conditions impacting on her ability to mentalize. For example, the videos can be used in a dialogue with the mothers to give feedback on their resources and challenges in the interactions. For some mothers, this kind of visual representation of developmental points in the interactions with their infants may be more relatable than a verbal explanation (Juffer & Bakermans-Kranenburg, 2018). Fourth, this study can help future researchers investigating PPD to reflect on the assessment of PPD and potentially include both a variable regarding PPD diagnosis and a variable regarding levels of depressive symptoms in the same model. This could also pave the way for more knowledge on the specific characteristics of the potential threshold effect identified in this study.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author statement

All of the authors of this article have contributed to the manuscript.

Declaration of Competing Interest

The authors report no declarations of interest.

Acknowledgement

The authors thank the families involved for participating in this study.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: Author.

Avery, D., & Silverman, J. (1984). Psychomotor retardation and agitation in depression: Relationship to age, sex, and response to treatment. *Journal of Affective Disorders, 7*(1), 67–76. https://doi.org/10.1016/0165-0327(84)90066-1.

Beebe, B., & Lachmann, F. M. (2002). *Infant Research and Adult Treatment. Co-constructing interactions*. Nj & London: The analytic Press, Hillsdale.

Beebe, Beatrice, Jaffe, J., Markese, S., Buck, K., Chen, H., Cohen, P., … Feldstein, S. (2010). The origins of 12-month attachment: A microanalysis of 4-month mother-infant interaction. *Attachment and Human Development*. https://doi.org/10.1080/14616730903338985.

Boone, T., Cunningham, J. G., Tucker, J., Watson, M., & Boyatzis, C. (1998). *Developmental Psychology Children's Decoding of Emotion in Expressive Body Movement: The Development of Cue Attunement* (Vol. 34). Psychological Association, Inc.

Bowlby, J. (1969). *Attachment and Loss: Vol. 1 Attachment*. New York: Basic Books.

Brazelton, T. B. (1979). Evidence of communication during neonatal behavioural assessment. In M. Bullowa (Ed.), *Before Speech: The Beginning of Human Communication* (pp. 79–88). London: Cambridge University Press.

Buyukdura, J. S., McClintock, S. M., & Croarkin, P. E. (2011). Psychomotor retardation in depression: Biological underpinnings, measurement, and treatment. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*. https://doi.org/10.1016/j.pnpbp.2010.10.019.

Cohn, J. F., Matias, R., Tronick, E. Z., Connell, D., & Lyons-Ruth, K. (1986). Face-to-face interactions of depressed mothers and their infants. *New Directions for Child and Adolescent Development, 1986*(34), 31–45. https://doi.org/10.1002/cd.23219863405.

Cox, J. L., Holden, J. M., & Sagovsky, R. (1987). Detection of Postnatal Depression. *British Journal of Psychiatry, 150*(06), 782–786. https://doi.org/10.1192/bjp.150.6.782.

Feldman, R. (2015). Sensitive periods in human social development: New insights from research on oxytocin, synchrony, and high-risk parenting. *Development and Psychopathology*. https://doi.org/10.1017/S0954579415000048.

Field, T., Healy, B. T., Goldstein, S., & Guthertz, M. (1990). Behavior state matching and synchrony in mother-infant interactions of nondepressed versus depressed dyads. *Developmental Psychology, 26*, 7–14.

Fonagy, P., Steele, M., Steele, H., Moran, G. S., & Higgitt, A. C. (1991). The Capacity for Understanding Mental States: The Reflective Self in Parent and child and its significance for security of attachment. *Infant Mental Health Journal, 12*(3). Retrieved from https://web-a-ebscohost-com.ep.fjernadgang.kb.dk/ehost/pdfviewer/pdfviewer?vid=1&sid=469f99c1-42f1-44fd-86b0-277b0b111636%40sessionmgr4008.

Fonagy, P., & Target, M. (1997). Attachment and reflective function: Their role in self-organization. *Development and Psychopathology, 9*(04), 679–700. https://doi.org/10.1017/S0954579497001399.

Fuchs, T., & Schlimme, J. E. (2009). Embodiment and psychopathology: A phenomenological perspective. *Current Opinion in Psychiatry*. https://doi.org/10.1097/YCO.0b013e3283318e5c.

Gavin, N. I., Gaynes, B. N., Lohr, K. N., Meltzer-Brody, S., Gartlehner, G., & Swinson, T. (2005). Perinatal depression – a systematic review of prevalence and incidence. *Obstetrics and Gynecology, 106*, 1071–1083.

Herrera, E., Reissland, N., & Shepherd, J. (2004). Maternal touch and maternal child-directed speech: Effects of depressed mood in the postnatal period. *Journal of Affective Disorders*. https://doi.org/10.1016/j.jad.2003.07.001.

Hertenstein, M. J., Holmes, R., McCullough, M., & Keltner, D. (2009). The communication of emotion via touch. *Emotion*. https://doi.org/10.1037/a0016108.

Juffer, F., & Bakermans-Kranenburg, M. J. (2018). Working with Video-feedback Intervention to promote Positive Parenting and Sensitive Discipline (VIPP-SD): A case study. *Journal of Clinical Psychology*. https://doi.org/10.1002/jclp.22645.

Krink, S., Muehlhan, C., Luyten, P., Romer, G., & Ramsauer, B. (2018). Parental Reflective Functioning Affects Sensitivity to Distress in Mothers with Postpartum Depression. *Journal of Child and Family Studies, 27*(5), 1671–1681. https://doi.org/10.1007/s10826-017-1000-5.

Lovejoy, M. C., Graczyk, P. A., O'hare, E., & Neuman, G. (2000). Maternal Depression and parenting behavior: A meta-analytic review. *Clinical Psychology Review, 20*. Retrieved from https://ac-els-cdn-com.ep.fjernadgang.kb.dk/S0272735898001007/1-s2.0-S0272735898001007-main.pdf?_tid=7a63b345-a598-49f9-b0b7-41391692d690&acdnat=1543779426_3c5cf77070ce8a106d94c495240d18b1.

Mantis, I., Mercuri, M., Stack, D. M., & Field, T. M. (2018). Depressed and non-depressed mothers' touching during social interactions with their infants. *Developmental Cognitive Neuroscience*. https://doi.org/10.1016/j.dcn.2018.01.005.

Merleau-Ponty, M. (2002). *Phenomenology of Perception*. London: Routledge.

Michalak, J., Troje, N. F., Fischer, J., Vollmar, P., Heidenreich, T., & Schulte, D. (2009). Embodiment of sadness and depression-gait patterns associated with dysphoric mood. *Psychosomatic Medicine*. https://doi.org/10.1097/PSY.0b013e3181a2515c.

Murray, L., Halligan, S., & Cooper, P. (2010). Effects of Postnatal Depression on Mother-Infant Interactions and Child Development. *The Wiley-Blackwell Handbook of Infant Development* (pp. 192–220). Oxford, UK: Wiley-Blackwell. https://doi.org/10.1002/9781444327588.ch8.

Nielsen, D., Videbech, P., Hedegaard, M., Dalby Salvig, J., & Secher, N. J. (2000). Postpartum depression: identification of women at risk. *British Journal of Obstetrics and Gynaecology, 107*.

O'hara, M. W., & Swain, A. M. (1996). Rates and risk of postpartum depression—a meta-analysis. *International Review of Psychiatry, 8*(1), 37–54.

Pollick, F. E., Paterson, H. M., Bruderlin, A., & Sanford, A. J. (2001). Perceiving affect from arm movement. *Cognition, 82*, B51–B61.

Rochat, P. (2013). Sense of 'sameness' as foundation of infants' embodied subjectivity and intersubjectivity. *From the Couch to the Lab* (pp. 427–438). Oxford University Press. https://doi.org/10.1093/med/9780199600526.003.0024.

Shai, D. (2017). *PEM Coding System Manual. (No. Version 2.2)*.

Shai, D., & Belsky, J. (2011). When words just won't do: Introducing parental embodied mentalizing. *Child Development Perspectives*. https://doi.org/10.1111/j.1750-8606.2011.00181.x.

Shai, D., & Belsky, J. (2017). Parental embodied mentalizing: how the nonverbal dance between parents and infants predicts children's socio-emotional functioning. *Attachment and Human Development*. https://doi.org/10.1080/14616734.2016.1255653.

Shai, D., Dollberg, D., & Szepsenwol, O. (2017). The importance of parental verbal and embodied mentalizing in shaping parental experiences of stress and coparenting. *Infant Behavior and Development, 49*(October), 87–96. https://doi.org/10.1016/j.infbeh.2017.08.003.

Shai, D., & Fonagy, P. (2014). Beyond words: Parental embodied mentalizing and the parent infant dance. In M. Mikulincer, & P. R. Shaver (Eds.), *Mechanisms of social connection from brain to group* (pp. 185–203). Washington, DC: American Psychological Association.

Shai, D., & Meins, E. (2018). Parental Embodied Mentalizing and its Relation to Mind-Mindedness, Sensitivity, and Attachment Security. *Infancy*. https://doi.org/10.1111/infa.12244.

Smith-Nielsen, J., Tharner, A., Steele, H., Cordes, K., Mehlhase, H., & Væver, M. S. (2016). Postpartum Depression And Infant-Mother Attachment Security At One Year: The Impact Of Co-Morbid Maternal Personality Disorders. *Infant Behavior and Development, 44*, 148–158.

Smith-Nielsen, J., Matthey, S., Lange, T., & Væver, M. S. (2018). Validation of the Edinburgh Postnatal Depression Scale against both DSM-5 and ICD-10 diagnostic criteria for depression. *BMC Psychiatry, 18*(1), 1–12. https://doi.org/10.1186/s12888-018-1965-7.

Stern, D. N. (1985). *The Interpersonal World of the Infant: A View From Psychoanalysis and Developmental Psychology*. New York: Basic Books.

Taubner, S., Kessler, H., Buchheim, A., Kächele, H., & Staun, L. (2011). The Role of Mentalization in the Psychoanalytic Treatment of Chronic Depression. *Psychiatry: Interpersonal and Biological Processes*. https://doi.org/10.1521/psyc.2011.74.1.49.

Trevarthen, C., & Aitken, K. (2001). Infant intersubjectivity: research, theory, and clinical applications. *Annual Research Review. The Journal of Child Psychology and Psychiatry and Allied Disciplines, 41*(1), 3–48.

Væver, M. S., Krogh, M. T., Smith-nielsen, J., & Harder, S. (2013). Measuring spatial proximity in mother – infant interaction: A kinematic approach for an examination of the effects of maternal postpartum depression. *Infant Behavior and Development, 36*(3), 427–431. https://doi.org/10.1016/j.infbeh.2013.03.007.

Wing, J. K., & Stuart, E. (1978). *The PSE-ID-Catego system supplementary manual.* London: MRC Social Unit.

Wing, J. K., Cooper, J. E., & Sartorius, N. (1974). *Measurement and classification of psychiatric symptoms, an instruction manual for the PSE and Catego program.* London: Cambridge University Press.