Abstract

Background: Postnatal mental illnesses are associated with less maternal sensitivity. Differences in how mothers with and without mental illness process infant emotions could explain this. People with mental illness in non-perinatal populations show certain processing patterns when viewing emotional faces, but it is not clear whether these patterns are present in mothers.

Objective: Compared to mothers without affective symptoms (anxiety, depression and post-traumatic stress). Task 1 aimed to identify whether mothers with affective symptoms show an attentional bias towards negative infant faces; and Task 2 aimed to identify whether mothers with affective symptoms look less at infants' eyes compared to eyes and mouth.

Design: An experimental design was used in two tasks to answer the research objective.

Methods: Mothers with affective symptoms (n = 23) and without affective symptoms (n = 47) had their eye-movements tracked whilst: Task 1) viewing pairs of infant faces; and Task 2) viewing morphed infant faces.

Results: In Task 1 mothers with affective symptoms were more likely to fixate first on neutral faces when the choice was between negative and neutral. In Task 2, no differences were found between groups.

Conclusions: The findings from Task 1 are unexpected given previous research. More research is needed to identify potential explanations for this.

Keywords: Attentional bias; eye-tracking; postnatal mental health; infant faces

Postnatal mental health and mothers' processing of infant emotion: An eye-tracking study

Research suggests that postnatal mental illness such as anxiety, depression and Post-Traumatic Stress Disorder (PTSD) may influence a mother's responses to her infant. For example, mothers with depression may interact in a controlling and over-stimulating way with their infant, or they may be withdrawn and passive (Field, 2010). Furthermore, mothers with anxiety show less sensitive responses when interacting with their infant, through reduced emotional tone or overly intense vocalisations, acknowledgments, positive affect and gaze (Kaitz et al., 2010; Nicol-Harper et al., 2007). Similarly, there is emerging evidence that mothers with PTSD may be more hostile and less sensitive when interacting with their infants (Feeley et al., 2011; van Ee et al., 2012).

It is unclear why some mothers with mental health difficulties are less sensitive in their interactions with their infant. One possible mechanism is attentional and perceptual patterns or biases displayed by these mothers (Webb & Ayers, 2015). It has been suggested that the ability to perceive emotions and interpret them appropriately is key to maternal sensitivity (Eisenberg et al., 1998; Shin et al., 2008; van Doesum et al., 2007). In other words, mothers need to notice their infant's cues and interpret them appropriately to be sensitive to their infant's needs. For a mother to notice her infant's cues her attention needs to firstly be directed towards her infant (orienting) and then her infant's emotional expression/behaviour/vocalisation will need to be singled out for processing (selection) (Yiend, 2010). A mother must then be able to disengage her attention from her infant's cue when it has stopped, her infant has been responded to, or her infant shows a new cue (disengagement).

Research has found that mental health difficulties can affect attention. For example, Yiend (2010) conducted a review of attentional processing of emotional information and found that individuals with anxiety and depression show biased attention towards material matching the concerns of the individual when using dot-probe and Stroop paradigms. This preferential allocation of attention to certain stimuli is known as an attentional bias. Attentional biases are thought to be comprised of facilitated selective attention towards certain stimuli, difficulty disengaging attention away from certain stimuli, or attentional avoidance of certain stimuli (Cisler & Koster, 2010).

Perinatal mental health difficulties have also been associated with attentional biases towards emotional expressions. For example, perinatal depression has been associated with faster disengagement from negative infant emotional expressions when using a go/no-go paradigm (Pearson et al., 2010; Pearson et al., 2013). Furthermore, research has found that mothers with parenting stress show faster reaction times when identifying a target blue-eyed infant emotional face out of an array of brown eyed baby faces when using a visual search task (Thompson-Booth et al., 2014b). If a mother disengages from her infant's distress during interaction, such as through behavioural withdrawal, this could lead to less sensitive maternal interactions. These studies are the only three published studies that have investigated attentional biases towards infant emotional expressions in mothers with perinatal mental illness. Therefore, it is not clear whether attentional biases found are due to selective attention, difficulty disengaging or attentional avoidance.

Eye-tracking methodology could provide some insight into the mechanisms underpinning attentional biases found in mothers with perinatal mental health difficulties. It has been suggested that eye tracking provides a continuous measure of attentional selection performed via

eye movements. Therefore, eye tracking arguably has a very close relationship to attention (Armstrong & Olatunji, 2012). Eye tracking studies that have been carried out in non-perinatal populations find certain gaze patterns are displayed when individuals with mental health difficulties are shown negative or threatening images. For example, individuals with depression are more likely to orient their attention towards sad faces, spend more time looking at them (Duque & Vázquez, 2015) and spend less time looking at happy faces (Lu et al., 2017). Individuals with anxiety have been found to orient their attention towards emotional faces, and have difficulty disengaging from angry expressions (Schofield, Johnson, Inhoff, & Coles, 2012). Individuals with domestic violence related PTSD spend longer looking at angry faces compared to fearful and neutral faces (Lee & Lee, 2013). Furthermore, war veterans with PTSD have been found to spend more time looking at negatively valenced images, especially if the images were trauma relevant (i.e. images of war) (Kimble, Fleming, Bandy, Kim, & Zambetti, 2010). These studies show the impact mental health difficulties can have on orientation and attention towards stimuli.

Maternal sensitivity in interactions is about both orienting attention towards relevant environmental stimuli (such as a crying infant) and being able to interpret this appropriately. However, mothers with perinatal mental health difficulties have been shown to be less accurate at interpreting certain infant emotional expressions. For example, mothers with diagnosed depression have been found to be less accurate at labelling happy faces compared to sad faces (Arteche et al., 2011; Broth et al., 2004; Flanagan et al., 2011; Gil et al., 2011). Furthermore, mothers with symptoms of anxiety and depression display an increased sensitivity towards negative faces, being more likely to rate neutral and sad faces as being sadder than controls (Gil et al., 2011; Stein et al., 2010; van Bakel et al., 2013).

This research suggests that perinatal mental health difficulties can influence the interpretation of emotional expressions. It is not clear why mothers with perinatal mental health difficulties show these patterns, but research carried out with non-perinatal populations suggests that individuals with mental health difficulties might not attend to those areas on the face, also known as areas of interest, that are most indicative of a given emotion. For example, negative emotions are expressed more on the upper part of the face (such as theeyes), whereas positive emotions are expressed more on the lower part of the face (such as the mouth) (Dimberg & Petterson, 2000; Ekman & Friesen, 1969), and individuals will focus on the mouth for positive faces and the eyes for sad faces (Beaudry, Roy-Charland, Perron, Cormier & Tapp, 2014; Calvo & Nummenaa, 2008; Calder, Young, Keane & Deane, 2000; Schurgin et al., 2014).

However, differences in face processing when identifying emotions can reduce the accuracy with which individuals categorise emotions. For example, in one cross-cultural study individuals from Japan and China had difficulty distinguishing fear from surprise, and anger from disgust, compared to their Western counterparts (individuals from Europe). The authors suggested that this could be because East Asian people spend less time looking at the mouth compared to Western Caucasian people when identifying emotional expressions (Jack, Blais, Scheepers, Schyns, & Caldara, 2009). Likewise, individuals affected by autism often struggle to identify emotional expressions (Bal et al., 2010; Uljarevic & Hamilton, 2013) and research has found they tend to look less at the eyes and spend more time looking at the mouth (Neumann, Spezio, Piven, & Adolphs, 2006). Less research has been carried out with people with mental illnesses, however one study found that people with depression spend less time looking at areas of interest such as the eyes, and instead spend more time looking at the left-hand-side of the face (Wu, Pu, Allen, & Pauli, 2012). Further, people who have psychopathic traits tend to look less at

the eyes when categorising fear (Dargis, Wolf & Koenigs, 2018). Overall, this literature suggests that to categorise a facial expression correctly, individuals must look at the eyes and the mouth, and those that tend to not follow this pattern, such as people with mental health difficulties, display more difficulty when categorising faces. In summary, previous research has found that mental health difficulties are associated with certain eye gaze patterns when attending to, or interpreting emotional displays. However, to date no research has investigated gaze patterns when viewing infant emotional expressions in the postnatal period. Therefore, the aim of this study was to firstly investigate whether mothers with affective symptoms of anxiety, depression and PTS display attentional biases towards certain infant emotional expressions by tracking mother's eye movements during a free viewing paradigm. Based on previous research (Duque & Vazquez, 2015; Lee & Lee, 2013; Lu et al., 2017; Schofield et al., 2012) it was predicted that mothers with affective symptoms would orient their attention first to more negative images, and then spend more time looking at negative images than mothers without affective symptoms. The second aim was to investigate whether mothers with affective symptoms spend a different proportion of time looking at the eyes in comparison to the eyes and mouth, compared to mothers without affective symptoms when interpreting infant emotional expressions. Based on previous research (Wu et al., 2012) it was predicted that mothers with affective symptoms would spend less time looking at the eyes compared to mothers without affective symptoms.

Method

Design

Two tasks were carried out with a group of mothers with and without symptoms of anxiety, depression and PTS (affective symptoms). The first task (attentional bias to emotional

faces) investigated mother's attentional biases during a free viewing paradigm, and was a 2 (Group: Mothers with affective symptoms vs Mothers without affective symptoms) x 3 (Trial type: Positive/ Negative vs Positive/Neutral vs Negative/Neutral) repeated measures design. This aimed to investigate mother's attentional biases towards infant emotional expressions with regards to their first fixation, and proportion of time spent looking at more positive expressions.

The second task (perceptual strategy study) had a 2 (Group: Mothers with affective symptoms vs Mothers without affective symptoms) x 2 (Emotional Category: Positive vs Negative) repeated measures design. This aimed to investigate which regions of interest (eyes or mouth) mothers looked more at during an emotional categorisation task, using a morphed faces paradigm similar to the one used by Arteche et al. (2011).

Tasks were counterbalanced across participants and groups.

Participants

Two groups of mothers were recruited: mothers with affective symptoms and mothers without affective symptoms. Inclusion criteria were that mothers were aged 18 or over, and that they had an infant aged 3-8 months. The age of the infants was set at 3-8 months due to the developmental ability of the infants. From 3 months infants can recognise emotions and smile intentionally (Watson, Hayes, Vietze & Becker, 1979), and by 8 months specific attachment is already beginning to form (Schaffer & Emerson, 1964).

Mothers were recruited into the affective symptoms group if they had current symptoms of anxiety or depression as measured by the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith) and/or symptoms of PTS, as measured by the PTSD Diagnostic Scale (PDS; Foa, 1995). Mothers with different clusters of affective symptoms (i.e. anxiety symptoms, depression symptoms) were grouped together due to the high level of comorbidity within this

population (Agius, Xiereb, Carrick-Sen, Saltana & Rankin, 2016; Dikmen Yildiz, Ayers & Phillips, 2017).

Over 200 women (n = 228) completed the screening questionnaires, and 194 eligible women left contact details. All 194 women were invited to City, University of London. A total of n = 50 (25.77%) mothers without affective symptoms and n = 30 (15.46%) mothers with affective symptoms agreed to attend and participated. Three women without affective symptoms had to be excluded due to technical difficulties with the eye tracker and seven women with affective symptoms had to be excluded because their baby was too old by the time they could participate. This left a total of n = 47 mothers without affective symptoms, and n = 23 mothers with affective symptoms. Maternal age ranged from 23 to 50 (M = 34.01, SD = 4.57). The majority of the mothers had completed an undergraduate degree (42.9%) or a postgraduate degree (42.9%), were married (68.6%) and were white (87%). Most of the mothers (48.3%) and their partners (44.7%) worked in professional occupations (Office for National Statistics, 2010). Infants age ranged from 3 to 8 months (M = 5.04, SD = 1.24). There were no significant differences in demographic characteristics between the groups. Mothers with affective symptoms had significantly higher symptom scores than mothers without affective symptoms (see Table 1).

[Table 1 about here]

Materials

Screening questionnaires. To assess mothers' eligibility brief demographic information was collected online regarding participants' age, ethnicity, level of education, infant's age and number of other children. To assess mothers' mental health, two questionnaires were used:

Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983). The HADS scale has two subscales that measure depression and anxiety. The HADS had high internal consistency in this sample (Whole scale: Cronbach's α = .89, Anxiety subscale: Cronbach's α = 0.7; depression subscale: Cronbach's α = .89). A cut-off of eight or more on either subscale of the HADS was used as inclusion criteria for the affective symptoms group (Stern, 2014). This cut-off has good sensitivity for depression (0.77 – 1; Lepine et al., 1986, as cited in Bjelland, Dahl, Haug, & Neckelmann, 2002; Silverstone, 1994) and anxiety (0.64 -.94; Lepine et al. 1986; Razavi et al., 1992).

Post-traumatic stress disorder diagnostic scale (PDS) (Foa, 1995) is a short checklist made of 40 items, which asks participants to rate their response to a traumatic event. The PDS is made up of six subscales (A: event; B: re-experiencing; C: avoidance & numbing, D: arousal, E: duration, F: significant impact/impairment). The PDS had high internal consistency in this sample (Cronbach's α = 0.97). Mothers were asked to complete this questionnaire with regards to their most recent birth, and separately with regards to any other traumatic events they may have experienced. Symptom severity was measured by adding up items for subscales B, C and D. Participants were classed as having PTS symptoms if they scored more than 11 on the PDS symptom severity. A cut off of 11, as a score of 11 or more reflects moderate to severe symptoms of PTS (Foa, 1995).

Stimuli. For the attentional bias task 48 images of infants were used. These faces were taken from the City Infant Faces Database (Webb et al., 2017). These were paired into three trial types: 1) positive/negative emotion; 2) positive/neutral emotion; 3) negative/neutral emotion. Each image was 224 x 308 pixels and participants were sat approximately 60cm from the screen.

For the perceptual strategy task, 50 images were selected from a set of infant faces, developed by the authors for a previous study (Ayers et al., Unpublished). These images contained photographs of 5 babies showing very positive facial expressions (smiling, laughing) and very negative facial expressions (crying, anger). The images were then morphed together at increments of 11% (Image 1 = happiest, Image 10 = saddest) to create a set of 10 images per baby; eight of which were ambiguous (i.e. a mixture of positive and negative). For example, Image 1 was 100% positive, Image 2 was 89% positive and 11% negative; Image 3 was 78% positive and 22% negative, and so on until Image 10 which was 100% negative. Images were turned into grayscale using Photoshop 2014 for the purpose of this task. Each image was 224 x 274 pixels.

Apparatus. A Tobii Tx300 eye tracker was used to assess eye-movements throughout the experiments. Both experiments were viewed on a 23" widescreen monitor. E-Prime version 2.0 was used to present the stimuli. Participants were sat approximately 60cm from the screen. Gaze data was acquired at a sampling rate of 120 Hz. E-prime v2.0 was used to present the stimuli for the mothers.

Procedure.

This study was approved by City, University of London School of Health Sciences Ethics Committee. Participants were assessed for symptoms of anxiety, depression and PTS via an on online survey platform, Qualtrics (Qualtrics., 2015). Participants were asked to leave their contact details at the end of the survey if they wanted to take part in the computer tasks. If participants met eligibility criteria they were invited to come to the university to take part in the tasks. Participants who consented completed two eye-tracking tasks, the order of which was counterbalanced across participants. Calibration was performed using the default calibration

procedure in Tobii extensions for E-Prime before the start of each experiment. Tasks were counterbalanced across participants and groups i.e. participant 1 from group 1 (no affective symptoms) would complete the attentional bias task first; participant 1 from group 2 (affective symptoms) would complete the perceptual strategy task first, participant 2 from group would complete perceptual strategy task first, and so on.

Attentional biases to emotional faces. The experiment was set up so that for each trial, two faces of the same infant were on the screen (see Figure x). To ensure that the Tobii extensions for E-Prime output identified which image the participant was looking at, the left-hand side image, and the right-hand side image were defined as regions of interest in the Tobii Extensions for E-Prime script. To avoid participants altering their viewing patterns because of response bias (i.e. looking more at one face in order to make the experimenter judge them in a positive light or looking at a certain face because they believe this is what the experimenter wants) participants were told the eye tracker was measuring their pupil dilation (rather than fixation and movement).

Participants were then exposed to three experimental conditions: 1) positive/negative (16 trials); 2) positive/neutral (16 trials); 3) negative/neutral (16 trials). Two versions of the experiment were made to ensure image sides were counterbalanced (see supplementary materials for more detail), and the version used was alternated by participant (i.e. participant 1, version 1; participant 2, version 2). The order in which the trials were presented were set to be shown randomly in E-Prime for both versions.

Each trial began with a fixation cross in the centre of the screen which participants were asked to focus on until the stimuli appeared (after 200ms). A pair of faces then appeared on the screen for 10 seconds. Participants were asked to look freely at the screen “as if watching

television" while the stimuli were presented, see Figure 5.1 for a diagrammatical representation of a trial. Participants were provided with a short break, every 16 trials**.**

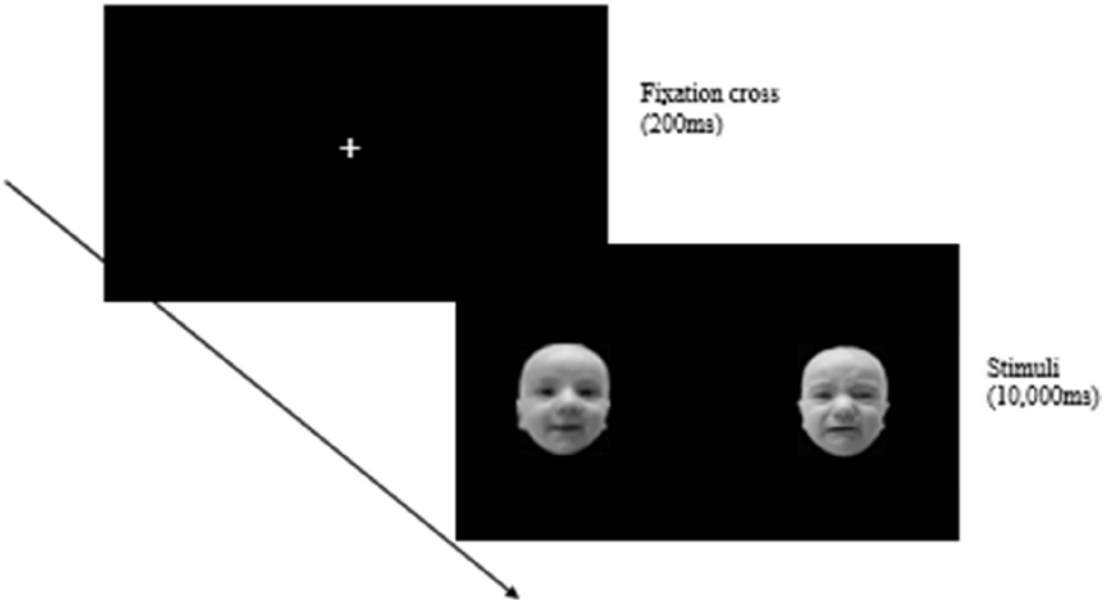

Figure 1. Example trial of the mother's attention to emotional expressions task.

Image not to scale.

Perceptual strategy Morphed infant faces, shown as greyscale images, appeared on the screen for 500ms. Images were presented randomly and E-Prime was used to present the stimuli. Fifty faces were presented in total. Participants were required to press the space bar as soon as they were able to categorise the emotion, and then press 1 on the keyboard if they thought the emotion was positive, and 2 if they thought the emotion was negative. These options were displayed in writing on the screen to ensure participants did not forget the answer options. Accuracy was measured by E-Prime and results have been reported elsewhere Webb and Ayers (Submitted). To identify maternal perceptual strategy whilst mothers were categorising infant

emotional expressions, their gaze data was recorded. Regions of interest were defined prior to the experiment using E-prime extensions for Tobii. These were defined as the eyes and the mouth.

Data Analysis.

Eye tracking data was analysed using R version 3.4.1. Samples where validity codes were less than 2, or where gaze values fell beyond 0 or 1 (indicating samples where the participant was not looking at the screen) were removed prior to analysis.

Attentional biases to emotional faces. Two analyses were carried out for this study; 1) first fixation analysis which aimed to identify whether participants fixated first on the more positive image, compared to the neutral or negative image, and whether this was influenced by group; 2) Dwell time analysis which aimed to identify whether participants spent more time look at the more positive image, compared to the negative or neutral image, and whether this dwell time was influenced by group.

1) First fixation analysis. In the context of this analysis, the first fixation in a trial was defined as the first period of 200ms after stimulus onset in a trial in which a participant looked at one area of interest (face). The first fixation was calculated for each trial for every participant. The proportion of which each participant looked at the more positive image first for each trial was calculated Firstly, to identify whether there are any overall biases towards more positive images, a Wilcoxon test was carried out to identify whether any group fixated first towards the positive images on more than 50% of the trials. Next, to identify whether mothers with affective symptoms were more likely to orient their attention to more negative images compared to mothers without affective symptoms, an ANOVA was used. Proportions were not normally distributed, therefore a robust mixed ANOVA was used as described by (A. Field, Miles, & Field, 2012). The ANOVA used a trimmed mean of 20% and was calculated using bwtrim

function in the WRS2 package in R (https://www.rdocumentation.org/packages/WRS2). Within-subjects factors were trial type (Positive vs Negative; Negative vs Neutral and Positive vs Neutral) and the between-subject factor was Group (Affective symptoms; No affective symptoms). To foreshadow our results, this analysis revealed marginal results at best. As our technique reduces power, we assessed the reliability of these null effects using multiple analysis not corrected for multiple comparisons, thus increasing the family-wise type 1 error rate. This was done using two Mann-Whitney test, collapsed across trial, and group. To calculate effect sizes, a robust Cohen's D using 2000 bootstrap trials, was calculated using Group as grouping variable, and proportion as the dependent variable. The robust Cohen's D effect sizes take the standardized mean difference to calculate the magnitude of an effect between two independent groups (Algina, Keselman, & Penfield, 2005). The effect sizes were calculated using software from http://plaza.ufl.edu/algina/index.programs.html.

Next, to assess whether specific symptoms of anxiety, PTS or depression (rather than grouped affective symptoms) were associated with first fixation a Kendall's Tau analysis was carried out to examine the association between symptoms and the proportion of trials where first fixation was the more positive image.

2) Dwell time. For this analysis, the proportion of time spent looking at the more positive image was calculated.

Firstly, to identify whether there are any overall biases towards more positive images, a Wilcoxon test was carried out to identify whether any group spent more than 50% of the trials looking at the positive images. To identify whether mothers with affective symptoms were more likely to spend more time looking at negative images compared to mothers without affective symptoms, an ANOVA was used. Proportions were normally distributed, however the data

violated Mauchley's test of sphericity ($p < .001$), therefore a robust mixed ANOVA (based on trimmed means as described above) was carried out. The dependent variable was the proportion of time spent looking at the more positive image (relative to the time spent looking at either image). We predicted that mothers in the affective symptoms group would have a lower proportion than mothers without affective symptoms. The within-subjects factor was Trial Type (Positive vs Negative; Negative vs Neutral and Positive vs Neutral) and the between subject factor was Group (Affective symptoms; No affective symptoms). Again, as our technique reduces power, we assessed the reliability of any null effects using multiple analysis not corrected for multiple comparisons, thus increasing the family-wise type 1 error rate. This was done using two Mann-Whitney tests, collapsed across trial, and group. Effect sizes were calculated as described above.

Next, to assess whether any specific symptoms of anxiety, PTS or depression (rather than grouped affective symptoms) were associated with time spent looking at the more positive image, a Kendall's Tau analysis was carried out to examine the association between symptoms and the proportion of time spent looking at the more positive image.

Perceptual strategy. To assess mothers' perceptual strategy in terms of the areas of interest they look at on the face when categorising infant emotional expressions, the time spent looking at the eyes and the eyebrows was averaged across participants and trial. The proportion of time spent looking at the eyes in comparison to the eyes and mouth was then calculated. As the proportion was not normally distributed a Mann-Whitney test was used with group (affective symptoms; no affective symptoms) as the predictor variable and proportion as the outcome variable.

Next, to assess whether symptom severity was associated with proportion of time spent looking at the eyes compared to the mouth, a Kendall's Tau analysis was carried out.

Results

Attentional biases to emotional faces.

First fixation. The Wilcoxon tests found that neither the control group nor experimental group first fixated on the positive image in any trial type more than 50% of the time ($p > .05$ – all statistical values can be found in the supplementary materials).

The hypothesis that mothers with affective symptoms would fixate first on more negative images was not supported. The trimmed means ANOVA (within subject factors: trial type, between subject factors: group) detected no significant differences in first fixations between groups ($Q = 2.29$ $p = .14$, robust Cohen's $D = 0.286$, robust CI95 [-.007 – 0.578]), or as a function of trial type ($Q = .53$, $p = .58$). This was confirmed by the Mann-Whitney test. Collapsing across groups revealed no overall difference between trial types (Positive Negative and Positive Neutral: $W = 2454$, $p = .99$; Positive Negative and Negative Neutral: $W = 2125$, $p = .17$; Negative Neutral and Positive Neutral: $W = 2149.5$, $p = .21$). Likelihood ratios confirmed this finding that the likelihood of the null hypothesis being correct was 0.96 times more likely for Negative Neutral trials, 4.79 times more likely for Positive Negative trials and 6.25 times more likely for Positive Negative trials. Collapsing across trial type revealed no significant differences between groups ($W = 401$, $p = .08$). The likelihood ratio confirmed this finding that the null hypothesis was 1.89 times more likely than the alternative hypothesis (BIC = 0.53). Mean differences suggest that mothers with affective symptoms were more likely to first look at the

more positive image (M = 0.55 SD = 0.15) than mothers without affective symptoms (M = 0.5, SD = 0.15), however this was not significant.

The trimmed means ANOVA found a marginally significant interaction between group and trial type in terms of first fixation (Q = 2.95, p = .06). The post-hoc Mann-Whitney tests by group and trial type confirmed this, showing that mothers with affective symptoms were more likely to fixate first on the neutral image in neutral/negative trials (see Table 2), but that there was no significant difference between groups for the other trial types. It should be noted, however, that, even for neutral/negative trials, neither group had a significant preference for either image. Therefore, we tentatively conclude that the hypothesis that mothers with affective symptoms would orient their attention first to negative images was not supported.

[Table 2 about here]

The Kendall's Tau analysis found no significant associations between anxiety, depression or PTS symptoms and trial types: Anxiety symptoms (Negative Neutral trials: r_T = 1.64, p = .1, Positive Negative trials: r_T = .41, p = .68; Positive Neutral trials: r_T = 0.60, p = .55), depressive symptoms (Negative Neutral trials: r_T = 1.64, p = .1; Positive Negative trials: r_T = .48, p = .64; Positive Neutral trials: r_T = 1.62, p = .11) and PTS symptoms (Negative Neutral trials: r_T = 1.56, p = .12, Positive Negative trials: r_T = -.04, p = .97; Positive Neutral trials: r_T = -.06, p = .95).

Dwell time. The Wilcoxon tests found that neither the control group nor experimental group spent more time fixated on the positive image in any trial type more than 50% of the time (p >.05 – all statistical values can be found in the supplementary materials).

The hypothesis that mothers with affective symptoms would spend more time looking at more negative images was not supported. The trimmed means ANOVA (within subject factors: trial type, between subject factors: group) showed no significant effect of group (Q = 1.27, p

= .26, robust Cohen's d = 0.067, 95% CI.95 = [-0.211.-0.353]). The collapsed-by-trial Mann-Whitney test confirmed this (W = 434, p = 0.19). However, the likelihood ratio showed that the alternative hypothesis was 1.21 times more likely than the null (.89). The trimmed means ANOVA showed that the proportion of time spent looking at the more positive image varied by trial type (Q = 8.03, p =.001). The collapsed-by-group Mann- Whitney tests confirmed this. As can be seen from Table 3, more time was spent looking at the positive image in the positive/negative trials and positive/neutral trials compared to the negative/neutral trials. The trimmed means ANOVA did not show an interaction between trial type and group (Q = 1.05, p = .36) and the Mann- Whitney tests confirmed this (p = .186).

The Kendall's Tau analysis found no significant associations between anxiety, depression or PTS symptoms and trial types: Anxiety symptoms (Negative Neutral trials: rζ = 1.61, p = .1, Positive Negative trials: rζ = -.02, p = .98; Positive Neutral trials: rζ = -1.02, p = 26 27 .31), depressive symptoms (Negative Neutral trials: rζ 28 = .94, p = .35; Positive Negative trials: rζ = -.74, p = .46; Positive Neutral trials: rζ = -.48, p = .63) and PTS symptoms (Negative Neutral trials: rζ = .02, p = .98, Positive Negative trials: rζ = .47, p = .64; Positive Neutral trials: rζ = -.45, p = .65).

[Table 3 about here]

Perceptual Strategy.

The hypothesis that mothers with affective symptoms would have a different perceptual strategy when categorising emotions compared to mothers without affective symptoms was not confirmed. There were no differences between groups in the amount of time spent looking at the eyes compared to the mouth (Mann-Whitney, W = 446, p = 0.44). The likelihood ratio showed that the null hypothesis was 8.057 times more likely than the alternative. No associations

between the amount of time spent looking at the eyes compared to the mouth and symptom severity were found. The accuracy of emotional interpretation did not differ between groups or in relation to symptom severity ($p = 0.30$; $p = .89$). More information about this can be found in (Webb & Ayers, Submitted).

Discussion

The first aim of this study was to investigate whether mothers with affective symptoms display attentional biases towards certain infant emotional expressions in relation to the image they first fixate on, and their dwell time. The results suggest that mothers with affective symptoms may fixate first on neutral images when the choice is between negative and neutral images. This finding had a medium effect size, suggesting the significance value may be influenced by the low sample size. There were no differences between mothers with and without affective symptoms in dwell time on images.

The second aim of the study was to investigate whether mothers with affective symptoms spend a different proportion of time looking at the eyes in comparison to the eyes and mouth when interpreting infant emotional expressions. The results found no difference between mothers with and without affective symptoms in time spent looking at the eyes in comparison to the eyes and mouth, which is against the hypothesis. Mothers with and without affective symptoms did not differ in their ability to categorise emotions (Webb & Ayers, Submitted), therefore, it is perhaps not surprising that null effects were found with regards to gaze patterns.

The finding that mothers with affective symptoms fixate first on the neutral face in negative neutral trials is unexpected. For example, previous research has found that people with anxiety are more likely to orient their attention towards angry, disgusted or judgemental faces (Gamble & Rapee, 2010; Pishyar et al., 2004; Schofield et al., 2012) and people with depression

are more likely to have their attention captured by negative faces (Gotlib et al., 2004; Joormann & Gotlib, 2007).

There are a few potential explanations for this unexpected finding. Firstly, it could be suggested that mothers process infant faces in a different way to non-perinatal populations. For example, in comparison to non-mothers, mothers are more likely to orient their attention towards baby faces (Thompson-Booth et al., 2014) and tend to have different regions of brain activation when looking at infant faces (Mado Proverbio, Brignone, Matarazzo, Del Zotto & Zani, 2006; Nishanti, Doi, Koyama, & Shinohara, 2011). However, with so few studies in this research area, more work is needed to test this suggestion.

Another potential explanation for this finding may be due to the way mothers with affective symptoms process emotions. For example, Gil et al. (2011) asked mothers to judge infant and adult emotional expressions on a 7-point scale and found that mothers with postnatal mental health difficulties were more likely to evaluate neutral infant faces as being sad. They were also more likely to rate neutral adult faces as being angry. Literature outside of the postnatal period supports this, finding that people with depression rate neutral or ambiguous faces as being sad (Bourke, Douglas, & Porter, 2010) and people with anxiety interpret neutral faces as being angry (Mohlman, Carmin, & Price, 2007). Therefore, it could be suggested that mothers with affective symptoms fixated first to the neutral image rather than negative image in an attempt to interpret what the emotion was displaying. However, this is likely to be associated with longer dwell time, which was not the case in this study.

Another possible explanation may be because mothers with affective symptoms may avoid threatening or negative infant faces. This is consistent with research that has found anxiety (Gamble & Rapee, 2010; Koster, Crombez, Verschuere, & De Houwer, 2006) and PTSD may be

associated with attentional avoidance of threatening stimuli. For example, Wald et al. (2010) recruited soldiers who had been exposed to a battlefield simulation exercise and found that individuals who completed a dot-probe paradigm directly after battlefield simulation showed avoidance of threatening stimuli. In addition, stronger threat avoidance was associated with severity of PTS symptoms. It could therefore be suggested that mothers with affective symptoms avoid looking at negative faces, perhaps as a protective mechanism, as emotional interactions may trigger uncomfortable feelings within the mother (Fraiberg, Adelson, & Shapiro, 1975). However, mothers only fixated first towards the more positive image in the negative/neutral trials. If avoidance of negativity is the true explanation, this avoidance would be expected on all trial types.

On the other hand, it could be suggested the results are due to mothers with affective symptoms displaying a bias towards more positive images, rather than away from negative images. For example, Williams, Watts, MacLeod, and Mathews (1988) suggested that the processing biases in anxiety might not be restricted to threatening stimuli and that anxious individuals may show an attentional bias to all emotional stimuli. This is known as the emotionality hypothesis and some research supports this theory (Ruiz-Caballero & Bermudez, 1997). For example, Mogg and Marden (1990) found that individuals with high-trait anxiety showed longer reaction times to both positive and negative, but not neutral words, when using the Stroop paradigm. The same result also has been found in individuals with panic disorder when using positive and neutral non-words (McNally, Riemann, Louro, Lukach, & Kim, 1992). However, again, if this was the case the bias towards positivity would be expected for all trial types.

It also possible that the design of this study may have influenced the results. Although mothers were told that only their pupil dilation was being recorded whilst they were looking at the screen, it is possible that some participants worked out the true nature of the experiment. Mothers with affective symptoms may have therefore consciously or unconsciously adjusted their gaze patterns in a certain way to conform to demand characteristics. This could therefore explain why mothers with affective symptoms were more likely to fixate first on neutral rather than negative images first. Other methodological limitations include the small sample size, especially for the experimental group, which may have led to reduced statistical power and type II errors. However, effect sizes were small to medium, analyses were carried out to inflate type I error, and results were consistent. This suggests that the small sample size may not have significantly reduced type II error rates. Additionally, the sample in this study were mainly white, well-educated mothers. This suggests that the results from the study may not be generalizable to the wider population.

Despite these limitations, this study provides new information about attentional biases towards infant emotion in mothers with affective symptoms. Overall, the results from this study suggest that mothers with affective symptoms show a bias towards neutral images when their choice is between negative and neutral images. Future research should develop these findings further by investigating potential causes of these attentional biases (such as a protective mechanism, or demand characteristics). Furthermore, future studies should apply these findings in a behavioural context to find out whether attentional biases do indeed influence maternal sensitivity

References

Agius, A., Xiereb, R. B., Carrick-Sen, D., Sultana, R., & Rankin, J. (2016). The co-existence of depression, anxiety and post-traumatic stress symptoms in the perinatal period: A systematic review. *Midwifery, 36*, 70-79. doi: https://doi.org/10.1016/j.midw.2016.02.013

Algina, J., Keselman, H. J., & Penfield, R. D. (2005). An alternative to Cohen's standardized mean difference effect size: a robust parameter and confidence interval in the two independent groups case. *Psychol Methods, 10*(3), 317-328. doi:10.1037/1082-989x.10.3.317

Armstrong, T., & Olatunji, B. O. (2012). Eye tracking of attention in the affective disorders: a meta-analytic review and synthesis. *Clinical Psychology Review, 32*(8), 704-723. doi:10.1016/j.cpr.2012.09.004

Arteche, A., Joormann, J., Harvey, A., Craske, M., Gotlib, I. H., Lehtonen, A., Stein, A. (2011). The effects of postnatal maternal depression and anxiety on the processing of infant faces. *Journal of Affective Disorders, 133*(1-2), 197-203. doi:10.1016/j.jad.2011.04.015

Ayers, S., Kling, S., Hole, G., & Wright, D. B. (Unpublished). *The association between maternal psychopathology symptoms, perception of infant emotions, and the quality of the mother-baby bond.*

Bal, E., Harden, E., Lamb, D., Van Hecke, A. V., Denver, J. W., & Porges, S. W. (2010). Emotion recognition in children with autism spectrum disorders: relations to eye gaze and autonomic state. *J Autism Dev Disord, 40*(3), 358-370. doi:10.1007/s10803-009-0884-3

Beaudry, O., Roy-Charland, A., Perron, M., Cormier, I., & Tapp, I. (2014). Featural processing in recognition of emotional facial expressions. *Cognition & Emotion, 28*(3), 416-432. doi: 10.1080/02699931.2013.833500

Bjelland, I., Dahl, A. A., Haug, T. T., & Neckelmann, D. (2002). The validity of the Hospital Anxiety and Depression Scale: An updated literature review. *Journal of Psychosomatic Research, 52*(2), 69-77. doi:https://doi.org/10.1016/S0022- 3999(01)00296-3

Bradley, B. P., Mogg, K., White, J., Groom, C., & Bono, J. (1999). Attentional bias for emotional faces in generalized anxiety disorder. *British Journal of Clinical Psychology, 38*(3), 267-278.

Broth, M. R., Goodman, S. H., Hall, C., & Raynor, L. C. (2004). Depressed and Well Mothers' Emotion Interpretation Accuracy and the Quality of Mother—Infant Interaction. *Infancy, 6*(1), 37-55. doi:10.1207/s15327078in0601_2

Bourke, C., Douglas, K., & Porter, R. (2010). Processing of facial emotion expression in major depression: a review. *Australian and New Zealand Journal of Psychiatry, 44*(8), 681-696.

Bowlby, J. (1969). *Attachment. Attachment and loss: Vol1. Loss.* New York: Basic.

Buckner, J. D., Maner, J. K., & Schmidt, N. B. (2010). Difficulty Disengaging Attention from Social Threat in Social Anxiety. *Cognitive Therapy and Research, 34*(1), 99-105. doi:10.1007/s10608-008-9205-y

Calder, A. J., Young, A. W., Keane, J., & Dean, M. (2000). Configural information in facial expression perception. Journal of Experimental Psychology: *Human Perception and Performance, 26*, 527–551. doi:10.1037/0096-1523.26.2.527

Calvo, M. G., & Nummenmaa, L. (2008). Detection of emotional faces: Salient physical features guide effective visual search. *Journal of Experimental Psychology: General, 137*, 471–494. doi:10.1037/ a0012771

Cisler, J. M., & Koster, E. H. (2010). Mechanisms of attentional biases towards threat in anxiety disorders: An integrative review. *Clin Psychol Rev, 30*(2), 203-216. doi:10.1016/j.cpr.2009.11.003

Coates, R., Ayers, S., & de Visser, R. (2014). Women's experiences of postnatal distress: a qualitative study. *BMC Pregnancy and Childbirth, 14*(1), 359. doi:10.1186/1471- 2393-14-359

Dargis, M., Wolf, R. C., & Koenigs, M. (2018). Psychopathic traits are associated with reduced fixations to the eye region of fearful faces. *Journal of Abnormal Psychology, 127*(1), 43-50. doi: 10.1037/abn0000322.

Dikmen Yildiz, P., Ayers, S., & Phillips, L. (2017). Depression, anxiety, PTSD and comorbidity in perinatal women in Turkey: A longitudinal population-based study. *Midwifery, 55,* 29-37. doi: 0.1016/j.midw.2017.09.001

Dimberg, U., & Petterson, M. (2000). Facial reactions to happy and angry facial expressions: evidence for right hemisphere dominance. *Psychophysiology, 37*(5), 693-696.

Duque, A., & Vázquez, C. (2015). Double attention bias for positive and negative emotional faces in clinical depression: Evidence from an eye-tracking study. *Journal of Behavior Therapy and Experimental Psychiatry, 46,* 107-114. doi:http://dx.doi.org/10.1016/j.jbtep.2014.09.005

Eisenberg, N., Cumberland, A., & Spinrad, T. L. (1998). Parental Socialization of Emotion. *Psychological Inquiry, 9*(4), 241-273. doi:10.1207/s15327965pli0904_1

Ekman, P., & Friesen, W. V. (1969). Nonverbal leakage and clues to deception. *Psychiatry: Journal for the Study of Interpersonal Processes, 32*, 88–106

Feeley, N., Zelkowitz, P., Cormier, C., Charbonneau, L., Lacroix, A., & Papageorgiou, A. (2011). Posttraumatic stress among mothers of very low birthweight infants at 6 months after discharge from the neonatal intensive care unit. *Applied Nursing Research: ANR, 24*(2), 114-117. doi:10.1016/j.apnr.2009.04.004

Field, A., Miles, J., & Field, Z. (2012). Discovering Statistics Using R. London: Sage Publications.

Field, T. (2010). Postpartum depression effects on early interactions, parenting, and safety practices: A review. *Infant Behavior & Development, 33*(1), 1-6. doi:10.1016/j.infbeh.2009.10.005

Flanagan, T. J., White, H., & Carter, B. G. (2011). Differential impairments in emotion face recognition in postpartum and nonpostpartum depressed women. *J Affect Disord, 128*(3), 314-318. doi:10.1016/j.jad.2010.07.021

Foa, E. B. (1995). *Posttraumatic stress diagnostic scale manual.* United States of America: National Computer Systems.

Fraiberg, S., Adelson, E., & Shapiro, V. (1975). Ghosts in the Nursery. *Journal of the American Academy of Child Psychiatry, 14*(3), 387-421. doi:10.1016/S0002- 7138(09)61442-4

Gamble, A. L., & Rapee, R. M. (2010). The time-course of attention to emotional faces in social phobia. *Journal of Behavior Therapy and Experimental Psychiatry, 41*(1), 39- 44. doi:http://dx.doi.org/10.1016/j.jbtep.2009.08.008

Georgiou, G. A., Bleakley, C., Hayward, J., Russo, R., Dutton, K., Eltiti, S., & Fox, E. (2005). Focusing on fear: Attentional disengagement from emotional faces. *Visual Cognition, 12*(1), 145-158. doi:10.1080/13506280444000076

Gil, S., Teissèdre, F., Chambres, P., & Droit-Volet, S. (2011). The evaluation of emotional facial expressions in early postpartum depression mood: a difference between adult and baby faces? *Psychiatry Research, 186*(2-3), 281-286. doi:10.1016/j.psychres.2010.06.015

Ionio, C., & Di Blasio, P. (2014). Post-traumatic stress symptoms after childbirth and early mother-child interactions: an exploratory study. *Journal of Reproductive and Infant Psychology, 32*(2), 163-181.

Jack, R. E., Blais, C., Scheepers, C., Schyns, P. G., & Caldara, R. (2009). Cultural confusions show that facial expressions are not universal. *Curr Biol, 19*(18), 1543-1548. doi:10.1016/j.cub.2009.07.051

Kaitz, M., Maytal, H. R., Devor, N., Bergman, L., & Mankuta, D. (2010). Maternal anxiety, mother–infant interactions, and infants' response to challenge. *Infant Behavior and Development, 33*(2), 136-148. doi:http://dx.doi.org/10.1016/j.infbeh.2009.12.003

Kimble, M. O., Fleming, K., Bandy, C., Kim, J., & Zambetti, A. (2010). Eye tracking and visual attention to threating stimuli in veterans of the Iraq war. *Journal of Anxiety Disorders, 24*(3), 293-299. doi:http://dx.doi.org/10.1016/j.janxdis.2009.12.006

Koster, E. H. W., Crombez, G., Verschuere, B., & De Houwer, J. (2006). Attention to Threat in Anxiety-prone Individuals: Mechanisms Underlying Attentional Bias. *Cognitive Therapy and Research, 30*(5), 635-643. doi:10.1007/s10608-006-9042-9

Koster, E. H. W., Crombez, G., Verschuere, B., Van Damme, S., & Wiersema, J. R. (2006). Components of attentional bias to threat in high trait anxiety: Facilitated engagement, impaired disengagement, and attentional avoidance. *Behav Res Ther, 44*(12), 1757- 1771. doi: https://doi.org/10.1016/j.brat.2005.12.011

Lee, J. H., & Lee, J. H. (2013). Attentional bias towards emotional facial expressions in survivors of dating violence. *Cognition & Emotion*. doi:10.1080/02699931.2013.867834

Lu, S., Xu, J., Li, M., Xue, J., Lu, X., Feng, L., Hu, B. (2017). Attentional bias scores in patients with depression and effects of age: a controlled, eye-tracking study. *J Int Med Res*, 300060517708920. doi:10.1177/0300060517708920

Mado Proverbio, A., Brignone, V., Matarazzo, S., Del Zotto., & Zani, A. (2006). Gender and parental status affect the visual cortical response to infant facial expression. *Neuropsychologia, 44*(14), 2987-2999. doi: https://doi.org/10.1016/j.neuropsychologia.2006.06.015

Martin, M., Williams, R. M., & Clark, D. M. (1991). Does anxiety lead to selective processing of threat-related information? *Behav Res Ther, 29*(2), 147-160.

McNally, R. J., Riemann, B. C., Louro, C. E., Lukach, B. M., & Kim, E. (1992). Cognitive processing of emotional information in panic disorder. *Behav Res Ther, 30*(2), 143- 149.

Mogg, K., & Marden, B. (1990). Processing of emotional information in anxious subjects. *Br J Clin Psychol, 29* (Pt 2), 227-229.

Mohlman, J., Carmin, C. N., & Price, R. B. (2007). Jumping to interpretations: Social anxiety disorder and the identification of emotional facial expressions. *Behaviour research and therapy, 45*(3), 591-599.

Morel, S., George, N., Foucher, A., Chammat, M., & Dubal, S. (2014). ERP evidence for an early emotional bias towards happy faces in trait anxiety. *Biol Psychol, 99,* 183-192. doi:10.1016/j.biopsycho.2014.03.011

Neumann, D., Spezio, M. L., Piven, J., & Adolphs, R. (2006). Looking you in the mouth: abnormal gaze in autism resulting from impaired top-down modulation of visual attention. *Soc Cogn Affect Neurosci, 1*(3), 194-202. doi:10.1093/scan/nsl030

Nicol-Harper, R., Harvey, A. G., & Stein, A. (2007). Interactions between mothers and infants: Impact of maternal anxiety. *Infant Behavior and Development, 30*(1), 161- 167. doi:http://dx.doi.org/10.1016/j.infbeh.2006.08.005

Nishanti, S., Doi, H., Koyama, A., & Shinohara, K.(2011). Differential prefrontal response to infant facial emotions in mothers compared with non-mothers. *Neuroscience Research, 70*(2), 1830188. doi: https://doi.org/10.1016/j.neures.2011.02.007

Office for National Statistics. (2010). *Standard Occupational Classification Volume 2: The Coding Index*. In Classifications and Harmonisation Unit (Ed.), Standard Occupational Classification for the UK (Vol. 2). Hampshire, UK: Office for National Statistics.

Pearson, R. M., Cooper, R. M., Penton-Voak, I. S., Lightman, S. L., & Evans, J. (2010). Depressive symptoms in early pregnancy disrupt attentional processing of infant emotion. *Psychol Med, 40*(4), 621-631. doi:10.1017/S0033291709990961

Pearson, R. M., O'Mahen, H., Burns, A., Bennert, K., Shepherd, C., Baxter, H., Evans, J. (2013). The normalisation of disrupted attentional processing of infant distress in depressed pregnant women following Cognitive Behavioural Therapy. *Journal of Affective Disorders, 145*(2), 208-213. doi:10.1016/j.jad.2012.07.033

Pishyar, R., Harris, L. M., & Menzies, R. G. (2004). Attentional bias for words and faces in social anxiety. *Anxiety, Stress, & Coping, 17*(1), 23-36. doi:10.1080/10615800310001601458

Qualtrics. (2015). Provo, Utah, USA

Ruiz-Caballero, J. A., & Bermudez, J. (1997). Anxiety and attention: is there an attentional bias for positive emotional stimuli? *J Gen Psychol, 124*(2), 194-210. doi:10.1080/00221309709595517

Schaffer, H. R., & Emerson, P. E. (1964). The development of social attachments in infancy. *Monographs of the Society for Research in Child Development, 29*(3), 1-77. doi: http://dx.doi.org/10.2307/1165727

Schofield, C. A., Johnson, A. L., Inhoff, A. W., & Coles, M. E. (2012). Social anxiety and difficulty disengaging threat: Evidence from eye-tracking. *Cognition and Emotion, 26*(2), 300-311. doi:10.1080/02699931.2011.602050

Schurgin, M. W., Nelson, J., Iida, S., Ohira, H., Chiao, J. Y., & Franconeri, S. L. (2014). Eye movements during emotion recognition in faces. *J Vis, 14*(13), 14. doi:10.1167/14.13.14

Shin, H., Park, Y., Ryu, H., & Seomun, G. (2008). Maternal sensitivity: a concept analysis. Journal of Advanced Nursing, 64(3), 304-314. doi:10.1111/j.1365-2648.2008.04814.x Silverstone, P. H. (1994). Poor efficacy of the Hospital Anxiety and Depression Scale in the diagnosis of major depressive disorder in both medical and psychiatric patients. *J Psychosom Res, 38*(5), 441-450.

Stein, A., Arteche, A., Lehtonen, A., Craske, M., Harvey, A., Counsell, N., & Murray, L. (2010). Interpretation of infant facial expression in the context of maternal postnatal depression. *Infant Behavior and Development, 33*(3), 273-278. doi:10.1016/j.infbeh.2010.03.002

Stern, A. (2014). The Hospital Anxiety and Depression Scale: Questionnaire Review. *Occupational Medicine, 64*, 393-394. doi:10.1093/occmed/kqu024

Thompson-Booth, C., Viding, E., Mayes, L. C., Rutherford, H. J. V., Hodsoll, S., & McCrory, E. J. (2014). Here's looking at you, kid: attention to infant emotional faces in mothers and non-mothers. *Developmental Science, 17*(1), 35-46. doi:10.1111/desc.12090

Uljarevic, M., & Hamilton, A. (2013). Recognition of emotions in autism: a formal meta-analysis. J *Autism Dev Disord, 43*(7), 1517-1526. doi:10.1007/s10803-012-1695-5

van Bakel, H. J., Hoffenkamp, H. N., Tooten, A., Hall, R. A., ter Beek, M., Hartman, E. E., & Vingerhoets, A. J. (2013). " MOODY BLUES": Affect Interpretation of Infant Facial Expressions and Negative Affect in Mothers of Preterm and Term Infants. *Psihologijske teme, 22*(2), 351-366.

van Doesum, K. T., Hosman, C. M., Riksen-Walraven, J. M., & Hoefnagels, C. (2007). Correlates of depressed mothers' sensitivity toward their infants: the role of maternal, child, and contextual characteristics. *Journal of the American Academy of Child and Adolescent Psychiatry, 46*(6), 747-756. doi:10.1097/CHI.0b013e318040b272

van Ee, E., Kleber, R. J., & Mooren, T. T. M. (2012). War trauma lingers on: Associations between maternal posttraumatic stress disorder, parent–child interaction, and child development. *Infant Mental Health Journal, 33*(5), 459-468. doi:10.1002/imhj.21324

Wald, I., Lubin, G., Holoshitz, Y., Muller, D., Fruchter, E., Pine, D. S., Bar-Haim, Y. (2010). Battlefield-like stress following simulated combat and suppression of attention bias to threat. *Psychol Med, 41*(4), 699-707. doi:10.1017/S0033291710002308

Watson, J. S., Hayes, L. A., Vietze, P., Becker, J. (1979). Discriminative infant smiling to orientations of talking faces of mother and stranger. *Journal of Experimental Child Psychology, 28* (1), 92-99. doi: https://doi.org/10.1016/0022-0965(79)90104-8

Weaver, J. (1997). Childbirth: Preventing post-traumatic stress disorder. *Professional Care of Mother and Child*, *7*, 2–3.

Webb, R., & Ayers, S. (2015). Cognitive biases in processing infant emotion by women with depression, anxiety and post-traumatic stress disorder in pregnancy or after birth: A systematic review. *Cognition & Emotion, 29*(7), 1278-1294. doi:10.1080/02699931.2014.977849

Webb, R., & Ayers, S. (submitted). Maternal affective symptoms and processing of infant emotion. *Infant Mental Health Journal.*

Webb, R., Ayers, S., & Endress, A. (2017). The City Infant Faces Database: A validated set of infant facial expressions. *Behavior Research Methods*. doi:10.3758/s13428-017- 0859-9

Williams, J. M. G., Watts, F. N., MacLeod, C., & Mathews, A. (1988). *Cognitive Psychology and Emotional Disorders*. Chichester: Wiley.

Wu, L., Pu, J., Allen, J. J. B., & Pauli, P. (2012). Recognition of Facial Expressions in Individuals with Elevated Levels of Depressive Symptoms: An Eye-Movement Study. *Depression Research and Treatment*, 2012, 7. doi:10.1155/2012/249030

Yiend, J. (2010). The effects of emotion on attention: A review of attentional processing of emotional information. *Cognition & Emotion, 24*(1), 3-47. doi:10.1080/02699930903205698

Zigmond, A. S., & Snaith, R. P. (1983). The hospital anxiety and depression scale. *Acta Psychiatrica Scandinavica, 67*(6), 361-370.

Table 1.

Demographics, PTSD and HADS scores for mothers with and without affective symptoms

	Mothers without affective symptoms n (%)	Mothers with affective symptoms n (%)	x^2	*p*
Mothers Education			1.90	.594
Undergraduate	21 (44.7)	9 (39.1)		
Postgraduate	18 (38.3)	12 (52.2)		
Marital status			10.32	.016
Married	32 (68.1)	16 (69.6)		
Living with partner	15 (31.9)	3 (13)		
In a relationship		2 (8.7)		
Single		2 (8.7)		
Ethnicity			2.61	.450
White	41 (87.2)	19 (86.4)		
Planned pregnancy			1.01	.604
Planned	43 (91.5)	22 (95.7)		
Not sure	2 (4.3)	0 (0)		
Not planned	2 (4.3)	1 (4.3)		
Previous children			.723	.696
None	28 (59.6)	16 (69.6)		
One	17 (36.2)	6 (26.1)		
Two	2 (4.3)	1 (4.3)		

	Mothers without affective symptoms n (%)	Mothers with affective symptoms n (%)	x^2	*p*
Infant feeding choices			2.13	.345
Breast	28 (59.6)	13 (56.5)		
Mixed	9 (19.1)	4 (17.4)		
Bottle	5 (10.6)	6 (26.1)		
Affective symptoms	M (SD)	M (SD)	*t*	*p*
PTSD symptoms	2.36 (2.44)	11.09 (7.16)	-5.69	<.001
Anxiety symptoms	3.64 (1.94)	9.93 (3.08)	-8.81	<.001
Depression symptoms	2.26 (2.26)	7.35 (3.92)	-.602	<.001

Note. x^2 = chi-squared; t = independent t-test. PTSD symptoms as measured by PDS (Foa, 1995); Anxiety and Depression symptoms as measured by HADS (Zigmond & Snaith, 1983).

Table 2.

Proportion of first fixation towards more positive image by group and trial type

	Affective symptoms M (SD)	No affective symptoms M (SD)	*W*	*p*	Cohen's Robust D
Negative Neutral	0.56 (0.15)	0.47 (0.17)	350	.017	.63
Positive Neutral	0.54 (0.16)	0.52 (0.13)	516.5	.77	.01
Positive Negative	0.55 (0.14)	0.51 (0.14)	468	.37	.20

Note. W = Mann-Whitney test; affective symptoms as measured by PDS (Foa, 1995) and HADS (Zigmond & Snaith, 1983).

Table 3.

Proportion of time spent looking at more positive image by trial type

	M (SD)	*W*	*p*	Cohen's robust D	95% CI
Positive Negative vs Positive Neutral	.55(.004) .49 (.004)	3601	<.001	-.95	-1.31- -.54
Positive Negative vs Negative Neutral	.55 (.004) .50 (.009)	1550	<.001	.63	.26-1.03
Positive Neutral vs Negative Neutral	.49 (.004) .5 (.009)	2426	.965	.026	-.33 - .36

Note. W = Mann-Whitney test; 95% CI = Confidence Interval