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REVIEW ARTICLE

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Theory of mind during pregnancy and postpartum: A systematic review

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Abstract

Pregnancy is associated with prominent structural changes in brain areas involved in Theory of Mind (ToM), pointing to the possibility of modifications in ToM-related behavior and brain responses in parents. We performed a systematic review screening for studies that examined ToM in pregnant and/or early postpartum parents. The evaluation of the included 12 studies allowed us to construct an overview of ToM changes during pregnancy and postpartum as well as other associated factors, such as oxytocin, mental health, and parental behavior. Four studies examined ToM changes by comparing pregnant/early postpartum parents with nulliparous parents or prepregnancy measures. They reported no differences between groups measured with a self-report questionnaire but found group differences using an experimental approach. The results from the summarized studies further suggest a mediatory role of oxytocin between ToM and certain parental behavior. In addition, while no link between postpartum depression and ToM was observed, findings do point to an association between depressive and remote maternal behavior and anxious attachment style and ToM abilities in pregnant participants. Research findings regarding the interaction of ToM with both parity and maternal attachment to the fetus are ambivalent. Overall, research on this topic is scarce, limiting our ability to draw firm conclusions and stressing the need for further research on this topic. This review presents an overview of research findings on ToM and associated factors in pregnancy and the postpartum period and discusses directions for future research.

KEYWORDS
cognitive empathy, early postpartum, oxytocin, pregnancy, theory of mind

1 | INTRODUCTION

Pregnancy and parturition have a significant impact on both the brain and behavior of new parents. Large fluxes of hormones take place during pregnancy and the early postpartum period, including dramatic increases in sex steroid hormones, prolactin, and oxytocin. In addition, substantial changes in brain structure have been observed in women who were investigated before and after pregnancy.[1] Comparisons between the pattern of structural brain changes and cognitive neural networks showed the strongest overlap with regions recruited by Theory of Mind (ToM) tasks, such as the superior temporal sulcus and the inferior frontal gyrus, suggesting that ToM-related brain areas are strongly altered during pregnancy.

ToM has been theorized to represent the "cognitive" route of empathy, enabling inferences of others' thoughts, goals, or intentions.[2] ToM differs from affective empathy, which entails directly sharing an observed persons' emotions.[3] ToM has been assessed by various tasks and questionnaires. Meta-analyses present that different ToM tasks lead to divergent brain responses, although there are some core brain areas activated in ToM tasks, including temporoparietal areas such as the superior temporal sulcus, inferior frontal gyrus, and medial prefrontal cortex.[4,5] The wide variety is likely due to the many processes involved in ToM, such as memory, joint attention, complex perceptual recognition (such as face and gaze processing), language, executive functions (such as tracking of intentions and goals, and moral reasoning), emotion processing-recognition, empathy, and imitation.[6]

Neural modifications during pregnancy in ToM-related brain areas suggests that pregnancy may be associated with changes in ToM abilities. ToM represents an important component of parental behavior,[7] which speculatively facilitates the new parents' interpretation of subtle cues of the baby's mental state through facial and non-verbal signals. This might offer an adaptive advantage for parents to promote parent-infant bonding and to stimulate the development of the child's own social cognitive functions.[8] Accordingly, there are preliminary indications of facilitated processing of social information in pregnant women, including enhanced emotion and face recognition.[9–11] Previous studies have for instance shown that brain regions involved in the ToM network respond when parents are presented with infant stimuli.[12] The described changes in ToM-related brain regions during pregnancy elicit the question whether there is a change in ToM-related behavior and brain response during or after pregnancy. We therefore performed a systematic search to review the available literature on ToM in relation to pregnancy.

2 | METHODOLOGY

Original peer-reviewed research papers in English were obtained without publication date restrictions. Four different electronic databases (PubMed, PsychINFO, Embase, and Web of Science) were used in order to cover the interdisciplinary nature of this topic. Broad terminology for pregnancy and the postpartum period were used, based on terms used in previous systematic reviews[13] and by using Mesh for medical synonyms of pregnancy and postpartum. Besides "theory of mind", we included "cognitive empathy", since both these terms are used to study "inferences of other's thoughts, goals, or intentions".

The searches were conducted on the July 4, 2022 using the following search string: ((theory of mind [Title/Abstract]) OR (cognitive empath* [Title/Abstract])) AND ((pregnan* [Title/Abstract]) OR (antenatal [Title/Abstract]) OR (perinatal [Title/Abstract]) OR (birth [Title/Abstract]) OR (birth-related [Title/Abstract]) OR (childbearing [Title/Abstract]) OR (childbearing [Title/Abstract]) OR (postnatal [Title/Abstract]) OR (postpartum [Title/Abstract]) OR (mother* [Title/Abstract]) OR (maternal [Title/Abstract]) OR (parent* [Title/Abstract]) OR (gestation* [Title/Abstract])).

To focus on the pregnancy and early postpartum period, studies that involved parents during pregnancy and parents up to 12 months postpartum were included. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; prisma-statement.org) model[14] was used to follow the search process. Electronic searching yielded 2462 records with 1406 articles after removing duplicates. In addition, four records were identified through previous reviews. Titles and abstracts of these articles were screened by two researchers independently. Based on this screening, 69 articles were retained after screening on title and abstract level. After whole-text screening by a single researcher, 57 additional articles were excluded: seven because the participant was not an expectant parent or postpartum, 26 because the measurements were later than 12 months postpartum, 11 because there was no ToM related measure and 13 because the article was not an original research paper published in a peer-reviewed journal. This resulted in 12 studies that were included in this review. For an overview of the PRISMA chart, see Figure 1.

3 | RESULTS

In total, 12 studies have assessed ToM in parents during pregnancy or the early postpartum period. These studies also addressed additional related factors, including the role of oxytocin, parental behavior and mental health in relation to ToM, which are also discussed in this review. An overview of details from studies included in this systematic review can be found in Table 1 and descriptions of measures of ToM discussed in this section can be found in box 1.

3.1 | Changes in theory of mind across pregnancy and the early postpartum period

Our search rendered four studies that have examined ToM during pregnancy or in the early postpartum period in parents. Zhang et al.[22] compared ToM measured with the IRI questionnaire between early postpartum and nulliparous women and found no significant differences on subscales of the IRI. Hoekzema et al.[1] compared ToM using the subscores of the IRI of first-time mothers before and after pregnancy, of first-time fathers before and after their partner's pregnancy, and of women and men who remained nulliparous during the study. They did not find any difference between the pre- and post-pregnancy scores of the IRI in these groups. Gómez-Carvajal et al.[23] also found no differences on subscales of the IRI between early postpartum parents, both men and women combined, and non-parents.

In contrast, when using an experimental task for measuring ToM, Hodges et al.[16] found a difference between early postpartum women and nulliparous women. Specifically, while they observed no differences between groups (i.e., pregnant, new mothers, and nulliparous women) in their first measure of empathic accuracy (i.e., writing down what the target was thinking at certain points during the video), the

second measure of empathic accuracy (the MAQ scores) showed that nulliparous women were less accurate than early postpartum women. Notably, pregnant women did not differ significantly from early postpartum women. The authors further differentiated between stereotype accuracy (i.e., the extent to which a perceiver's guess accurately represented how early postpartum women generally respond to this questionnaire), and differential accuracy (i.e., the perceiver's ability to guess how the target would respond in ways that deviated from the prototype). The advantage of early postpartum women over nulliparous women appeared to be entirely due to their stereotype accuracy. Lastly, the researchers assessed how similar the answers of perceivers and targets were and showed that the perceivers' answers on the MAQ significantly predicted the targets' answers to the MAQ. The authors conclude that early postpartum women project their own feelings to other postpartum women, which leads to the higher accuracy in guessing their response.

In summary, although subjective self-report measures of ToM assessed with the IRI do not show any effects of pregnancy, an experimental task to measure ToM does show increased empathic accuracy in early postpartum women compared to nulliparous women. In addition, pregnant women did not differ significantly from early postpartum women.

3.2 | Oxytocin

In this systematic review, two papers, one following women through gestation and the early postpartum period and the other including expectant fathers, indicated an association between ToM and oxytocin. In the study of MacKinnon et al.[24] oxytocin levels of pregnant women were assessed at 12–14 weeks of gestation, 32–34 weeks of gestation, and 7–9 weeks postpartum. ToM was assessed only during the last visit with the RMET. Only oxytocin levels at 32–34 weeks of gestation were significantly positively correlated with performance on the RMET task postpartum. In addition, path analyses revealed a statistically significant direct path from oxytocin at 32–34 weeks of gestation to ToM postpartum, while controlling for confounding variables (i.e., anxiety, prenatal psychosocial risk, education, and parity).

The study of MacKinnon et al.[24] also showed both a negative correlation between oxytocin levels and parity in late gestation and a negative correlation between parity and ToM. They concluded that the more children a mother has, the lower her levels of oxytocin during the third trimester and the poorer her ToM performance postpartum. This is in contrast with a study by Zimerman & Doan[25] that did not find a difference in ToM measured with the IRI between three groups of pregnant women: women expecting a first child, women expecting a second child while having a healthy first child, and women expecting a second child while having a first child with Down syndrome. Oxytocin and ToM were assessed in expectant fathers by Cardenas et al.[26] with a Why-How task during a functional Magnetic Resonance Imaging (fMRI) scan. Higher levels of oxytocin predicted greater signal change during ToM processing in the inferior parietal lobule. In addition, oxytocin was associated with brain responses during the ToM processing in the dorsolateral prefrontal cortex.

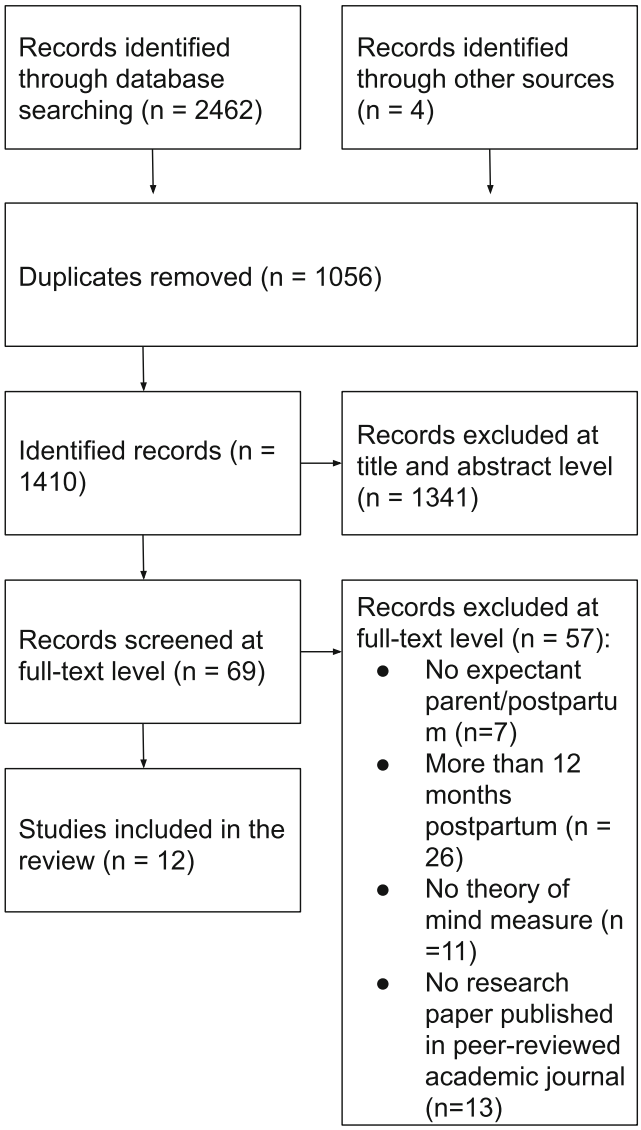

FIGURE 1 PRISMA flowchart.

Overall, research suggests that ToM during pregnancy and the early postpartum period in both mothers and fathers is associated with oxytocin levels. Specifically, higher oxytocin levels in late pregnancy relate to better ToM performance after birth in mothers. Results regarding changes in abilities in ToM and parity are ambivalent. In fathers, the strength of ToM-related brain activation was dependent on their oxytocin levels during the pregnancy of their partner.

3.3 | Parental behavior

Since ToM is considered to be an important component of parental behavior, several studies have examined the link between parental behavior and ToM in pregnant and early postpartum parents.

In pregnant participants, Zimerman and Doan[25] observed a positive correlation between the fantasy subscale of the IRI with a

TABLE 1 Overview of studies ($N = 12$) included in this systematic review.

First Author	Year	ToM measure	Population	Mean ± SD Age	Education	ToM outcome
Barr et al.[22]	2014	IRI	Fifty-four early postpartum women	32.4 ± 4.0	17.2 ± 2.7 educational years;	No correlation between ToM and frustration ratings during prolonged crying sounds.
			57 early postpartum women	33.1 ± 5.4	16.7 ± 2.3 mean educational years	
Cardenas et al. [20]	2021	Why-how task during fMRI	Thirty-nine expectant fathers during mid-to-late pregnancy	31.56 ± 4.25	76.9% reported a college degree or higher	Prenatal oxytocin levels predicted greater signal change during ToM processing in the inferior parietal lobule. Both prenatal oxytocin and attunement parenting beliefs were associated with ToM processing in the dorsolateral prefrontal cortex. Posterior parahippocampal gyrus and dorsolateral prefrontal cortex activation during ToM processing predicted fathers' attunement parenting beliefs.
Diop et al. [23]	2022	RMET; FPT; IRI	Twenty-five early postpartum women diagnosed with postpartum depression with a child under 1 year old	30.72 ± 5.76	Fourteen general qualifications for university entrance; 9 secondary school certificates; 2 basic secondary schooling	No significant differences between women with postpartum depression early postpartum and healthy women on ToM measures.
			Twenty-five healthy early postpartum women with a child under 1 year old	32.03 ± 3.54	Twenty-four general qualifications for university entrance; 9 secondary school certificates; 2 basic secondary schooling	
Gómez-Carjaval et al. [16]	2020	IRI	Early postpartum parents (31 women, 24 men)	28.40 ± 5.16	14.16 ± 3.99 educational years	No significant differences between parent and non-parent group on subscales of IRI.
			Nulliparous people (35 women, 25 men)	26.97 ± 6.38	16.22 ± 2.60 educational years	
Hodges et al. [17]	2010	Empathic Accuracy Task	Twenty early postpartum women with babies between 2 and 4 months	30 (range = 20–43)	All had at least some college experience	No difference between perceiver groups on first measure (similarity with target group on thoughts during the interview). Significant difference on second measure (MAQ similarity with targets) between nulliparous women and pregnant and early postpartum women.
			20 pregnant women for at least 4.5 months with their first child (on average 54 (SD = 37.28) days from due date	32 (range = 21–40)	All but one had at least some college experience	
			20 nulliparous women	29 (range = 20–38)	All had at least some college experience	
Hoekzema et al.[1]	2017	IRI	Twenty-five women before and after their first pregnancy	35.21 ± 4.30	Two finished secondary school; 4 college; 19 university	No differences between subscales of IRI between post- and prepregnancy for all groups.
			15 nulliparous women	31.64 ± 6.41; Based on whole group of 20 participants	Of whole group ($N = 20$), 2 finished secondary school; 3 college; 15 university; based on whole group of 20 participants	

TABLE 1 (Continued)

First Author	Year	ToM measure	Population	Mean ± SD Age	Education	ToM outcome
			Seventeen men before and after the first pregnancy of the partner	33.36 ± 3.97; Based on whole group of 19 participants	Of whole group ($N = 19$), 2 finished secondary school; 4 college; 13 university; based on whole group of 19 participants	
			Ten men without (expecting) a child	31.30 ± 5.63; Based on whole group of 17 participants	Of whole group ($N = 17$), 1 finished secondary school; 3 college; 13 university; based on whole group of 17 participants	
MacKinnon et al. [18]	2014	RMET during 7–9 weeks postpartum	A total of 316 pregnant women measured at 12–14 and 32–34 weeks of gestation and 7–9 weeks postpartum	31.40 ± 4.60	16.46 ± 3.07 years of education	Oxytocin levels at 32–34 weeks of gestation, but not 12–14 weeks of gestation or 7–9 week postpartum, were correlated with ToM measure postpartum. No difference in ToM measure in women breastfeeding or not. Higher ToM significantly correlated with less remote and depressive maternal behavior. Higher ToM significantly correlated with years of education and prenatal psychosocial risk. General anxiety and prenatal worry were not significant predictors of ToM abilities.
Massey et al. [21]	2022	RMET	A total of 154 pregnant women at on average 12.5 weeks of gestation (SD = 4.6)	28.3 ± 4.1	Twelve less than high school; 29 high school/GED; 60 vocational/assoc. degree; 27 any four-year college; 26 bachelor's degree or more	No direct or interactive effects of ToM measures on smoking outcomes (i.e., whether the participants quit smoking during pregnancy).
Rigby et al. [24]	2016	Second-order false belief task, RMET, and a Frith-Happé Animations task	A total of 40 early postpartum women with babies of a mean age of 21.28 weeks (SD = 13.01, range 7–52) with different severe mental illness diagnoses: 1 anxiety; 18 depression; 10 bipolar affective disorder; 4 schizo-affective disorder; 7 schizophrenia	31.47 ± 5.12	Fifteen obtained a degree; 4 attended university; 18 secondary; 1 primary only; 2 unknown	No significant differences on ToM measures between diagnostic groups.
Yildiz Inanici et al. [25]	2021	RMET	A total of 283 pregnant women; only 68 completed ToM measure	28.72 ± 5.59	Elementary and lower (125); high school (102); university and higher (56)	No significant differences between abused and non-abused group on ToM measure; no correlation between self-efficacy and ToM measure.
Zhang et al. [15]	2020	IRI	20 early postpartum women with babies between 2 and 11 months, (mean baby age 6.5 months, SD = 3.0);	29.8 ± 2.0 (range 27–33)	14.4 ± 0.5 educational years	No difference in ToM measure between early postpartum and nulliparous women.

(Continues)

TABLE 1 (Continued)

First Author	Year	ToM measure	Population	Mean ± SD Age	Education	ToM outcome
			22 nulliparous women	26.5 ± 2.0 (range 24–32)	15.6 ± 0.6 educational years	
Zimerman & Doan[19]	2004	IRI	A total of 171 women expecting a first child, mean gestational week 30.3 (between 12 and 39 weeks)	30.6 (range 20–41.4)	3 only grade school; 10 high school; 14 university or college; 105 undergraduate degree; 38 graduate degree	No significant differences between groups, frequency of attachment behaviors and feelings. A subscale of the Maternal Antenatal Attachment Scale, was correlated with cognitive empathy subscales of the IRI in second-time mothers.
			50 women expecting a child with a typically developed child as a first child, mean gestational week 31.3 (between 12 and 39 weeks)	34.2 (range 27–41.9)	One high school; 5 college/ university; 35 undergraduate degree; 9 graduate	
			12 women expecting a second child mean gestational week 26.3 (between 12 and 38 weeks) while having a child with Down syndrome	35.7 (range 28–41.9)	One high school; 5 college/ university; 3 undergraduate degree; 3 graduate	

Abbreviations: FPT, faux pas test; IRI, interpersonal reactivity index; RMET, reading the mind in the eyes task.

subscale of fetal attachment for second-time pregnant women, who had a first child with Down syndrome. Additionally, the perspective-taking subscale of the IRI positively correlated with a subscale of fetal attachment in second-time mothers, irrespective of the health status of the first child, but not in first-time mothers. Another form of maternal caregiving that already occurs during pregnancy are changes in behavior motivated by concerns about the health of the unborn baby. Massey et al.[27] examined ToM ability with the RMET in pregnant participants who were smoking before pregnancy and compared results for women who did or did not quit smoking during pregnancy. Results show that cognitive empathy did not show direct nor interactive effects on smoking cessation.

In early postpartum women, Barr et al.[28] measured the level of frustration when they were listening to prolonged baby cries in combination with measures of ToM as extracted from the IRI. They did not find any correlation between the amount of frustration and ToM. The authors suggest this might be because the compelling nature of prolonged inconsolable crying is salient regardless of individual differences in ToM. In addition, MacKinnon et al.[24] compared women who were breastfeeding to women who were not and did not find any differences in ToM ability. When coding the mothers' behavior during interaction with their two-month-old babies on four dimensions (sensitivity, intrusiveness, remoteness, and depression-related behaviors), they showed that higher scores on the RMET in the early postpartum period were associated with less remote and less depressive behavior. Path analyses showed significant direct paths from ToM to remote and depressive maternal behavior.

In fathers, signal change in the bilateral dorsolateral prefrontal cortex and right posterior hippocampal gyrus during the Why-How task 3 months before their baby was born predicted parental attunement (i.e., the responsiveness to in-the-moment infant cues) at 3 months postpartum.[26] The authors suggest that more attuned parenting may require more competent mentalizing abilities, since the parents need to read infant cues rather than follow certain routines.

In summary, studies indicate a role of ToM in different types of parental behavior. During pregnancy, fetal attachment is correlated to self-reported ToM, but only in second-time mothers. ToM ability was correlated with depressive and remote maternal behavior in early postpartum women. In expectant fathers, brain response during ToM tasks predicted paternal behavior later in their early postpartum period.

3.4 | Other factors associated with ToM during pregnancy and the early postpartum period

ToM is a complex ability that can be influenced by various factors such as a person's mental health, education and experience. Factors that might be related to ToM in pregnant and early postpartum parents examined by studies included in this review will be discussed in this section. Regarding mental health, Diop et al.[29] found no difference between early postpartum women with and without a clinical diagnosis of postpartum depression in ToM measured with the IRI,

BOX 1 ToM measures

ToM can be assessed in multiple ways, subjectively through questionnaires or more experimentally with behavioral tasks. Here, we will explain measures used by studies discussed in this review:

- The commonly used Interpersonal Reactivity Index (IRI) assesses four dimensions, of which the fantasy and perspective-taking dimension make up a cognitive empathy subscale.[15] The fantasy dimension measures the tendency of the participant to identify with fictitious characters in books and movies, and the perspective-taking dimension assesses the tendency to take the psychological point of view of others.
- Hodges et al.[16] use a self-designed empathic accuracy task to assess empathic accuracy, defined as "the cognitive ability to accurately infer what someone is thinking or feeling", which closely resembles definitions of ToM. In their experiment, early postpartum women, labeled as "targets", were asked to describe their experience of new motherhood on videotape. After, the targets watched their own video and were asked to stop the videotape at moments during the interview when they remembered having a compelling thought. They were also asked to complete the Maternal Attitudes Questionnaire (MAQ). Subsequently, three new groups (early postpartum, pregnant and nulliparous women), labeled as "perceivers", were asked to watch the videos of the targets. Each video was stopped by the experimenter at the same moments that the target stopped the video and the perceivers were asked to write down their best guess about what the target was thinking. Afterwards, the perceivers also completed the MAQ. Similarity in answers between targets and perceivers were used to assess empathic accuracy.
- One of the most widely used paradigms to assess ToM is the Reading the Mind in the Eyes Test (RMET). In this task, participants are presented with images of adult eyes and asked to choose one of four words that they feel best describes what the person in the picture is thinking or feeling as quickly as possible.[17]
- During the Why-How task, participants are presented with photographs of common hand actions or facial expressions followed by "Why" and "How" questions.[18] The Why is associated with ToM, and the How with action perception. The contrast of Why over How is used as a measure of ToM.
- The Faux Pas Test consists of 10 stories containing social faux pas (an embarrassing or tactless act or remark in a social situation) and 10 control stories.[19] After each story, participants are asked to answer false belief and faux pas detection questions, used to score the cognitive component of ToM, and affective questions, used to score the affective component of ToM.
- The Bowler Coat Story is a second-order false belief task. A story is read aloud to participants who have to answer questions about what one character thinks and another character believes.[20]
- The Frith-Happé Animations task requires mental states to explain the interaction between two triangles in a short, silent animation.[21]

RMET performance, and Faux Pas Test outcomes. Rigby et al.[30] administered a battery of ToM tasks (i.e., the Bowler Coat Story, RMET, and a Frith-Happé Animations task) to postpartum women suffering from different severe, chronic mental illnesses (i.e., bipolar affective disorder, schizo-affective disorder, schizophrenia, depression, and anxiety). When comparing the different diagnostic groups on ToM variables, they found no significant differences between those groups. Additionally, they filmed the mothers when playing with their child and coded the videos for maternal sensitivity. In all groups, only the performance on the Frith-Happé Animation task positively correlated with maternal sensitivity.

Another factor that may influence ToM during pregnancy is the experience of traumatic events. MacKinnon et al.[24] assessed maternal prenatal psychosocial risk (i.e., history of physical/sexual abuse, history of depression, marital quality, availability of support, and stressful life events) during 32–34 weeks of gestation with self-report on the Antenatal Risk Questionnaire. They showed that higher psychosocial risk was correlated with higher performance on the RMET. In contrast, Yildiz Inanici et al.[31] used the Childhood Trauma Questionnaire to divide pregnant participants in an abused and non-abused group. They found no significant differences in correct answers on the RMET between groups, nor a correlation between correct answers and self-efficacy (assessed with The Parental Self Efficacy Questionnaire). They did, however, present a negative correlation between RMET performance and the anxious preoccupied attachment score (i.e., attachment of the pregnant women with their own parents) of the pregnant participants. This score is one of four attachment styles assessed with the Relationships Questionnaire. Note that these attachment styles are not indicators of general anxiety. Mackinnon et al.[24] assessed general anxiety and prenatal worry, but these were not significant predictors for ToM ability in early postpartum women. They do show a positive correlation between years of education and ToM in early postpartum women. Furthermore, years of education were the only predictor to approach significance for remote and depressive maternal behavior observed during the mother–child interaction 2 months postpartum.

In short, studies included in this review present no difference in ToM abilities between women with and without a postpartum depression and also no differences between different types of severe mental illness in the early postpartum period. In women with severe mental illness in the early postpartum period, there was a relation between maternal sensitivity and ToM, but only for one specific ToM task. Other factors related to ToM were attachment style in pregnant women and prenatal psychosocial risk, attachment style, and education in early postpartum women.

4 | DISCUSSION

In this systematic review, we summarized studies that investigated ToM changes during pregnancy and the early postpartum period. In addition, we evaluated the potential influence of factors such as oxytocin, mental health, history of trauma, education, and attachment on ToM. Only four studies have compared ToM ability between parents and nulliparous individuals, using either a subscale of a questionnaire or an experimental approach examining empathic accuracy. Self-reported measures of ToM did not show any differences between pregnant women or early postpartum men and women compared to measures before pregnancy or a nulliparous group.[1,22,23] An experimental approach did, however, suggest improved ToM abilities in pregnant/early postpartum women in comparison to nulliparous women.[16]

This discrepancy between self-reported and experimental measures of ToM has also been presented by other studies.[32] For instance, studies have shown very small positive correlations between the IRI and ToM experimental approaches[32–34] or differences between groups restricted to one dimension of the cognitive empathy subscale of the IRI and experimental ToM measures.[33,34] This is in line with results of a recent meta-analysis indicating that self-report scores for cognitive empathy account for approximately 1% of the variance in behavioral cognitive empathy assessment.[35] The findings in this systematic review point to an increased ability of ToM in the peripartum period that is only detected by means of experimental ToM tasks but is not perceived by parents themselves when assessed with self-report measures. It should be noted that research on this topic is scarce, with only four studies with small samples having incorporated a measure of ToM in the perinatal period, and our conclusions are thus based on relatively little data. Future studies should examine ToM using experimental and self-report measures in larger samples of pregnant or postpartum participants. Furthermore, to date, no neuroimaging studies have been performed involving ToM-based tasks to examine potential changes in the neural substrates of ToM during the peripartum period. The application of social cognitive fMRI tasks in combination with other measures of ToM could potentially further elucidate potential peripartum changes in ToM performance or ToM-related brain activity.

The one study using an experimental approach[16] showed that early postpartum women have a higher empathic accuracy when predicting other early postpartum women's state of mind. Based on this finding, the authors suggest that personal experience may make one more familiar with a certain experience, leading to higher cognitive accuracy on tasks focusing on that specific experience. However, it should be noted that early postpartum women did not significantly outscore pregnant women, who have not yet experienced the early postpartum attitudes primarily measured by the used self-report measure. This suggests that the degree of familiarity with the experience does not represent the sole factor underlying the observed difference in empathic accuracy. Other processes, such as fluctuating hormones and changes in the brain during pregnancy might influence changes in ToM during pregnancy and the postpartum period.

Previous studies have shown a strong link between oxytocin and ToM abilities. For example, intranasal administration of oxytocin improved performance on the RMET in healthy males[36] and males with autism spectrum disorder.[37] A role of oxytocin in ToM is also observed in studies included in this review, in both expectant fathers[26] and mothers.[24] However, in women, only oxytocin during late gestation, not during early gestation or in the early postpartum period, was positively correlated with ToM in the early postpartum period.[24] This correlation between oxytocin and ToM suggests that the rise in oxytocin during late pregnancy might potentially contribute to improvements in ToM. In addition, Mackinnon et al.[24] found a negative relation between parity and oxytocin levels, which is in line with previous studies showing lower increases of oxytocin in multiparous compared to primiparous parents.[38] However, Zimerman and Doan[25] present no differences in ToM between first- and second-time pregnant women. As highlighted above, significant differences in ToM between first- and second-time pregnant women were found using an experimental approach[24] but not using a questionnaire.[25] In addition, fetal attachment seems to be linked to ToM only in multiparous women and not in primiparous women.[25] This could potentially be related to an increase in sensitivity due to the repeated experience of pregnancy in multiparous women. In order to further unravel the relation between parity, oxytocin, fetal attachment and ToM future research comparing primi- and multiparous (pregnant) participants is needed.

Besides a link between oxytocin and ToM, previous research has also shown an association between oxytocin and parental behavior,[39–41] suggesting a potential relationship between oxytocin, ToM, and parental behavior. In Mackinnon et al.[24] maternal behavior assessed in mother-infant interaction paradigms, specifically less depressive and remote behavior, was found to positively correlate with ToM ability. The authors propose a model where ToM is seen as an intermediate between oxytocin and maternal behavior, although they do not find a direct path between oxytocin and maternal behavior. A follow-up study revealed that these indirect effects were present even 2–3 years postpartum.[42] Although animal studies have shown a direct path between oxytocin and parental behavior,[43] the findings by Mackinnon et al.[24,42] suggest more complex relationships in humans. In humans, oxytocin during late gestation might help to kickstart the ToM abilities that last until at least 2–3 years postpartum, which in turn have an effect on parental behavior.

To further elucidate whether a possible change in ToM is linked to pregnancy-related neurobiological changes or parenting behavior in

general, it would be interesting to examine whether a change in ToM ability also occurs in parents that do not undergo pregnancy. Although the pronounced changes in brain structure as observed in primiparous women across pregnancy have not been detected in parents who do not undergo pregnancy,[1] other studies have observed both increases and decreases in gray matter in a range of brain areas in fathers.[44,45] Additionally, higher prenatal testosterone in fathers was linked to greater activation in the brain during presentation of infant stimuli.[46] In addition, Abraham et al.[47] included primary caregiving mothers who gave birth, primary caregiving fathers, and secondary caregiving fathers in their study. They showed brain activation to infant stimuli that was specific for the primary caregiving parent, whether it was the mother or the father, but also brain activation specific to the mother. Another study showed greater activity in limbic areas when mothers were presented with infant videos, which positively correlated with oxytocin levels, whereas fathers show greater activity in social-cognitive cortical areas that positively correlated with vasopressin levels.[48] In line with these results, another study included in this review found that ToM ability can function as a predictor for parenting styles in expectant fathers.[26] These findings suggest that ToM is important in parenting in fathers as well, although they do not provide insights into the timing of these potential changes. Together, these studies show that both parents that do and do not go through pregnancy undergo neurobiological and hormonal changes when becoming parents, which might be linked to ToM ability, although there are clear differences in the extent, type, and onset of these changes and the brain regions involved.

In individuals suffering from depression, a recent meta-analysis presented small to moderate impairments in ToM.[49] Diop et al.[29] however, found no differences between women with and without postpartum depression on different measures of ToM. This might point to a difference between depression and postpartum depression in terms of the degree of ToM impairment. Untangling differences in ToM ability in both major depression outside the peripartum period and postpartum depression specifically could increase our understanding of the similarities and differences between these types of depression.[50]

Studies included in this review present several other factors that might be related to ToM within the pregnant or early postpartum population. Of the four attachment styles reported by pregnant women, the anxious preoccupied attachment style was negatively correlated with ToM.[31] This is in line with previous work showing a relationship between RMET performance and attachment-related anxiety.[51] Results regarding the relation between a history of traumatic experiences and ToM are less straightforward. Mackinnon et al.[24] found a positive correlation between prenatal psychosocial risk and ToM abilities postpartum, whereas Yildiz Inanici et al.[31] observed no differences between an abused and a non-abused group on ToM. Both findings are surprising in light of previous research, as a previous study showed that women with PTSD-related childhood trauma respond slower on the RMET[52] but only during emotionally salient mental states and not in neutral mental states. This might reflect the emotional stimuli being overwhelming or distracting. Based on this, one would expect a negative correlation between psychosocial risk and ToM ability but Mackinnon et al.[24] found a positive correlation. It should be noted that in this study psychosocial risk was measured with a questionnaire tackling a variety of different factors: history of physical/sexual abuse, history of depression, marital quality, availability of support, and stressful life events. To further elucidate which of these factors are the driving force of the positive correlation with ToM, future research should investigate these factors separately. In addition, these differences in ToM found between women with and without childhood trauma[52] are in contrast with findings of Yildiz Inanici et al.[31] An important difference between these studies is that Yildiz Inanici et al.[31] included healthy pregnant women who were classified as abused based on a questionnaire, whereas other studies enrolled clinically diagnosed groups. Future research on ToM could therefore benefit from including women with a clinical diagnosis to further elucidate possible deficits in ToM due to a history of trauma.

Furthermore, ToM tasks differ in their level of difficulty and the education and/or intelligence level of the participants may therefore play an important role in their performance on the tasks. Indeed, previous studies have shown a link between intelligence and ToM.[53,54] Studies in children, for example, have shown a negative correlation between fluid intelligence and RMET performance.[53] In adults, emotional intelligence was significantly positively correlated with Faux Pas Test performance, but not with RMET performance.[54] The study by Mackinnon et al.[24] also presents a significant positive correlation between years of education and ToM ability in early postpartum women. An overview of the level of education of participants included in studies discussed in this review is presented in Table 1, showing relatively highly educated participants overall. Besides differences in level of complexity, different ToM tasks also assess particular aspects of ToM. For instance, the Frith-Happé Animation task is focused on "detecting" mental states whereas the RMET focuses more on "decoding". Meta-analytic work also points to brain responses that differ based on the employed ToM task.[4,5] Both the difference in complexity of ToM tasks and as well as the different aspects targeted in ToM tasks might lead to substantial variance in outcomes. Future research could therefore benefit from including a measure of education as well as a battery of basic (e.g., Frith-Happé Animation task or RMET) and more complex tasks (e.g., Faux Pas Test).

5 | LIMITATIONS

The results of this review should be interpreted with caution due to certain limitations. Notably, the majority of studies included highly educated participants, potentially confounding the results as education may influence ToM ability.[24,53,54] Furthermore, the search strategy was restricted to articles published in the English language, thereby potentially excluding relevant studies and curtailing the generalizability of the conclusions drawn from this review.

Overall, the studies exhibit several methodological limitations that limit the ability to draw definitive conclusions. Most studies lacked a control group or longitudinal design and were based on small sample sizes. There are only four studies that include either a measure of

ToM before the peripartum period or had a control group. Among these, three studies used self-reported questionnaires, which according to a recent meta-analysis, may not accurately capture actual changes in ToM ability.[35] The one study that applied an experimental paradigm used a non-validated paradigm aimed at measuring empathic accuracy, which is conceptually similar but distinct from ToM. Consequently, it is not possible to state that ToM abilities change in the peripartum period based on these findings.

6 | CONCLUSION

To conclude, the limited research conducted on the subject indicates that there are no differences in ToM abilities between individuals who are parents and those who are not, as measured through the use of a questionnaire. However, the one study using an experimental approach suggests an enhanced ToM ability during pregnancy and in the postpartum period. Future research should focus on examining the impact of pregnancy and parenthood on ToM abilities by applying both ToM experimental tasks and questionnaires in larger cohorts. Furthermore, the application of ToM-based fMRI tasks would be beneficial in exploring potential peripartum changes in the neural substrates of ToM.

This review additionally highlights the intriguing relationships between ToM and related constructs and identifies areas of research that require further investigation. Specifically, oxytocin might serve as a mediator between ToM and certain parental behavior.[24] Some findings also point to a relationship between maternal ToM and parity, as well as to maternal attachment to the fetus, but these results remain ambivalent.[24,25] Associations between ToM and parental behavior do not seem to be restricted to parents who have undergone pregnancy,[26] indicating potential involvement of ToM in parental behavior. Although no direct link between postpartum depression and ToM was observed, studies indicate an association between ToM abilities and depressive and remote maternal behavior, as well as anxious attachment style, in pregnant participants.

While important first steps have been taken to unravel the potential impact of becoming a parent on ToM, further research is needed. A multidisciplinary approach combining experimental tasks, self-report, and neurobiological measures, such as neuroimaging and hormonal measures, could help to further elucidate the complex construct of ToM in relation to pregnancy and parenthood.

AUTHOR CONTRIBUTIONS

Sophie R. van't Hof: Conceptualization; data curation; formal analysis; methodology; visualization; writing – original draft. **Milou Straathof:** Conceptualization; data curation; methodology; supervision; writing – review and editing. **Klara Spalek:** Conceptualization; data curation; methodology; supervision; writing – review and editing. **Elseline Hoekzema:** Conceptualization; supervision; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no competing financial interests.

DATA AVAILABILITY STATEMENT

NA

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REFERENCES

1. Hoekzema E, Barba-Müller E, Pozzobon C, et al. Pregnancy leads to long-lasting changes in human brain structure. *Nat Neurosci*. 2017;20(2):287-296. doi:10.1038/nn.4458
2. Frith C, Frith U. Theory of mind. *Curr Biol*. 2005;15(17):644-645. doi:10.1016/j.cub.2005.08.041
3. de Vignemont F, Singer T. The empathic brain: how, when and why? *Trends Cogn Sci*. 2006;10(10):435-441. doi:10.1016/j.tics.2006.08.008
4. Schurz M, Radua J, Aichhorn M, Richlan F, Perner J. Fractionating theory of mind: a meta-analysis of functional brain imaging studies. *Neurosci Biobehav Rev*. 2014;42:9-34. doi:10.1016/j.neubiorev.2014.01.009
5. Schurz M, Radua J, Tholen MG, et al. Toward a hierarchical model of social cognition: a neuroimaging meta-analysis and integrative review of empathy and theory of mind. *Psychol Bull*. 2021;147(3):293-327. doi:10.1037/bul0000303
6. Korkmaz B. Theory of mind and neurodevelopmental disorders of childhood. *Pediatr Res*. 2011;69(5 PART 2):101R-108R. doi:10.1203/PDR.0b013e318212c177
7. Swain JE, Kim P, Spicer J, et al. Approaching the biology of human parental attachment: brain imaging, oxytocin and coordinated assessments of mothers and fathers. *Brain Res*. 2014;1580:78-101. doi:10.1016/j.brainres.2014.03.007
8. Meins E, Fernyhough C, Fradley E, Tuckey M. Rethinking maternal sensitivity: Mothers' comments on infants' mental processes predict security of attachment at 12 months. *J Child Psychol Psychiatry Allied Discip*. 2001;42(5):637-648. doi:10.1017/S0021963001007302
9. Roos A, Lochner C, Kidd M, van Honk J, Vythilingum B, Stein DJ. Selective attention to fearful faces during pregnancy. *Prog Neuro-Psychopharmacology Biol Psychiatry*. 2012;37(1):76-80.
10. Raz S. Behavioral and neural correlates of cognitive–affective function during late pregnancy: An event-related potentials study. *Behav Brain Res*. 2014;267:17-25.
11. Pearson RM, Lightman SL, Evans J. Emotional sensitivity for motherhood: late pregnancy is associated with enhanced accuracy to encode emotional faces. *Horm Behav*. 2009;56(5):557-563.
12. Swain J, Ho SH, Dayton C, Rosenblum K. Brain activity in empathy and approach-motivation domains for high-risk parents is increased by intervention and inversely related to parenting stress. *Neuropsychopharmacology*. 2014;39(1):S523-S524. doi:10.1038/npp.2014.282
13. Boorman RJ, Creedy DK, Fenwick J, Muurlink O. Empathy in pregnant women and new mothers: a systematic literature review. *J Reprod Infant Psychol*. 2019;37(1):84-103. doi:10.1080/02646838.2018.1525695
14. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *J Clin Epidemiol*. 2009;62(10):e1-e34.
15. Davis MH. Interpersonal reactivity index. 1980.

16. Hodges SD, Kiel KJ, Kramer ADI, Veach D, Villanueva BR. Giving birth to empathy: the effects of similar experience on empathic accuracy, empathic concern, and perceived empathy. *Personal Soc Psychol Bull*. 2010;36(3):398-409. doi:10.1177/0146167209350326
17. Baron-Cohen S, Wheelwright S, Hill J, Raste Y, Plumb I. The "Reading the mind in the eyes" test revised version: a study with normal adults, and adults with Asperger syndrome or high-functioning autism. *J Child Psychol Psychiatry Allied Discip*. 2001;42(2):241-251.
18. Spunt RP, Adolphs R. Validating the why/how contrast for functional MRI studies of theory of mind. *Neuroimage*. 2014;99:301-311. doi:10.1016/j.neuroimage.2014.05.023
19. Baron-Cohen S, O'Riordan M, Stone V, Jones R, Plaisted K. Recognition of faux pas by normally developing children and children with asperger syndrome or high-functioning autism. *J Autism Dev Disord*. 1999;29(5):407-418. doi:10.1023/A:1023035012436
20. Bowler DM. "Theory of mind" in Asperger's syndrome Dermot M. Bowler. *J Child Psychol Psychiatry*. 1992;33(5):877-893.
21. Abell F, Happe F, Frith U. Do triangles play tricks? Attribution of mental states to animated shapes in normal and abnormal development. *Cogn Dev*. 2000;15(1):1-16.
22. Zhang K, Rigo P, Su X, et al. Brain responses to emotional infant faces in new mothers and nulliparous women. *Sci Rep*. 2020;10(1):1-10. doi:10.1038/s41598-020-66,511-x
23. Gómez-Carvajal AM, Santamaría-García H, García AM, et al. The unique social sense of puerperium: increased empathy and schadenfreude in parents of newborns. *Sci Rep*. 2020;10(1):1-10. doi:10.1038/s41598-020-62622-7
24. MacKinnon AL, Gold I, Feeley N, Hayton B, Carter CS, Zelkowitz P. The role of oxytocin in mothers' theory of mind and interactive behavior during the perinatal period. *Psychoneuroendocrinology*. 2014;48:52-63. doi:10.1016/j.psyneuen.2014.06.003
25. Zimerman A, Doan HK. Prenatal attachment and other feelings and thoughts during pregnancy in three groups of pregnant women. *J Prenat Perinat Psychol Heal*. 2004;18(2):131 http://usyd.summon.serialssolutions.com/link/0/eLvHCXMwQ4wAwMqDxPR0lyKKA2NzExPQRhGUQW6kst5NlEHOzTXE2UMXVmbGp-TkxAP1gTZzm1gYGvIV7X_YoNLrenSV7555vxa1IAAAVjgreg
26. Cardenas SI, Stoycos SA, Sellery P, et al. Theory of mind processing in expectant fathers: associations with prenatal oxytocin and parental attunement. *Dev Psychobiol*. 2021;63(5):1549-1567. doi:10.1002/dev.22115
27. Massey SH, Estabrook R, Lapping-Carr L, et al. Are empathic processes mechanisms of pregnancy's protective effect on smoking? Identification of a novel target for preventive intervention. *Soc Sci Med*. 2022;305:115071. doi:10.1016/j.socscimed.2022.115071
28. Barr RG, Fairbrother N, Pauwels J, Green J, Chen M, Brant R. Maternal frustration, emotional and behavioural responses to prolonged infant crying. *Infant Behav Dev*. 2014;37(4):652-664. doi:10.1016/j.infbeh.2014.08.012
29. Diop S, Turmes L, Specht C, Seehagen S, Juckel G, Mavrogiorgou P. Capacities for meta-cognition, social cognition, and alexithymia in postpartum depression. *Psychiatry Res*. 2022;309:114430. doi:10.1016/j.psychres.2022.114430
30. Rigby J, Conroy S, Miele-Norton M, Pawlby S, Happé F. Theory of mind as a predictor of maternal sensitivity in women with severe mental illness. *Psychol Med*. 2016;46(9):1853-1863. doi:10.1017/S0033291716000337
31. Yildiz Inanici S, Akgun B, Karatas HO. Self-efficacy in abused and neglected pregnant women: attachment theory and theory of mind perspectives. *Aust J Forensic Sci*. 2021;53(3):347-358. doi:10.1080/00450618.2019.1695940
32. Bedwell JS, Compton MT, Jentsch FG, Deptula AE, Goulding SM, Tone EB. Latent factor modeling of four schizotypy dimensions with theory of mind and empathy. *PLoS One*. 2014;9(11):e113853. doi:10.1371/journal.pone.0113853
33. Park HY, Seo E, Park KM, Koo SJ, Lee E, An SK. Shame and guilt in youth at ultra-high risk for psychosis. *Compr Psychiatry*. 2021;108:152241. doi:10.1016/j.comppsych.2021.152241
34. Salazar Kaempf M, Kanske P, Kleiman A, Haberkamp A, Glombiewski J, Exner C. Empathy, compassion, and theory of mind in obsessive–compulsive disorder. *Psychol Psychother Theory, Res Pract*. 2022;95(1):1-17.
35. Murphy BA, Lilienfeld SO. Are self-report cognitive empathy ratings valid proxies for cognitive empathy ability? Negligible meta-analytic relations with behavioral task performance. *Psychol Assess*. 2019;31(8):1062-1072.
36. Domes G, Heinrichs M, Michel A, Berger C, Herpertz SC. Oxytocin improves "mind-reading" in humans. *Biol Psychiatry*. 2007;61(6):731-733. doi:10.1016/j.biopsych.2006.07.015
37. Guastella AJ, Einfeld SL, Gray KM, et al. Intranasal oxytocin improves emotion recognition for youth with autism spectrum disorders. *Biol Psychiatry*. 2010;67(7):692-694.
38. Prevost M, Zelkowitz P, Tulandi T, et al. Oxytocin in pregnancy and the postpartum: relations to labor and its management. *Front Public Heal*. 2014;2:1-9. doi:10.3389/fpubh.2014.00001
39. Strathearn L. Maternal neglect: oxytocin, dopamine and the neurobiology of attachment. *J Neuroendocrinol*. 2011;23(11):1054-1065. doi:10.1111/j.1365-2826.2011.02228.x
40. Feldman R, Gordon I, Schneiderman I, Weisman O, Zagoory-Sharon O. Natural variations in maternal and paternal care are associated with systematic changes in oxytocin following parent–infant contact. *Psychoneuroendocrinology*. 2010;35(8):1133-1141.
41. Russell J, Douglas A, Ingram C. Brain preparations for maternity—adaptive changes in behavioral and neuroendocrine systems during pregnancy and lactation. An overview. *Matern Brain*. 2001;133:1-38. http://www.sciencedirect.com/science/article/pii/S0079612301330029
42. MacKinnon AL, Carter CS, Feeley N, et al. Theory of mind as a link between oxytocin and maternal behavior. *Psychoneuroendocrinology*. 2018;92:87-94. doi:10.1016/j.psyneuen.2018.03.018
43. Yoshihara C, Numan M, Kuroda KO. Oxytocin and parental behaviors. *Behav Pharmacol Neuropeptides Oxytocin*. 2017;35:119-153.
44. Kim P, Rigo P, Mayes LC, Feldman R, Leckman JF, Swain JE. Neural plasticity in fathers of human infants. *Soc Neurosci*. 2014;9(5):522-535. doi:10.1080/17470919.2014.933713
45. Martínez-García M, Paternina-Die M, Cardenas SI, et al. First-time fathers show longitudinal gray matter cortical volume reductions: evidence from two international samples. *Cereb Cortex*. 2023;33(7):4156-4163.
46. Khoddam H, Goldenberg D, Stoycos SA, et al. How do expectant fathers respond to infant cry? Examining brain and behavioral responses and the moderating role of testosterone. *Soc Cogn Affect Neurosci*. 2020;15(4):437-446. doi:10.1093/scan/nsaa051
47. Abraham E, Hendler T, Shapira-Lichter I, Kanat-Maymon Y, Zagoory-Sharon O. Father's brain is sensitive to childcare experiences. *Proc Natl Acad Sci U S A*. 2014;111(27):9792-9797. doi:10.1073/pnas.1402569111
48. Atzil S, Hendler T, Feldman R. The maternal and the paternal brain: synchronization, specifications and links with oxytocin and vassopresin. *Biol Psychiatry*. 2012;71(8):185S-216S. doi:10.1016/j.biopsych.2012.02.013
49. Nestor BA, Sutherland S, Garber J. Theory of mind performance in depression: a meta-analysis. *J Affect Disord*. 2021;2022(303):233-244. doi:10.1016/j.jad.2022.02.028
50. Batt MM, Duffy KA, Novick AM, Metcalf CA, Epperson CN. Is postpartum depression different from depression occurring outside of the perinatal period? a review of the evidence. *Focus (Madison)*. 2020;18(2):106-119.
51. Hünefeldt T, Laghi F, Ortu F, Belardinelli MO. The relationship between "theory of mind" and attachment-related anxiety and avoidance in Italian adolescents. *J Adolesc*. 2013;36(3):613-621. doi:10.1016/j.adolescence.2013.03.012
52. Nazarov A, McKinnon MC, Frewen P, et al. Theory of mind performance in women with postraumatic stress disoder related to childhood abuse. *Biol Psychiatry*. 2013;73(9 SUPPL. 1):51S http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed14&NEWS=N&AN=71148606

53. Ibanez A, Huepe D, Gempp R, Gutiérrez V, Rivera-Rei A, Toledo MI. Empathy, sex and fluid intelligence as predictors of theory of mind. *Pers Individ Dif*. 2013;54(5):616-621. doi:10.1016/j.paid.2012.11.022
54. Ferguson FJ, Austin EJ. Associations of trait and ability emotional intelligence with performance on theory of mind tasks in an adult sample. *Pers Individ Dif*. 2010;49(5):414-418. doi:10.1016/j.paid.2010.04.009

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