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Maternal childhood trauma and perinatal distress predict infants' attention from 6 to 18 months

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1 Abstract

2 Maternal distress is repeatedly reported to have negative impacts on the cognitive
3 development in children. Studies examining the association between maternal distress and the
4 development of attention in infancy are few. This study investigated the longitudinal
5 relationships between maternal distress (depressive symptoms, anxiety symptoms, and
6 exposure to childhood trauma) and the development of attention in infancy in 118 mother-infant
7 dyads. We found that maternal exposure to non-interpersonal traumatic events in childhood and
8 a large degree of anxiety during the 2nd trimester was associated with less attention of the infants
9 to audio-visual stimuli at 6, 10, and 18 months. In addition, exposure to interpersonal traumatic
10 events in childhood was identified as a moderator of the negative effect of maternal anxiety
11 during the 2nd trimester on the development of attention in infants. We discuss the possible
12 mechanisms accounting for these cross-generational effects. Our findings underscore the
13 importance of maternal mental health to the development of attention in infancy and address
14 the need for early screening of maternal mental health during pregnancy.

18 Keywords

19 Sustained attention, infancy, maternal anxiety, maternal childhood trauma, cross-generational
20 effect

1 Introduction

2 Attention in infancy is an important cognitive operation involving alerting, orienting,
3 and attending to information in the environment¹. Attention develops rapidly in the first
4 postnatal year² and continues to develop into adulthood³, playing a fundamental role in
5 learning^{4,5}. Attention is also linked to the development of self-regulation and executive function
6 in childhood^{6,7}. Attention is seen as a predictor of social development⁸, cognitive functioning⁹,
7 language development¹⁰, and academic skills¹¹. Poor attention skills are related to several
8 neurodevelopmental disorders, such as attention-deficit/hyperactivity disorder (ADHD)¹² and
9 autism spectrum disorder (ASD)¹³. Taken together, identifying the risk factors of the
10 development of attention in early years is crucial for prevention and intervention.

11 Maternal distress is seen to influence the trajectories of attentional development in
12 childhood. Extensive evidence from large cohort groups has shown that maternal depressive
13 and anxiety symptoms are associated with attention problems in offspring at the ages of 2
14 years¹⁴, 3 and 4 years¹⁵, as well as 5, 6.5, and 14 years^{16,17}. Maternal distress is also linked to
15 ADHD symptoms at the age of 4 and 8–9 years^{18,19}. Moreover, recent studies also reported that
16 maternal childhood adverse experiences contribute to ADHD and ASD in children²⁰⁻²².

17 In nonhuman primates, exposure to mild stress during pregnancy is related to less visual
18 exploration and higher distractibility of offspring²³. In humans, maternal stress during
19 pregnancy has a negative impact on infants' attention shifting at the age of 18 months²⁴. It is
20 been shown that infants whose mothers perceived higher stress during pregnancy needed more
21 time than others to process visual information at the age of 7.5 months and looked away from
22 the tasks significantly more than infants whose mothers had low perceived stress during
23 pregnancy²⁵. Preliminary evidence also suggests that this cross-generational association
24 between maternal distress and infant development might be linked to trauma exposure prior to
25 pregnancy^{26,27}. Moreover, infants of depressed mothers have less synchronous mutual gaze with
26 their mothers than infants of non-depressed mothers²⁸. In turn, mutual gaze has been associated

with visual attention in the first postnatal year of life²⁹. The impact of maternal distress on mother-infant interactions³⁰ and maternal sensitivity³¹ have been related to infants' selective attention³² and gaze-following ability³³.

Maternal distress is often symptomized by an unbalanced and/or strained emotional state from pregnancy to postpartum commonly including depression and/or anxiety^{34,35}. The severity of psychological distress is strongly linked to exposure to traumatic experiences earlier in life^{36,37}. Evidence also suggests different types of traumatic events, such as interpersonal and non-interpersonal trauma, have different impacts on mental distress and psychiatric symptoms^{38,39}. Overall, the literature suggests that maternal distress is multifaceted and it contributes to the development of attention in children. However, contrary to compelling evidence indicating the impact of specific variables related to maternal psychological distress on the development of attention in childhood, there is only very little evidence investigating the impact of multiple dimensions of maternal distress on infants and following the full path from mother's childhood, pregnancy to 1st postnatal year. The analysis of multiple risk factors together is essential due to the high likelihood of co-morbidity and high correlations between risk factors. To bridge this gap, in the current study, we took depression, anxiety, and trauma exposure into consideration. The main aim of this longitudinal study was to investigate how maternal childhood trauma and maternal distress are related to infants' attention from 6 to 18 months of age. We hypothesize that maternal childhood trauma exposure and maternal distress are negatively associated with the infant's attention. In addition, besides identifying the risk factors that might hinder infants' attention, we also preliminarily explored the supportive factors that might buffer against the negative impact of maternal distress. Methods and results are reported in the supplementary information.

Results

Multivariate regression analysis

As seen in Table 1, Model A ($F(6, 103) = 3.698, R^2 = 0.177, p = 0.02$) includes all significant variables systematically selected from Table 2 as described in the Methods. We observed that higher levels of interpersonal traumatic experience in childhood interact with anxiety during the 2nd trimester and a decrease in infants' attention (see Model A in Table 1, $b = -0.037, p = 0.015$). We also found two main effects. First, when mothers were exposed to higher levels of non-interpersonal trauma in childhood, there was a decrease in infants' attention to audio-visual stimuli ($b = -0.029, p = 0.012$). Second, when mothers reported higher levels of anxiety during the 2nd trimester, infants increased their attention ($b = 0.053, p = 0.02$).

The second step, Model B ($F(4, 105) = 5.287, R^2 = 0.168, p < 0.001$) contained only variables that were significant predictors in Model A. All effects remained significant in Model B: the interaction between interpersonal traumatic events and anxiety level during the 2nd trimester ($b = -0.039, p < 0.001$), the main effect of non-interpersonal traumatic events ($b = -0.029, p < 0.05$), and the main effect of anxiety level during the 2nd trimester ($b = 0.051, p < 0.01$).

After controlling for infant's sex, mother's education, smoking habits, and maternal age at birth, Model C ($F(8, 99) = 2.658, R^2 = 0.177, p = 0.011$) showed that the interaction between interpersonal traumatic experiences and anxiety during the 2nd trimester ($b = -0.040, p < 0.001$), the main effect of non-interpersonal traumatic events ($b = -0.029, p < 0.05$), and the anxiety level during pregnancy during 2nd trimester ($b = 0.052, p < 0.01$) all remained significant. Figure 1 visualizes the results of Model C.

Insert Table 1.

1 -----

2 Insert Table 2.

3 -----

4 -----

5 Insert Figure 1.

6 -----

7

8 *Moderation analysis*

9 Following the results described above, exposure to interpersonal traumatic events in
10 childhood was examined as a moderator of the relationship between the anxiety level during
11 the 2nd trimester and the infants' look percentage after adjusting for infant sex and mother's
12 education. Figure 2 displays the slopes for the anxiety level during antenatal 17 weeks and the
13 levels of the exposure to interpersonal traumatic events predicting infants' attention. As
14 indicated by the change in the direction, the effect is moderated by interpersonal traumatic
15 events ($F(5, 103) = 2.916, R^2 = 0.124, p = 0.018$). In other words, with a higher exposure of
16 interpersonal traumatic events, infants' attention decreases as the mother's anxiety level
17 increases.

18 -----

19 Insert Figure 2.

20 -----

21

22 **Discussion**

23 The primary goal of the current study was to investigate whether maternal distress
24 affects the development of attention in infancy. We found that exposure to non-interpersonal
25 and interpersonal traumatic experiences childhood has cross-generational effects on infants'
26 attention. Moreover, childhood interpersonal trauma experience moderates the maternal anxiety

level during the 2nd trimester and hinders the development of attention in infancy. In other words, our results indicate that both traumatic experiences in mothers' childhood and perinatal anxiety increase the vulnerability of mothers and elevate the risk for poor attention of infants. From the standpoint of prevention, our findings underscore the importance of early screening and intervention for mental health issues to support mothers and infants and prevent long-term consequences, even before the pregnancy starts.

In our longitudinal data across pregnancy to early infancy, we found a particular vulnerability in the 2nd trimester. There are two main possible explanations for this finding. The first explanation is that the fetal brain is vulnerable to the in-utero environment due to the critical period of neurogenesis. Exposure to risk factors during this stage of development leads to altered neuron connectivity. Compared to the 1st and 3rd trimesters, exposure to ethanol in the 2nd trimester has been reported to cause great neuronal loss in rodents⁴⁰, attenuated cerebral blood flow⁴¹, and long-lasting alternations in synaptic plasticity⁴² in the human fetus. In children, a previous study also reported that maternal anxiety during the 2nd trimester, but not later during pregnancy, is associated with gray matter reduction in several brain areas in children (6–9 years old)⁴³, including the prefrontal lobe, which is a crucial area in cognitive development⁴⁴ and controls attention⁴⁵. The second explanation is associated with the elevated cortisol levels in mothers during pregnancy. Compared to mothers who do not experience maternal anxiety, childhood maltreatment, or an adverse environment, mothers who experience anxiety or these traumatic experiences have a higher level of cortisol⁴⁶⁻⁴⁸. Scheinost et al. reported that increased cortisol levels during the 2nd trimester and increased subjective maternal distress in the 3rd trimester are associated with weaker connectivity of the anterior cingulate cortex of neonates⁴⁹. The anterior cingulate cortex has been linked to infant's attention^{50,51} and ADHD in children^{52,53} and adults⁵⁴. In addition, one previous study investigating infants' cognitive development at 12 months of age reported that infants with higher cognitive

performance were born to mothers with lower maternal cortisol levels in the 2nd trimester but higher cortisol levels in the 3rd trimester⁵⁵.

Interestingly, maternal depression showed no association with infants' attention. However, previous literature has shown that infants of depressed mothers have a less synchronous gaze in the mother-infant interaction^{28,56} that may affect the development of attention²⁹. Similar to two well-controlled studies investigating cognitive development, maternal depression during pregnancy and infancy did not affect cognitive development at the age of 3 years⁵⁷ and 18 months⁵⁸, respectively. In the context of the current study, there are several plausible reasons for this finding. First, the association between maternal depression and infants' attention may not exist. However, using the same dataset investigating gaze following, infants of mothers with lower levels of postpartum depression presented better skills in synchronizing visual attention with others based on their gaze direction³³. Though mutual gaze interaction can predict attention in infancy²⁹, our data and Astor et al.'s study³³ show that there may be more than one pathway of mother-infant interaction that influences the development of attention. Second, it is possible that the impact of maternal depression on infants' attention is cumulative and becomes significant only in childhood¹⁷. Third, as maternal depression is complex and heterogeneous in nature⁵⁹⁻⁶¹, our four time points may not reflect the complexity and heterogeneity of associations across mothers and infants. Lastly, because of the rigorous nature of the BASIC study, among mothers with depressive symptoms, a higher proportion of those with high functioning/cognitive skills (of which the children might also have good attention) are hypothesized to have filled out the questionnaires, introducing a possible selection bias.

Keeping these alternatives in mind, we cautiously propose another reason. Given the high comorbidity of depression and anxiety in our data (Table 4) and the literature^{62,63}, we propose that anxiety may be the driving force behind peripartum depression. For example, when we examined depressive and anxiety symptoms separately (Table 2), they showed a unique

effect during the 2nd trimester. When we further combined all dimensions and examined the effect while simultaneously controlling others, anxiety dominated the effect. To the best of our knowledge, maternal depression and anxiety are rarely combined and related to child development, meaning that the importance of maternal anxiety may have been interpreted as an effect of depression in prior work. However, the complexity and dynamics between traumatic experiences, depression, and anxiety and how the dynamics change over time are beyond the scope of the current study. Future studies are needed to help us understand how maternal mental health affects infants' attention. Most importantly, it will provide us more knowledge on promoting maternal mental health and infant development.

Finally, and especially due to our limited sample size, our results must be interpreted in light of some limitations. Firstly, we could not compare clinically severe cases due to the relatively small number of severely depressed mothers. To deal with the relatively small sample size and the significant collinearity between depression and anxiety, we calculated the factor scores for depression and anxiety separately at four different time points. This may prevent the plausible interactions at different stages and different levels from being observable in our results. Moreover, our sample is limited to a homogenous population in Uppsala (Sweden), with more than half of participating mothers having education levels of university or higher. In addition, we did not control for the possible influence of partners' mental health on mothers' well-being and infants' attention. As our results indicate the important influence of interpersonal traumatic experiences, future studies should consider this interpersonal aspect and its dynamics with regard to mothers' well-being.

Our findings add to the growing body of research, suggesting that prevention and intervention should start before pregnancy for both mothers and infants. Lastly, the findings describe a previously undocumented connection between maternal early trauma, anxiety, and the development of attention in infants. Treating pregnant women's anxiety, especially if she

has experienced traumatic events in the past, may not only improve the lives of mothers, but also support positive development of their children from infancy onwards.

Methods

Participants

The final data included 118 mother-infant dyads from the BASICchild cohort as part of a longitudinal study (the BASIC Child Project)⁶⁴ of a subsample of the population-based BASIC study "Biology, Affect, Stress, Imaging, and Cognition (BASIC)"⁶⁵ collected from 2014 to 2018. Characteristics of the mother-infant dyads are shown in Table 3. Only healthy pregnant women > 18 years old who received a routine examination at Uppsala University Hospital were invited to participate in the projects. Mothers who consented to participate were invited to fill out a series of questionnaires online at 17 and 32 gestational weeks, and postpartum at 6 weeks, 6 months, and 12 months. Mothers and infants who took part in the BASIC Child Project visited the Uppsala Child and Baby Lab when the infants were aged 6 ($n = 118$; mean = 185 days, SD = 7.5 days, 59 boys), 10 ($n = 110$; mean = 302 days, SD = 9.2 days, 53 boys), and 18 months ($n = 104$; mean = 544 days, SD = 12.1 days, 53 boys). All infants were reported healthy. Sixty-five percent of the mothers held a university degree. All procedures in the study were conducted in accordance with the 1964 Declaration of Helsinki ethical standards and approved by the Regional Ethical Review Board in Uppsala, Sweden (EPN). Mothers who agreed to participate in the online surveys returned their written informed consent prior to the study. For participating infants, all legal guardians provided written informed consent during each visit prior to the experiment. Participants received a gift voucher worth approximately 30 euros after each visit to the lab.

Insert Table 3.

Measures of maternal distress

Symptoms of depression were measured using the Swedish version of the Edinburgh Postnatal Depression Scale (EPDS)^{66,67}. The EPDS includes 10 questions scored from 0 to 3. Thus, the total score ranges from 0 to 30, with higher scores indicating more severe symptoms. The reliability and validity of the EPDS has been shown to be adequate^{68,69}. Symptoms of anxiety was measured using the Beck Anxiety Inventory (BAI)⁷⁰. The scale consists of 21 items, with participants indicating the extent to which they were bothered by each item. The total score for each item ranges from 0 to 63, with higher scores indicating more server symptoms⁷¹. A high level of internal consistency and a good test-retest correlation have been reported⁷⁰. Mothers in the study completed the online version of both EPDS and BAI at 17 and 32 weeks of pregnancy and 6 weeks and 6 months of the first postnatal year. Childhood traumatic exposure was measured using the Swedish version of the Life Incidence of Traumatic Events (LITE)^{72,73}. The LITE is a self-reported checklist that consists of 15 fixed items and one optional item. Each item enquires whether the event has occurred, how many times, the age of the first occurrence, and how inconvenient it remains now. The first eight items ask whether different types of non-interpersonal traumatic events (nIP) have occurred, whereas the remaining items ask whether the seven types of events regarding interpersonal traumatic events (IP) occurred. Interpersonal events are defined as events dependent on a conscious act of another human being, such as physical harm, divorce, or separation of parents, etc. Non-interpersonal events include natural disasters, accidents, or illness of others, etc. The sums of occurrences of nIP and IP were used as two variables in the analysis. Acceptable test-retest reliability and validity have been reported⁷⁴. Mothers in the current study were invited to complete the LITE online during postpartum 12 months.

Measure of infants' attention

Infants' attention was measured by the look percentage (defined as the total fixation duration of the stimuli divided by the total duration of all tasks at each age) across a variety of free-looking tasks at the age of 6, 10, and 18 months. Attention is assumed to be closely linked to oculomotor movement and oculomotor control^{75,76} and, in this study, look percentage is used as a proxy for sustained attention^{77,78}. The mean look percentage at 6, 10, and 18 months was 73.63% (SD = 9.84), 73.47% (SD = 9.36), and 79.24% (SD = 6.86), respectively. The Pearson correlation coefficients (Table 4) of attention, look percentage, between different ages were 0.33 (6–10 months, $n = 110$, $p < 0.001$), 0.21 (6–18 months, $n = 103$, $p = 0.04$), and 0.31 (10–18 months, $n = 100$, $p < 0.01$), suggesting the stability and internal consistency of attention during the course of development. In the current study, the composite score of look percentage was calculated by averaging each participant's look percentage measured at three time points and used as the dependent variable. All tasks were recorded using an eye-tracker with a sampling rate of 60 Hz following a 5-point calibration (Tobii TX300, Tobii Technology AB, Sweden).

 Insert Table 4.

Statistical analysis

We used multivariate linear regression models and a moderator analysis to examine the association between multiple predictors across different time points and the outcome measure. To assess the reliability of the maternal scale instruments, we calculated the internal consistency coefficient, Cronbach's alpha for each tool: EPDS, 0.87, good; BAI, 0.81, good; and LITE, 0.9, excellent. Before adjusting their scores, the zero-order Pearson correlations (with Benjamini-Hochberg correction), skewness, and kurtosis of all variables were calculated (Table 4). The variance inflation factor (VIF) was calculated based on the assumption that infants' look

percentage is predicted by 10 variables from the EPDS (4 time points), BAI (4 time points), and LITE (1 time point). As seen in Table 4, raw scores for anxiety symptoms during antenatal 17 weeks and postpartum 6 weeks are not in the acceptable range of the kurtosis index. The raw scores of the EPDS, BAI, and LITE did not reach the range of approximate symmetric distribution (kurtosis index acceptable range, -2 to +2; skewness index acceptable range -0.5 to + 0.5)⁷⁹. In addition, the literature has shown that comorbidity of depression and anxiety is common^{62,63}, so we expected to detect a potential multicollinearity from the raw data. As seen in Table 4, the raw scores of the EPDS and the BAI during antenatal 17 weeks fit the strict criteria for multicollinearity ($VIF1 > 4$) with other variables^{80,81}. Considering non-normal distribution and multicollinearity of the EPDS and BAI, the Kaiser-Meyer-Olkin test was used to examine the sampling adequacy (MSA) and transformed all raw scores from four time points into factor scores ($MSA > 0.65$)⁸². Missing values were imputed using predictive mean matching⁸³. Individual factor scores of the EPDS and BAI at four time points were calculated using the imputed values. The LITE raw scores, including IP and nIP, were the frequency of the occurrences. They were transformed into dichotomic variables based on the median of the raw scores in order to interpret the interaction. The outcome measure was infants' look percentage composite.

Variable elimination and model fitting

Initially, there was a theoretical selection of 10 predictors included in the current data set that evaluated trauma exposure (1 time point of previous IP and nIP), depressive symptoms (4 time points), and anxiety symptoms (4 time points) in the main analysis to predict infants' look percentage. No other variables except those listed here have been evaluated as part of the analysis. In step 1, considering that maternal trauma exposure prior to pregnancy (both IP and nIP) may interact with depression or anxiety, we separated variables into four groups as listed in Table 2 and analyzed four linear regression models independently. Applying a backward

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1 stepwise method, the number of variables in each model was reduced (3rd column, Table 2). In
2 step 2, based on the statistical selection shown in Table 2, we combined the significant variables
3 and 2-degree interaction from all models to assess how they jointly predict infants' attention
4 (measured by look percentage; see Model A, Table 1). Based on Model A, we selected
5 significant variables for Model B (see Table 1). In the third step, we added the sex of infants^{84,85},
6 mothers' smoking habits⁸⁶, education⁸⁷, and the maternal age at birth⁸⁸ to the analysis (Model
7 C, Table 1). All tests were two-sided tests with $p < 0.05$ considered significant. All statistical
8 analyses were performed using R 4.0.3⁸⁹.

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MATERNAL DISTRESS AND INFANTS' ATTENTION

Table 1. The final multivariate linear model predicting infants' look percentage

Model	Variables	Beta	Std. Error	t value	p value	Model summary
A	(Constant)	0.805	0.022	36.522	<0.001	F (6, 103) = 3.698, p = 0.002, R ² 0.177
	nIP	-0.029	0.011	-2.571	0.012	
	BAI w17	0.053	0.023	2.361	0.020	
	EPDS w17	-0.006	0.023	-0.284	0.777	
	IP	-0.004	0.011	-0.383	0.702	
	IP*EPDS w17	-0.001	0.015	-0.079	0.937	
	IP*BAI w17	-0.037	0.015	-2.483	0.015	
B	(Constant)	0.804	0.022	36.662	<0.001	F (4, 105) = 5.287, p < 0.001, R ² 0.168
	nIP	-0.029	0.011	-2.599	0.011	
	IP	-0.004	0.011	-0.378	0.706	
	BAI w17	0.051	0.018	2.874	0.005	
	IP*BAI w17	-0.039	0.011	-3.534	<0.001	
C	(Constant)	0.820	0.055	14.791	<0.001	F (8, 99) = 2.658, p = 0.011, R ² 0.177
	nIP	-0.029	0.012	-2.495	0.014	
	IP	-0.002	0.012	-0.152	0.880	
	BAI w17	0.052	0.018	2.833	0.006	
	IP*BAI w17	-0.040	0.011	-3.572	<0.001	
	Infant's sex	0.001	0.012	0.50	0.961	
	Mother's education	0.022	0.014	01.588	0.115	
	Mother's smoking habit	0.004	0.013	0.274	0.785	
	Mother's age at birth	-0.002	0.002	-1.300	0.197	

Model A includes all significant variables united from Table 7. Model B uses the backward stepwise method to eliminate variables and improve the model. Model C is the final model after adjusting for infant sex, mother's education, smoking habit, and the mother's age birth. Abbreviations: EPDS, Edinburgh Postnatal Depression Scale; BAI, Beck Anxiety Inventory; LITE, Lifetime Incidence of Traumatic Events; w17, pregnancy week 17; w32, pregnancy week 32; pv6, postpartum 6 weeks; pm6, postpartum 6 months; IP, interpersonal events; nIP, non-interpersonal events.

Table 2. Four separate multivariable linear regression models for systematically selecting variables for the final model

Model	Initial included independent variables	Independent variables after backward stepwise elimination	Beta	Std. Error	Std. Beta	t value	p value	Model summary
Non-interpersonal traumatic events and depression	nIP, EPDS w17, EPDS w32, EPDS pw6, EPDS pm6, nIP*EPDS w17, nIP*EPDS w32, nIP*EPDS pw6, nIP*EPDS pm6	(Constant)	0.795	0.018		44.636	<0.001	$F(3, 106) = 3.602$, $p = 0.015$, $R^2 = 0.0925$
		nIP	-0.029	0.012	-0.233	-2.507	0.014	
		EPDS w17	-0.012	0.006	-0.199	-2.145	0.034	
		EPDS pm6	0.006	0.006	0.098	1.053	0.295	
Interpersonal traumatic events and depression	IP, EPDS w17, EPDS w32, EPDS pw6, EPDS pm6, IP*EPDS w17, IP*EPDS w32, IP*EPDS pw6, IP*EPDS pm6	(Constant)	0.754	0.006		130.371	<0.001	$F(3, 106) = 2.936$, $p = 0.037$, $R^2 = 0.076$
		EPDS w17	0.026	0.019	0.422	1.415	0.160	
		IP*EPDS w17	-0.025	0.012	-0.634	-2.125	0.036	
Non-interpersonal traumatic events and anxiety	nIP, BAI w17, BAI w32, BAI pw6, BAI pm6, nIP*BAI w17, nIP*EPDS w32, nIP*BAI pw6, nIP*BAI pm6	(Constant)	0.794	0.018		44.241	<0.001	$F(3, 106) = 2.936$, $p = 0.037$, $R^2 = 0.077$
		nIP	-0.028	0.012	-0.229	-2.445	0.016	
		BAI w17	-0.009	0.006	-0.147	-1.563	0.121	
		BAI pm6	0.006	0.006	0.098	1.046	0.298	
Interpersonal traumatic events and anxiety	IP, BAI w17, BAI w32, BAI pw6, BAI pm6, IP*BAI w17, IP*EPDS w32, IP*BAI pw6, IP*BAI pm6	(Constant)	0.756	0.006		132.995	<0.001	$F(4, 105) = 3.906$, $p = 0.005$, $R^2 = 0.130$
		BAI w17	0.051	0.018	0.829	2.812	0.006	
		BAI pw6	-0.008	0.005	-0.136	-1.496	0.181	
		IP*BAI w17	-0.039	0.011	-1.001	-3.396	0.001	

Look percentage is the common dependent variable in all four models. Significant variables of each model are included in the united model.
Abbreviations: EPDS, Edinburgh Postnatal Depression Scale; BAI, Beck Anxiety Inventory; LITE, Lifetime Incidence of Traumatic Events; w17, antenatal 17 weeks; w32, antenatal 32 weeks; pw6, postpartum 6 weeks; pm6, postpartum 6 months; IP, interpersonal traumatic events; nIP, non-interpersonal traumatic events.

Table 3. Demographic characteristics of 118 mother-infant dyads

Characteristic	Mother-infant dyad (n = 118)
Maternal age, years	30.54 (3.92)
Country of origin	
Scandinavian	93.1%
Other	6.9%
Maternal education	
University or higher	65.0%
Other	35.0%
Cohabiting with the second caregiver	99.2%
With smoking history	36.4%
Employment	
Full-time	61.2%
Part-time	18.1%
Student	9.5%
Sick leave	4.3%
Unemployed	6.9%
Length of gestation, days	280 (8.09)
Infant sex, female	59%
Infant birth weight, g	3,664 (481)
Infant's Apgar score at 5 minutes	
7	0.9%
8	2.6%
9	6.0%
10	90.6%

Data are given as the proportion of dyads or mean (SD).

Table 4. Pearson's zero order correlations between all variables using raw scores

	Timing of measure	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1.LP (6 months)	Postpartum	–													
2.LP (10 months)	Postpartum	0.33 ***	–												
3.LP (18 months)	Postpartum	0.21 *	0.31 **	–											
4.LP composite	Postpartum	0.76 ***	0.79 ***	0.62 ***	–										
5.EPDS w17	Antenatal	–	–	–	–	–									
6.EPDS w32	Antenatal	–	–	–	–	0.75 ***	–								
7.EPDS pw6	Postpartum	–	–	–	–	0.47 ***	0.58 ***	–							
8.EPDS pm6	Postpartum	–	–	–	–	0.54 ***	0.57 ***	0.63 ***	–						
9.BAI w17	Antenatal	–	–	–	–	0.74 ***	0.60 ***	0.40 ***	0.37 ***	–					
10.BAI w32	Antenatal	–	–	–	–	0.57 ***	0.68 ***	0.41 ***	0.41 ***	0.76 ***	–				
11.BAI pw6	Postpartum	–	–	–	–	0.43 ***	0.49 ***	0.62 ***	0.54 ***	0.53 ***	0.54 ***	–			
12.BAI pm6	Postpartum	–	–	–	–	0.37 ***	0.49 ***	0.40 ***	0.59 ***	0.52 ***	0.53 ***	0.66 ***	–		
13.LITE IP	Postpartum	–	–	–	–	0.22 *	0.24 *	0.25 **	0.25 *	0.21 *	0.19 *	0.34 ***	–	–	
14.LITE nIP	Postpartum	–	-0.17 +	-0.35 ***	-0.26 **	–	–	–	–	–	–	–	–	0.34 ***	–
Skewness	–	-0.87	-0.52	-0.85	-0.47	0.95	0.97	0.79	0.95	1.47	1.06	1.45	1.57	0.95	0.97
Kurtosis	–	1.52	-0.16	1.09	-0.03	0.68	1.33	0.01	0.88	2.46	1.12	1.90	2.40	0.68	1.33
VIF 1	–	NA	NA	NA	NA	5.24	3.95	2.50	2.86	4.23	2.83	2.78	2.98	1.24	1.23
VIF 2	–	NA	NA	NA	NA	2.05	1.43	1.40	1.54	2.01	1.47	1.50	1.50	1.13	1.07
MSA	–	NA	NA	NA	NA	0.70	0.71	0.76	0.77	0.72	0.72	0.77	0.77	0.42	0.43

+ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ with Benjamini-Hochberg correction. Abbreviations: LP, look percentage; LP composite, mean look percentage of three age points; EPDS, Edinburgh Postnatal Depression Scale; BAI, Beck Anxiety Inventory; LITE, Lifetime Incidence of Traumatic Events; VIF, variance inflation factor (using LP as an outcome, other 10 variables as predictors; VIF 1 is calculated all with raw scores; VIF 2 is calculated with factor scores of EPDS and BAI and composite scores of LITE); MSA, measure of sampling adequacy according to Kaiser-Meyer-Olkin test; w17, pregnancy week 17; w32, pregnancy week 32; pw6, postpartum 6 weeks; pm6, postpartum 6 months; IP, interpersonal events; nIP, non-interpersonal events; NA: not applicable, as LP 6, 10, and 18 months were used as dependent variables.

Figures

Figure 1

Illustration of the multivariate linear regression model after adjusting for the sex of the infant, mother's education level, smoking history, and the maternal age at birth. Non-interpersonal traumatic experiences in mother's childhood and maternal anxiety in early pregnancy had a direct impact on the infants' look percentage ($\beta = 0.014$ and 0.006 , respectively). When anxiety at week 17 of pregnancy interacts with interpersonal traumatic exposure in childhood, the negative impact on the infants' look percentage is highly significant ($p < 0.001$). LITE, Lifetime Incidence of Traumatic Events; IP, interpersonal events; nIP, non-interpersonal events.

Figure 2

The relationship between maternal anxiety (Beck Anxiety Inventory at antenatal 17 weeks, BAI week 17) and infants' attention, look percentage (LP), is moderated by the level of interpersonal traumatic events (IP) in childhood measured by Life Incidence of Traumatic Events (LITE). Level 1 (solid line) represents mothers who exposed to less trauma in childhood compared to those at level 2 (dotted line).

Supplementary Files

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