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**MATERNAL MENTAL HEALTH, PROCESSING OF EMOTION AND
MATERNAL SENSITIVITY**

Thesis submitted for the degree of Doctorate of Philosophy

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December 2017

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Declaration

The middle chapters of this thesis consist of distinct articles written for publication in peer-reviewed journals (Chapters 2-6). The first and the final chapter present overviews and discussions of previous literature and the research in this thesis. References for all chapters are at the end of the thesis.

All of the articles in this thesis have been accepted or submitted for publication in peer-reviewed journals and presented in this thesis as the final published or submitted manuscripts (see Appendix 6 for copies of the published articles). All articles are my own work with guidance from my PhD supervisors. I developed the cognitive model, the studies to test the model and wrote the first draft of each article. I took the lead on all subsequent revisions including those suggested as part of the peer-review process. Full references are detailed below:

Chapter 2 is published in *Cognition and Emotion* as:

Webb, R., & Ayers, S. (2015). Processing of infant emotions by women with symptoms of anxiety, depression or PTSD in pregnancy or after birth: a systematic review. *Cognition and Emotion*, 29(7), 1278-1294, doi: 10.1080/02699931.2014.977849

The author contributions are as follows: Rebecca Webb undertook the literature searches, data analysis and interpretation of results and drafted the manuscript. Susan Ayers provided feedback on each draft of the manuscript.

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The author contributions are as follows: Rebecca Webb drafted the protocol, collected and validated the stimuli, carried out data analysis, and drafted the manuscript. Ansgar Endress helped with data analysis and provided detailed

feedback on all drafts. Susan Ayers provided detailed feedback on all drafts of the manuscript.

Chapter 4 has been submitted to the Journal of Reproductive and Infant Psychology as:

Webb, R., & Ayers, S. (submitted). Attentional and perceptual biases to infant emotions in postnatal mental health difficulties. *Journal of Reproductive and Infant Psychology*.

The author contributions are as follows: Rebecca Webb designed the study, wrote the protocol, created the experiments, recruited and tested participants, analysed and interpreted the data and drafted the manuscript. Ansgar Endress helped with data analysis and provided detailed feedback. Susan Ayers provided detailed feedback on both the protocol and manuscript drafts.

Chapter 5 has been submitted to Anxiety, Stress & Coping as:

Webb, R., & Ayers, S. (submitted). Postnatal mental health and mothers' processing of infant emotion: An eye-tracking study. *Anxiety, Stress & Coping*

The author contributions are as follows: Rebecca Webb designed the study, wrote the protocol, created the experiments, recruited and tested participants, analysed and interpreted the data and drafted the manuscript. Ansgar Endress helped with data analysis and provided detailed feedback on all drafts. Susan Ayers provided detailed feedback on both the protocol and manuscript drafts.

Chapter 6 is in preparation for submission:

Webb, R., Ayers, S. (in prep). Exploration of a proposed cognitive model of maternal sensitivity.

The author contributions are as follows: Rebecca Webb designed the study, wrote the protocol, created the experiments, recruited and tested participants, analysed and

interpreted the data and drafted the manuscript. Susan Ayers provided detailed feedback on both the protocol and manuscript drafts and helped with data analysis. Ansgar Endress provided detailed feedback on all drafts.

I hereby declare that this thesis has not been, and will not be, submitted in whole or in part to another University for the award of any other degree.

Rebecca Webb

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City, University of London

Rebecca Webb

Thesis submitted for the degree of Doctorate of Philosophy

MATERNAL MENTAL HEALTH, PROCESSING OF EMOTION AND MATERNAL SENSITIVITY

Summary

Background: Research suggests that postnatal affective disorders such as anxiety, depression and post-traumatic stress disorder (PTSD) are associated with lower levels of maternal sensitivity. Understanding the mechanisms through which maternal affective disorders influence maternal sensitivity is important as it could lead to more tailored effective interventions to improve outcomes for women and their infants. One mechanism that is yet to be explored is the way in which mothers' process infant-related information. This thesis therefore developed a cognitive model that aimed to examine this mechanism.

Aim: The aim of this thesis was to test this cognitive model of maternal sensitivity using a range of experimental, observational and questionnaire studies. The model proposed that maternal affective symptoms would be associated with maternal processing of infant-related information, which in turn would be associated with maternal sensitivity.

Methods & Results: The aims were addressed through a systematic review and a study of women with ($n = 23$) and without ($n = 47$) affective symptoms and their infants (aged 2-8 months) after birth. The systematic review found that mothers with perinatal affective disorders are faster to disengage from sad infant faces and are more accurate at identifying sadness in infant faces (Article 1). To assess how mothers process infant-related information, validated pictures of infants' emotional faces were needed. Therefore, a validated set of infant emotional expressions was created and validated on student midwives and nurses and members of the general public. The images were found to have high criterion validity and good test-retest reliability (Article 2). Mothers processing of infant-related information and its relationship with maternal sensitivity was tested using a series of questionnaires, computerised and observational tasks. Results are reported in Articles 3, 4 and 5.

Conclusion: Overall, the cognitive model of maternal sensitivity was only partly supported, in that maternal affective symptoms explained more of the variance of maternal sensitivity than maternal processing of infant-related information. Despite this, the work in this thesis provides a novel contribution to the literature by developing and testing a model based on previous research and by using robust measures such as eye-tracking technology and observational measures of mother-infant interaction. However, interpretation of the data is hindered due to methodological issues such as small sample sizes, homogeneous sample and demand characteristics. Therefore, more research is needed to test this model on a larger, more heterogeneous sample.

1 Chapter one: Postnatal Mental Health – An Overview

1.1 Overview

Around 679,000 women give birth per year within the United Kingdom (Office for National Statistics, 2018). During pregnancy and the postnatal period some women suffer from psychological difficulties. These can include diagnoses of depression, anxiety disorders and post-traumatic stress disorder (PTSD) after a difficult or traumatic birth (NICE, 2014a). Women can also suffer from mild to moderate psychological symptoms during this time (Hogg, 2013). Mild to moderate psychological symptoms affect between 10 to 30% of women (Cigoli, Gilli, & Saita, 2006; Gavin et al., 2005; Hogg, 2013; Woolhouse, Brown, Krastev, Perlen, & Gunn, 2009). Diagnoses of anxiety, depression and PTSD tend to be less common with prevalence ranging from approximately 1 to 11.1% (Gavin et al., 2005; Grekin & O'Hara, 2014; Reck et al., 2008).

Research suggests that mothers with postnatal mental health difficulties show certain patterns of behaviour when they are interacting with their infants. Mothers with depression may interact in either a controlling or over-stimulating way, or be passive and withdrawn (Field, 2010). Mothers with PTSD show less sensitive, unstructured or hostile interactions (Feeley et al., 2011; van Ee, Kleber, & Mooren, 2012). Furthermore, mothers with anxiety may show reduced emotional tone, or exaggerated behaviour (Kaitz, Maytal, Devor, Bergman, & Mankuta, 2010; Nicol-Harper, Harvey, & Stein, 2007).

For a mother to display high levels of maternal sensitivity she must notice her infant's cues and respond appropriately (Eisenberg, Cumberland, & Spinrad, 1998; Shin, Park, Ryu, & Seomun, 2008; van Doesum, Hosman, Riksen-Walraven, & Hoefnagels, 2007). However, studies have shown that postnatal mental health difficulties are associated with less attentional capture towards infants' emotional expressions (Pearson, Cooper, Penton-Voak, Lightman, & Evans, 2010; Pearson et al., 2013; Thompson-Booth et al., 2014b) and less accurate interpretation of infants' emotional expressions (Arteche et al., 2011; Flanagan, White, & Carter, 2011; Stein et al., 2010).

It is possible that the patterns in infant-related information processing shown by mothers with postnatal mental health difficulties could explain mother-infant interaction patterns found within this population. For example, a mother who is consistently drawn to positive faces and is able to categorise positive faces accurately may perceive her infant as particularly positive and act in a concordant way. However, there is very little research in this area and the possible link between infant-related information processing and mother-infant interaction has yet to be tested empirically. It is important that this is investigated as research

suggests that maternal mental health difficulties may have negative consequences for offspring (Ahmadzadeh & Malekian, 2004; McMahon, Barnett, Kowalenko, Tennant, & Don, 2001; Murray et al., 2011; Samuelson & Cashman, 2008).

Therefore, this thesis developed and tested a cognitive model of maternal sensitivity which proposed that maternal mental health would influence processing of infant-related information, which in turn would explain some of the variance in maternal sensitivity. The overall aim of this thesis was therefore to test this cognitive model of maternal sensitivity using a range of experimental, observational and questionnaire studies.

This chapter provides an overview of the research about infant-related information processing in mothers with perinatal mental health difficulties, mother-infant interaction, and the possible mechanisms behind the relationship between the two. There are seven sections in this chapter. The first gives a brief overview of the cognitive model. The second section provides definitions of terms that will be used repeatedly throughout this thesis. Section three presents relevant research on postnatal mental health difficulties, looking at the prevalence of both diagnostic disorders and symptoms. The fourth looks at the impact postnatal mental health difficulties can have on mother-infant interaction and later child development. The fifth looks at potential reasons behind patterns of mother-infant interaction observed in mothers with postnatal mental health difficulties. The sixth section describes a model of maternal sensitivity that forms the basis for this thesis. Based on previous research this model hypothesises that there is a link between mothers processing of infant-related information and mother-infant interaction. The seventh section outlines the aims of the thesis and gives a brief description of each research study included in the thesis.

1.2 A cognitive model of maternal sensitivity

Cognitive experimental research has found that women with perinatal affective symptoms, such as depression, anxiety and post-traumatic stress-disorder (PTSD) are faster to look away from infant distressed faces, and are more accurate at categorising infant negative emotions, such as sadness (Flanagan et al., 2011; Gil, Teissèdre, Chambres, & Droit-Volet, 2011; Pearson et al., 2010; Pearson et al., 2013). Observational research has also found that mothers with perinatal affective symptoms are less sensitive to their infants needs when they are interacting with their infant (Feeley et al., 2011; Field, 2010; Nicol-Harper et al., 2007). It could therefore be possible that these cognitive biases in processing infant emotional expressions, associated with affective symptoms, could explain differences in maternal sensitivity. For example, a mother who displays no cognitive biases to any emotion would likely be just as drawn to infant sadness and happiness, and more able to interpret

these correctly. Interpretation of infant cues is a key aspect of maternal sensitivity, therefore mothers who can accurately identify and interpret infant emotional expressions may show more maternal sensitivity. The overall aim of this thesis was to test this model using a range of experimental, observational and questionnaire studies. The experiments and questionnaires looked at the way mothers' process information related to their infant. The experiments investigated a mother's cognitive biases towards infant emotional expressions in her: ability to accurately categorise infant emotional facial expressions, ability to look away from infant faces, and attentional patterns when viewing pairs of infant faces. The questionnaires looked at a mother's perception of her infant, and her relationship with her infant. The observational measures looked at maternal sensitivity and infant behaviour. The model and the experiments and questionnaires used to test the model are discussed in more detail in Section 1.8, Article 5 and Table 6-1.

1.3 Definitions

Throughout the thesis, certain terms and phrases will be repeated, therefore for clarity these have been defined below:

- Symptoms: These are indicators that someone may have a particular disease/illness. Individuals can have symptoms of a disease/illness but not necessarily meet the criteria for a diagnosis.
- Diagnoses: When people meet all diagnostic criteria for a mental illness as specified by diagnostic nomenclature such as the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2013) or the International Classification of Diseases (World Health Organization, 2018).
- Postnatal mental health: refers to both symptoms and diagnoses of anxiety, depression and Post Traumatic Stress Disorder (PTSD).
- Maternal affective symptoms: refers to mothers with anxiety, depression and post-traumatic stress symptoms
- Maternal sensitivity: the ability to perceive and interpret infants' attachment signals and respond to them promptly and adequately (Ainsworth, Blehar, Waters, & Wall, 1978).
- Cognitive bias: Any bias in processing stimuli, this includes attentional biases towards emotional expressions, and perceptual biases towards emotions.
 - Attentional bias: This is made up of 3 components which relate to the way individuals pay attention towards certain stimuli: 1) facilitated selective

attention towards stimuli; 2) difficulty disengaging attention away from certain stimuli; or 3) avoidance of certain stimuli (Cisler & Koster, 2010).

- o Perceptual bias: The individual's ability to perceive and interpret emotional expressions
- o Mothers' processing of infant-related information: this phrase refers to the way a mother processes the following infant-related information:
- o Attentional bias towards infant emotion: Mothers' first fixation, and subsequent dwell time towards certain infant emotional expressions
- o Disengagement: This was measured by asking mothers to look away from the centre of the screen, where a baby's face was acting as a distractor, and identify a line on one side of the screen. A mother's ability to do this refers to disengagement.
- o Accuracy: A mother's ability to accurately categorise infants' emotional expressions.
- o Infant Intentionality: A mother's perception of her infant as being intentional in their actions and their behaviour, measured using the Infant Intentionality Questionnaire (Feldman & Reznick, 1996).
- o Anger and Pathological Rejection: This refers to how a mother views her relationship with her baby. A mother's feelings of anger and rejection towards her infant, measured using the anger and pathological rejection subscale of the Postpartum Bonding Questionnaire (PBQ) (Brockington, Fraser, & Wilson, 2006).
- o Infant-focused anxiety: A mother's feelings of anxiety towards her infant, taken from the infant-focused anxiety subscale of the PBQ (Brockington et al., 2006).

1.4 Postnatal mental health difficulties

The cognitive model of maternal sensitivity discussed in this thesis posits that maternal affective symptoms are associated with certain infant-related information processing factors that may explain some of the variance of maternal sensitivity. This section will therefore focus on the following affective symptoms: anxiety, depression and PTSD. It will provide an overview of research on the prevalence of both symptoms and diagnostic criteria of these three mental health difficulties. These affective conditions have been chosen because they are common affective disorders (see below) and there is a high level of comorbidity

between these conditions (Ballard, Stanley, & Brockington, 1995; Lyons, 1998; White, Matthey, Boyd, & Barnett, 2006).

1.4.1 Diagnoses versus Symptoms

After birth, mothers can experience a range of psychological symptoms or diagnoses. These can include (from most to least common) adjustment difficulties, mild to moderate symptoms of anxiety and depression, major depressive disorder, generalised anxiety disorder, post-traumatic stress disorder, chronic serious mental illness and postnatal psychosis (Hogg, 2013). Mothers can therefore experience symptoms of mental health conditions, without reaching the criteria for a full diagnosis.

Within the UK healthcare system, there is a strong focus on diagnosis of mental health disorders. Diagnoses can be helpful in terms of providing criteria on which women are eligible for treatment, and ensuring women receive treatment that is appropriate for their disorder (O'Hara & Wisner, 2014). However, using a diagnostic approach can be problematic in the postnatal period. For example, many diagnoses include symptoms that may be normal after birth, such as feelings of fatigue or sleep disturbance (Matthey, 2010). It has also been suggested that when individuals do not reach the threshold for a diagnosis, they might not get treatment (McKenzie-McHarg et al., 2015). Furthermore, in a qualitative study of mothers who experienced perinatal psychological problems many described feeling that the diagnosis of postnatal depression did not apply to them, yet once the diagnosis had been ruled out there was no further discussion about the mothers' mental health symptoms (Coates, Ayers, & de Visser, 2014).

This thesis focuses on symptoms of PTS, anxiety and depression. To provide a clear overview of these mental health difficulties, these are outlined below in relation to diagnostic criteria and symptoms.

1.4.2 Post-traumatic stress (PTS)

For the purpose of this thesis, postnatal PTS refers to Post-Traumatic Stress symptoms caused by a difficult or traumatic birth. In terms of diagnosis, the Diagnostic and Statistical Manual for Mental Disorders 5 (American Psychiatric Association, 2013) states PTSD is characterised by eight main criteria. Criterion A states that PTSD must occur after a stressor, such as exposure to death, threatened death, actual or threatened serious injury, or actual or threatened sexual violence. This can be through direct exposure, witnessing the event, or indirect exposure such as hearing news about a close friend or relative, or being exposed via work (i.e. professionals exposed to details of child abuse). There are four clusters of symptoms. The first is intrusion symptoms (criterion B) such as recurrent

memories or traumatic nightmares. Next is Criterion C, persistent effortful avoidance of distressing trauma-related stimuli after the event, such as avoiding thoughts or activities related to the trauma. Criterion D is negative alterations in cognitions and mood that began or worsened after the traumatic event. Criterion E is trauma-related alterations in arousal and reactivity that began or worsened after the traumatic event (American Psychiatric Association, 2013). See Table 1-1 for full diagnostic criteria.

A lot of the research on perinatal PTSD has focused on postnatal PTSD caused by a traumatic or difficult birth. From the mid-1990s case studies of women experiencing PTSD after a traumatic birth began to raise awareness of this issue (Ballard et al., 1995; Fones, 1996) and researchers subsequently began investigating birth trauma. Research has found that approximately 3-4% of women develop PTSD after birth (Dikmen Yildiz, Ayers, & Phillips, 2016; Grekin & O'Hara, 2014). Additionally, approximately 30% of women experience partial symptoms of at least one dimension of intrusion, avoidance, or hyperarousal symptoms of PTSD after giving birth (Cigoli et al., 2006; Czarnocka & Slade, 2000; Olde et al., 2005).

1.4.3 Depression

Arguably the most researched and well known postnatal mental illness is postnatal depression. The DSM-5 does not have a specific definition for postnatal depression, but it does state that depression with a postnatal onset can be diagnosed if the depressed mood occurs during pregnancy or within four weeks of giving birth. According to the DSM-5 depression is characterised by a depressed mood and a loss of interest or pleasure in daily activities for more than two weeks as well as impaired functioning in social, occupational and educational domains (American Psychiatric Association, 2013), see Table 1-1 for full diagnostic criteria.

A meta-analysis found that between 1 and 5.6% of women develop major depression in the perinatal period and this increases to 10-15% for mild to moderate depression (Gavin et al., 2005). Postnatal depression is well known by medical professionals and mothers. Within the UK it is commonplace for Health Visitors (trained nurses with additional qualifications in public health) to visit families postnatally. Health visitors are taught about the importance of identifying depression in the postnatal period during their training (NICE, 2014b) and are given guidance on how to identify depression in the postnatal period (NICE, 2014a). The Royal College for Midwives have made maternal mental health a “pressure point” with the aim of increasing awareness and improving funding and resources into this area (Royal College of Midwives, 2014). Furthermore, antenatal courses for women such as those

provided by the National Childbirth Trust (NCT) teach about the importance of mental health during pregnancy and after birth (National Childbirth Trust, 2017).

1.4.4 Anxiety

A systematic review found that the prevalence for a clinical diagnosis of any anxiety disorder was 15.2% during pregnancy and 9.9% in the postnatal period. The review also found that self-reported anxiety symptoms ranged from 18.2 to 24.6% during pregnancy, and 15% postnatally (Dennis, Falah-Hassani, & Shiri, 2017). This suggests that anxiety is as prevalent as, or more prevalent than, depression after birth. There are different types of anxiety disorders that can occur in the postnatal period. These include generalised anxiety disorder (GAD), obsessive compulsive disorders, phobias and panic disorders. This thesis focuses specifically on anxiety symptoms or GAD as it is currently screened for in the postnatal period in the UK (NICE, 2014a). The DSM does not have a specification for a diagnosis of postnatal anxiety (American Psychiatric Association, 2013). The current criteria for a diagnosis GAD in the DSM-5 is excessive anxiety and worry, occurring more days than not and for at least 6 months, about a number of events or activities. Furthermore, the person finds it difficult to control their worry (American Psychiatric Association, 2013). See Table 1-1 for full diagnostic criteria.

In the early 2000's studies showed the high rate of maternal anxiety after birth (Matthey, 2004; Matthey, Barnett, Howie, & Kavanagh, 2003) and clinical guidelines in the UK now recommend that postnatal anxiety should be assessed as well as depression (NICE, 2007). The current clinical guidelines are that women should be asked the Whooley questions (NICE, 2007) which assess symptoms of depression (Whooley, Avins, Miranda, & Browner, 1997) and the GAD-2 questions to assess symptoms of anxiety (Kroenke, Spitzer, Williams, Monahan, & Löwe, 2007).

Table 1-1. *DSM-V Diagnostic Criteria for PTSD, Depression and Anxiety*

PTSD	Major depressive disorder	Generalised anxiety disorder
Criterion A (one required): The person was exposed to: death, threatened death, actual or threatened serious injury, or actual or threatened sexual violence, in the following way(s): • Direct exposure • Witnessing the trauma • Learning that a relative or close friend was exposed to a trauma • Indirect exposure to aversive details of the trauma, usually in the course of professional duties (e.g., first responders, medics) Criterion B (one required): The traumatic event is persistently re-experienced, in the following way(s): • Intrusive thoughts • Nightmares • Flashbacks	A. Five (or more) of the following symptoms have been present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms is either (1) depressed mood or (2) loss of interest or pleasure: 1. Depressed mood most of the day, nearly every day, as indicated by either subjective report (e.g., feels sad, empty, hopeless) or observation made by others (e.g., appears tearful). 2. Markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day (as indicated by either subjective account or observation.) 3. Significant weight loss when not dieting or weight gain (e.g., a change of more than 5% of body weight in a	A. Excessive anxiety and worry (apprehensive expectation), occurring more days than not for at least 6 months, about a number of events or activities (such as work or school performance). B. The individual finds it difficult to control the worry. C. The anxiety and worry are associated with three (or more) of the following six symptoms (with at least some symptoms having been present for more days than not for the past 6 months): 1. Restlessness, feeling keyed up or on edge 2. Being easily fatigued. 3. Difficulty concentrating or mind going blank 4. Irritability. 5. Muscle tension

• Emotional distress after exposure to traumatic reminders • Physical reactivity after exposure to traumatic reminders Criterion C (one required): Avoidance of trauma-related stimuli after the trauma, in the following way(s): • Trauma-related thoughts or feelings • Trauma-related reminders Criterion D (two required): Negative thoughts or feelings that began or worsened after the trauma, in the following way(s): • Inability to recall key features of the trauma • Overly negative thoughts and assumptions about oneself or the world • Exaggerated blame of self or others for causing the trauma • Negative affect • Decreased interest in activities • Feeling isolated	month), or decrease or increase in appetite nearly every day. 4. Insomnia or hypersomnia nearly every day. 5. Psychomotor agitation or retardation nearly every day (observable by others, not merely subjective feelings of restlessness or being slowed down). 6. Fatigue or loss of energy nearly every day. 7. Feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick). 8. Diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others). 9. Recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a	6. Sleep disturbance (difficulty falling or staying asleep, or restless, unsatisfying sleep). D. The anxiety, worry, or physical symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning. E. The disturbance is not attributable to the physiological effects of a substance (e.g., a drug of abuse, a medication) or another medical condition (e.g., hyperthyroidism). F. The disturbance is not better explained by another medical disorder
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• Difficulty experiencing positive affect Criterion E (two required): Trauma-related arousal and reactivity that began or worsened after the trauma, in the following way(s): • Irritability or aggression • Risky or destructive behavior • Hypervigilance • Heightened startle reaction • Difficulty concentrating • Difficulty sleeping Criterion F (required): Symptoms last for more than 1 month. Criterion G (required): Symptoms create distress or functional impairment (e.g., social, occupational). Criterion H (required): Symptoms are not due to medication, substance use, or other illness.	suicide attempt or a specific plan for committing suicide. B. The symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning. C. The episode is not attributable to the physiological effects of a substance or to another medical condition.	
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1.5 Attachment, maternal sensitivity and mother-infant interaction

As maternal sensitivity is the main outcome measure of the model, this section will describe the theory of attachment and explain how this is related to maternal sensitivity. Mother-infant interaction patterns in women with postnatal mental health difficulties will then be described. Finally, to show the importance of infant attachment and maternal sensitivity, the short-term and long-term impact of these mother-infant interaction patterns are considered.

1.5.1 Attachment theory

Attachment theory was developed by John Bowlby and Mary Ainsworth (Ainsworth & Bowlby, 1991). In 1969 Bowlby published a book entitled *Maternal Care and Mental Health* in which he described the four stages of attachment (Bowlby, 1969):

1. The infant orientates and signals need without discriminating different people (0-5 months).
2. The infant preferentially signals to one or more discriminated people. The infant is more likely to smile at these individuals and gain comfort from them when upset. This is the beginning of attachment and usually starts about 5-7 months.
3. The infant maintains proximity to the discriminated person, for example crawling towards them, or becoming upset if they leave (7-9 months). The infant becomes wary of unfamiliar people.
4. The formation of the 'goal corrected partnership' begins around 2-3 years old. Until now the attachment figure served as a resource for the child, being available when needed. Now children can begin to accommodate the attachment figure's needs, i.e. by doing as they are asked by the attachment figure (Smith, Cowie, & Blades, 2003).

Ainsworth and Wittig (1969) developed a method for assessing the type of attachment an infant had with their primary caregiver, known as the Strange Situation (See Table 1-2). Three attachment styles were identified based on the infant's behaviour during the Strange Situation. 1) Type A or Insecure/Avoidant attachment which is characterised by the infant showing no sign of distress when their mother leaves, being okay to interact with a stranger, and showing little interest when their mother returns. 2) Type B or Secure attachment is characterised by the infant showing distress when the mother leaves, the infant avoiding the stranger when alone, but being friendly when the mother is present, and being positive and happy when the mother returns. 3) Type C or Insecure/Ambivalent attachment, which is characterised by the infant showing signs of distress when mother leaves, showing fear

towards the stranger, and resisting the mother's contact on her return (Ainsworth, Bell, & Stayton, 1971; Ainsworth et al., 1978). A fourth attachment style known as disorganized was later identified (Main & Solomon, 1986, 1990) which is characterised by infants who do not fit any of the patterns described above.

Table 1-2. *Strange Situation Procedure*

Stage	Event
1	Mother, infant and experimenter in a room (1 minutes)
2	Mother and infant left alone (3 minutes)
3	A stranger joins the mother and infant (3 minutes)
4	The mother leaves and the baby and the stranger are alone (3 minutes)
5	Mother returns and the stranger leaves (3 minutes)
6	Mother leaves; infant is left completely alone (3 minutes)
7	Stranger returns (3 minutes)
8	Mother returns, and stranger leaves (3 minutes)

It is thought that having a secure attachment to one's primary caregiver is important for a child to learn, explore and relate to others (Rees, 2007). A secure attachment allows emotional regulation before infants can self-regulate, and over time an infant will become aware that their parent is always there when they need them and that they can soothe their emotions (Schore, 2005). This develops into an 'internal working model' of relationships and influences how individuals interact with others and the world around them (Bowlby, 1969). A secure attachment helps stress regulation, and ensures individuals feel safe and free to explore.

However, there is controversy surrounding attachment theory. For example, the original classification of infants into the three domains may be problematic. Main and Solomon (1990) suggested that investigators working with middle class parent-infant dyads would typically "force" each infant into an A, B or C attachment classification (p.122). Main and Solomon (1986) described 55 infants whose behavior didn't fit the ABC classifications. These infants seemed to lack a clear goal, intention or explanation for their behaviour, and so Main and Solomon created the disorganised and/or disoriented attachment style.

Furthermore, it has been argued that the Strange Situation is limited to behaviours that occur with the primary attachment figure, typically the mother. Other attachments are not

necessarily characterized by those same behaviours (Field, 1996, p. 544), and therefore the Strange Situation may only give a limited view of one attachment relationship.

Next, there are large cross-cultural differences in attachment classifications, Van Ijzendoorn and Kroonenberg (1988) conducted a meta-analysis and found significant differences between countries and continents in terms of attachment classifications. For example, higher rates of A classifications were found in Western European countries, and higher rates of C classifications were found in Israel and Japan. This may be because Western European countries are stereotypically more individualistic cultures, encouraging independence, whereas Japan and Israel are collectivistic cultures. However, it must also be noted that large differences were too found within Western Europe. Therefore, due to the large differences in attachment classifications across countries it could be suggested that the Strange Situation is an ethnocentric procedure, which is not applicable for all cultures.

Further, it has recently been argued that the power of attachment in predicting child development has been overrated. Meins (2017) argues that there is no strong evidence for parent–child attachment in infancy predicting much about children’s later development and that confusion may come from grouping different attachment styles together, when interpreting literature. For example, a recent meta-analysis found that early attachment security was associated with behaviour problems in later childhood (Madigan, Brumariu, Villani, Atkinson, & Lyons-Ruth, 2016). The authors stated that insecure attachment was associated with internalising and externalising behaviour. However, Meins (2017) points out that the authors grouped avoidant, ambivalent and disorganised attachment classifications into one group. Yet research that separated out attachment styles found avoidant, ambivalent and disorganized attachment classifications were associated with internalizing behaviour, but only disorganized attachment was associated with externalizing behaviour (Madigan et al., 2016). Meins (2017) therefore argues that promoting secure attachment in order to ensure children’s emotional wellbeing appears to be based on oversimplification of the evidence.

1.5.2 Maternal sensitivity

Parent infant interaction which is categorised by a high level of sensitivity to the infants’ needs has been associated with the development of secure attachments (Juffer, Bakermans-Kranenburg, & van Ijzendoorn, 2005; Meins, Fernyhough, Fradley, & Tuckey, 2001) and in turn positive psychological (Schorre, 2001; van Ijzendoorn et al., 1997), social (Bohlin, Hagekull, & Rydell, 2000) and cognitive development (Meins, 2003). On the other hand, interaction when the parent is not sensitive to the infant’s needs can have the opposite effect (Carter, Garrity-Rokous, Chazan-Cohen, Little, & Briggs-Gowan, 2001; Glasheen,

Richardson, & Fabio, 2010; Murray, Fiori-Cowley, Hooper, & Cooper, 1996; Parfitt, Pike, & Ayers, 2013).

Ainsworth et al. (1978) defined maternal sensitivity as the ability to perceive and interpret infants' attachment signals and respond to them promptly and adequately, and a lack of or inconsistent display of sensitivity has been found to be related to attachment type. The first evidence of this was published in 1963 by Ainsworth who conducted interviews with mothers and found that mothers who were able to talk in great detail about their infants' behaviour, and were therefore rated as "highly sensitive", were more likely to have a secure attachment with their infants (Ainsworth, 1963). This finding has been supported by many subsequent studies (De Wolff & van Ijzendoorn, 1997; Koren-Karie, Oppenheim, Dolev, Sher, & Etzion-Carasso, 2002; McElwain & Booth-LaForce, 2006; Meins et al., 2001; Pederson et al., 1990; Susman-Stillman, Kalkoske, Egeland, & Waldman, 1996). This shows the importance of maternal sensitivity for the development of attachment.

Measuring maternal sensitivity

1.5.2.1.1 Still-face paradigm

Maternal sensitivity can be measured through mother-infant interaction paradigms. One well known paradigm is the still face paradigm. This involves parents interacting with their infant as normal, and then putting on a "still face" where the adult becomes unresponsive and maintains a neutral facial expression. After this a reunion phase occurs where the adult resumes normal interaction. Infants typically react by increasing gaze aversion, smiling less and using more negative affect during the still face (Mesman, van Ijzendoorn, & Bakermans-Kranenburg, 2009). This response shows the infant's distress when their mother is looking at them but not responding, when they are typically not used to this happening. Field et al. (2007) found that 4-month-old infants of mothers with high levels of depression showed less distress during the still-face than comparison infants. The authors argued that this could be because infants of depressed mothers are used to their mothers having less expressive still faces. Therefore, the still-face paradigm can provide insights into mother-infant interaction from the infant's perspective.

1.5.2.1.2 Free-play paradigms

Maternal sensitivity can also be measured in a more naturalistic context where it is possible to look at both maternal and infant behaviour during spontaneous interactions. In these paradigms mothers are asked to play with their infant as they usually would, and this is video-recorded. Offline coding is then carried out rate the mother and infant's behaviour on a range of scales. There are many well-known coding systems that can be used such as the

CARE-Index (Crittenden, 2005); the National Institute for Child Development Measure (NICHD Early Child Care Research Network, 1996); Ainsworth Maternal Sensitivity Scales (Ainsworth, 1969); and Global Ratings of Mother-Infant Interaction Scales (Murray et al., 1996), all of which look at the mother's behaviour (such as warmth or intrusiveness) and infant behaviour (such as sustained attention and mood).

There are also measures that can be used to gauge the level of synchronicity in mother-infant interactions (e.g., Dyadic Mini Code; Censullo, Bowler, Lester & Brazelton, 1987; Parent Child Early Relational Assessment; Clark, 1999). It has been argued that synchrony encompasses both the mother's and the child's responsivity to one another (Leclère et al., 2014). During early development, synchrony involves a matching of behaviour, emotional states, and biological rhythms between parents and infants (Feldman, 2007) and is one of the main aims of parent-infant psychotherapy (Guedeney, Guedeney, Wendland, & Burtchen, 2014). These measures look at factors such as mutual attention, turn taking and responses to each other's cues.

1.5.3 Postnatal mental health difficulties and mother-infant interaction

Research suggests that mothers with postnatal mental health difficulties display different patterns when interacting with their infants, in comparison to mothers without these difficulties. The next sections will describe this research, which includes mothers with diagnostic disorders or symptoms of mental health difficulties.

Postnatal PTSD

1.5.3.1.1 Postnatal PTSD after a traumatic birth

Few studies have examined mother-infant interaction in women with perinatal PTSD. However, the available research suggests that birth trauma may impact the mother-baby bond. For example, one study found that women with a full diagnosis of PTSD, and women with symptoms of PTS after a traumatic birth were more likely to report their infant as being less warm, more invasive and more difficult in temperament. Women were also less likely to desire proximity with their infant (Davies, Slade, Wright, & Stewart, 2008). Qualitative studies support the potential impact of birth-related PTSD on the mother-baby bond. A meta-synthesis of these studies concluded many mothers with PTS feel unable to bond with their babies (Fenech & Thomson, 2014), explaining that their actions to care for their infant was an “empty affair” (Beck & Watson, 2008, p. 234) or “fake” (Nicholls & Ayers, 2007, p. 502). However, three studies found no association between postnatal PTSD and the parent-baby bond (Ayers, Wright, & Wells, 2007; McDonald, Slade, Spiby, & Iles, 2011; Parfitt, Ayers,

Pike, Jessop, & Ford, 2014), suggesting that the relationship between perinatal PTS and the mother-baby bond is not clear and more research is needed.

One experimental study, using the still face paradigm, recruited mothers with PTS symptoms and found that during the play phase infants of mothers who had high levels of PTS were less interested in objects nearby and showed more avoidance behaviours in general. During the still-face phase infants were more likely to adopt behaviours which physically distanced themselves from their mother, such as looking away, or putting themselves in an arch position. Furthermore, mothers with PTS symptoms were more likely to show intrusive behaviours during their interaction with their infant (Ionio & Di Blasio, 2014).

One study examined the impact of PTS symptoms caused by infant prematurity on mother-infant interaction. The authors found that mothers with PTS symptoms who had high-risk infants were less sensitive and more controlling when interacting with their infants (Muller-Nix et al., 2013). Similar results were found by Forcada-Guex and colleagues who found that mothers who had a preterm birth and high levels of PTS symptoms were more likely to be controlling when interacting with their infant (Forcada-Guex, Borghini, Pierrehumbert, Ansermet, & Muller-Nix, 2011).

1.5.3.1.2 Postnatal PTSD after other traumatic events

Studies of perinatal PTSD due to non-obstetric events mainly focus on women with childhood sexual or physical abuse as the causes of PTSD. Muzik et al. (2013) investigated the impact of PTSD as caused by neglect and sexual abuse history on mother-infant interaction and mothers' feelings or attitudes towards their infant. Maternal PTSD was found to be associated with poor perceived bonding with their infant, and in turn this impacted on mother-infant interaction. Mothers who perceived a poor bond with their infant were less likely to display sensitivity, flexibility, engagement and warmth when interacting with their infant. In another study investigating the impact of maternal childhood experiences of physical or sexual childhood abuse on PTS symptoms and mother-infant interactions, researchers found that a history of abuse was associated with more maternal hostile-intrusive behaviours when interacting with their infant (Lyons-Ruth & Block, 1996). However, Morelen, Menke, Rosenblum, Beeghly, and Muzik (2016) found that PTS symptoms associated with childhood sexual abuse, predicted less maternal negative affect. Therefore, more research is needed to determine whether PTSD influences maternal sensitivity.

Postnatal Depression

The association between postnatal depression and mother-infant interaction is well documented. Murray and her colleagues found that maternal depression is associated with

mothers being less attuned to their infant's needs and being less positive and more negating of their infant's experience during interaction (Murray et al., 1996). Similarly, compared to non-depressed mothers, depressed mothers' interactions with their baby have been found to be both less contingent and less affectively attuned to their infant's behaviour (Stanley, Murray, & Stein, 2004). Furthermore, a meta-analysis of 19 studies found that postnatal depression has a moderate to large effect on maternal-infant interaction ($r = .32-.50$) (Beck, 1995). In a recent review of the literature Murray, Fearon, and Cooper (2015) highlighted the impact postnatal depression can have on mothers' behavioural responsiveness and sensitivity to infant signals (Murray et al., 1996; Stanley et al., 2004). Depressed mothers show less physical contact (Ferber, Feldman, & Makhoul, 2008; Herrera, Reissland, & Shepherd, 2004), and slower, less responsive speech (Bettes, 1988; Breznitz & Sherman, 1987; Murray, Kempton, Woolgar, & Hooper, 1993; Zlochower & Cohn, 1996).

A meta-analytic review of studies of the early interactions of mothers with postnatal depression (both self-report symptoms and psychiatric diagnoses) found that the mothers who were depressed during their infants' first three months of life were more irritable and hostile, less engaged, and exhibited less emotion and warmth towards their infants (Lovejoy, Graczyk, O'Hare, & Neuman, 2000). Similarly, a more recent review of the literature reported that postnatal depression (diagnoses and self-report) is associated with controlling and over-stimulating interactions, or a withdrawn, passive and under-stimulating style of interaction (Field, 2010). For example, mothers with depressive symptoms touch their infants less frequently and in a less affectionate manner compared to non-depressed mothers (Beebe et al., 2008), or they touch their infant in a more negative manner (e.g. rough pulling, tickling and poking) (Malphurs, Raag, Field, Pickens, & Pelaez-Nogueras, 1996). Overall, these results suggest that both symptoms and diagnoses of postnatal depression can be linked to certain patterns of insensitivity when the mother is interacting with her infant.

Postnatal Anxiety

The association between postnatal anxiety and mother-infant interaction has been less explored. In a study carried out in 2007, Feldman and colleagues found that less trait anxiety in mothers was associated with easier infant temperament and greater maternal sensitivity to infants (Feldman, Greenbaum, Mayes, & Erlich, 1997). Another study looking at the 32 mothers with postnatal anxiety, found that mothers with high trait anxiety showed less sensitive responses towards their infant and reduced emotional tone during interaction. This was still the case when controlling for depression symptoms (Nicol-Harper et al., 2007).

Similar results are found with anxiety disorders. Kaitz et al. (2010) found that compared to controls, mothers with a diagnosis of any anxiety disorder showed exaggerated behaviour with their infant during free play and when the mothers were teaching their infant. Furthermore, Warren et al. (2003) found that mothers with panic disorder were less sensitive when interacting with their four-month-old infants.

However, some studies have found no impact of anxiety on maternal sensitivity. For example, Murray, Cooper, Creswell, Schofield, and Sack (2007) assessed 84 mothers with social phobia interacting with their 10-week-old infant and when engaging with a stranger. Mothers with social phobia were no less sensitive to their infants during face-to-face interactions than control mothers. However, when interacting with the stranger they appeared more anxious, engaged less with the stranger themselves, and were less encouraging of their infant's interaction with the stranger.

Overall, research suggests that postnatal anxiety symptoms may influence mother infant interaction, but the results are inconsistent. When mothers have diagnoses of anxiety conditions results are varied. More research is therefore needed to understand the mother-infant interaction patterns displayed by mothers with anxiety.

Overall, the literature provides the most support that postnatal depression influences maternal sensitivity in a way that can lead to controlling, hostile, or withdrawn interactions. There is less research for PTSD, but mothers with PTSD have been reported to be more controlling in their interactions. Mothers with anxiety have been found to have both reduced emotional tone and exaggerated behaviour, but some studies have found no impact of anxiety on maternal sensitivity. More research is needed to identify any associations between maternal sensitivity and anxiety and/or PTSD.

1.5.4 Impact of maternal psychological distress on infants and children

The theory of the 'intergenerational transmission of trauma' posits that the negative effects of parental trauma can be passed on to children through a complex set of factors, including trauma exposure itself and the parents' negative mental health outcomes associated with trauma (Schwerdtfeger & Goff, 2007; Yehuda, Halligan, & Grossman, 2001). Indeed, there is evidence supporting the intergenerational transmission of vulnerability to a range of psychological and physical problems, and this is thought to be underpinned by epigenetics and environmental exposure. Research has found that the environment has an influence over our inherited genes, and the expression of specific genes can be changed by the environment (van Otterdijk & Michels, 2016). There is also increasing evidence to show the association

between maternal psychological distress (anxiety, depression and post-traumatic stress) offspring outcomes. This association will be described below.

Short-term impact

Research suggests that maternal mental health difficulties can influence children in-utero and in their early years (up to pre-school age).

1.5.4.1.1 PTSD

Research from non-perinatal populations has found that maternal PTSD may influence childhood outcomes. For example, Lieberman, Van Horn, and Ozer (2005) found that maternal stress symptoms predicted pre-school children's behavioural problems and that this was mediated by the quality of the mother-child relationship. Further, another study of the effect of intimate partner violence on children's emotional and behavioural functioning found that a child's emotional regulation was associated with mothers' PTS symptoms, rather than the amount of violence witnessed (Samuelson & Cashman, 2008). Similar results were found by Lester et al. (2010) who found that parental distress and length of parental time at war predicted child depression and externalising symptoms such as hyperactivity, and disruptive and aggressive behaviours. Additionally, Garthus-Niegel, Ayers, Martini, von Soest, and Eberhard-Gran (2017) found that PTS symptoms eight weeks after birth were associated with poor child social-emotional development two years postnatally in a population-based sample of 1,472 women.

Four studies have assessed the impact of perinatal PTSD on infant and child development, with mixed results. Parfitt et al. (2013) found that women with postnatal PTSD reported a poorer mother-baby bond which in turn was associated with poor infant cognitive development at 15 months of age. However, a study of preterm infants reported that the maternal postnatal PTSD symptom score was not related to infant cognitive development at six months after birth (Feeley et al., 2011).

Physiological responses may also be affected. There is some evidence for the association between postnatal PTSD and sleeping and eating difficulties. Muller-Nix et al. (2013) found that mothers with higher numbers of PTS symptoms reported significantly more difficulties with their preterm infant, such as eating and sleeping trouble. Research has also shown that maternal PTS can influence the child's cortisol regulation as young as one year old. For example, Yehuda et al. (2005) found that mothers who had been exposed to the terrorist attack known as "9/11" during their third trimester and who developed PTS symptoms were more likely to have infants with lower levels of stress hormones (Yehuda et al., 2005). One group of authors suggested that PTSD may exhaust the HPA axis in adults

leading to reduced levels of stress hormones (Yehuda et al., 2000). This relationship can be explained by the foetal programming hypothesis which posits that prenatal environmental exposures, such as maternal psychological state, which affects physiological correlates, such as cortisol production, maternal nutrition, smoking, alcohol intake etc. can influence the baby's development *in utero* and have sustained effects across the lifespan (Kinsella & Monk, 2009).

Overall, it appears that both symptoms and diagnoses of PTSD can influence children's behavioural and emotional development as well as their physiological responses, however more research is needed examining perinatal PTSD.

1.5.4.1.2 Depression

Three meta-analyses have been carried out examining the influence of both self-reported and diagnosed depression may have on mother-infant interaction. Beck (1998) carried out a meta-analysis of nine studies and found that postnatal depression had a small but significant effect on children's cognitive and emotional development. A more recent meta-analysis had similar findings, suggesting that postnatal depression affects childhood cognitive development, particularly among boys (Grace, Evindar, & Stewart, 2003). The most recent meta-analysis of 193 studies found maternal depression was significantly related to higher levels of internalising and externalising behaviour, general psychopathology and lower levels of positive affect (Goodman et al., 2011). Therefore, the association between postnatal depression and child development is well established.

1.5.4.1.3 Anxiety

Most research investigates the impact of antenatal anxiety on childhood outcomes. There is some evidence that antenatal anxiety is associated with behavioural/emotional problems in children (Connor, Heron, Golding, Beveridge, & Glover, 2002). For example, in a cohort study, antenatal anxiety was related to a twofold increase in the risk of developing childhood mental disorders and was also related to higher behavioural and emotional symptoms (O'Donnell, Glover, Barker, & O'Connor, 2014).

Few studies have investigated the impact of postnatal anxiety of childhood outcomes. Mothers with diagnoses of anxiety, living in a residential care unit were found to rate their infant's temperament as more difficult (McMahon et al., 2001). Similarly, postnatal anxiety symptoms are associated with self-reported temperamental difficulty (Britton, 2011; Clout & Brown, 2015; Jover et al., 2014).

One study used anxiety and depression scales based on DSM-IV criteria and found that both postnatal anxiety and depression were associated with delays in infants' social,

emotional, language, cognitive, gross motor and fine motor development (Ali, Mahmud, Khan, & Ali, 2013). Furthermore, social phobia has been related to infant avoidance behaviour and a fearful response in male infants towards strangers (Murray et al., 2008). Maternal social phobia has also been related to more infant distress in novel (still-face paradigm) situations (Reck et al., 2008).

This research suggests that both anxiety symptoms and diagnoses may be associated with early childhood development.

Long-term impact

Parental mental health difficulties have also been associated with long-term effects, impacting on offspring into adolescence and adulthood.

1.5.4.1.4 PTSD

Ahmadzadeh and Malekian (2004) found a higher rate of aggression and anxiety in adolescent children of war veterans with PTSD. Yehuda, Halligan, and Grossman (2001) recruited adult offspring of holocaust survivors and asked them about their childhood experiences. Adult offspring of Holocaust survivors reported significantly higher levels of childhood trauma, particularly emotional abuse and neglect and this difference was largely due to parental PTSD. Furthermore, self-reported childhood trauma was also related to severity of PTSD in subjects. Another study asked participants about their symptoms of PTSD, anxiety and depression, as well as completing a checklist based on the DSM-IV criteria of PTSD about their parents. Results found parental trauma exposure was significantly associated with lifetime depressive disorder in offspring (Yehuda, Halligan, & Bierer, 2001). These studies reflect the intergenerational transmission of trauma.

Research has also found that altered HPA axis responses can continue after infancy to adulthood. For example, healthy young adults whose mothers experienced severe stress during their pregnancy in the form of major negative life events (e.g. death of someone close) had their diurnal cortisol profile assessed. Adults whose mothers were exposed to traumatic events during their pregnancy had lower levels of cortisol generally compared to adults whose mothers had not experienced traumatic events. Additionally, after these adults were given a stressful task (a free speech and a mental arithmetic task performed in front of an audience) adults whose mothers had been exposed to traumatic events had significantly higher cortisol levels (Entringer, Kumsta, Hellhammer, Wadhwa, & Wüst, 2009). These studies show the association between maternal PTSD and long-term child development.

1.5.4.1.5 Depression

Postnatal depression has also been found to influence children in the long term. For example, a study carried out in South London found that 11-year-old children whose mothers had postnatal depression had significantly lower IQ scores. The children of depressed mothers were also more likely to have attentional problems, difficulties with mathematical reasoning and were more likely to have special educational needs (Hay et al., 2001). Furthermore, research has found that children of mothers who had postnatal depression were more likely to experience depression themselves at 16 years of age (Murray et al., 2011). A longitudinal study has also found that adolescent offspring of mothers with postnatal depression were more likely to have an anxiety disorder, depressive disorder or behavioural disorder at 13 years (Halligan, Murray, Martins, & Cooper, 2007).

1.5.4.1.6 Anxiety

Little research has been carried out which investigates the long-term association between postnatal anxiety and child development. Tangney, Miller, Flicker, and Barlow (1996) looked at the effect of maternal depression and GAD diagnoses on children's behaviour problems. Both depression and GAD were associated with maternal report of child behaviour problems and higher levels of emotional negativity. However, only maternal depression was related to observed child behaviour problems. In an epidemiological study Barker, Jaffee, Uher, and Maughan (2011) found postnatal anxiety diagnoses to be associated with childhood internalising behaviours at 8 years old. Furthermore, O'Connor, Heron, Golding, and Glover (2003) found that postnatal anxiety at 8 weeks postnatal was associated with emotional problems in boys and conduct problems in girls at 81 months.

Overall, the literature suggests that postnatal mental health difficulties may lead to both short and long-term consequences for children of mothers with mental health difficulties.

1.6 Potential explanations for poor mother-infant interaction in mothers with symptoms of psychological distress.

As can be seen from the literature described above, perinatal mental health difficulties can lead to short- and long-term negative effects on offspring. It is important to understand potential reasons for this relationship so that targeted evidence-based treatments can be developed. This section outlines some of the theories that have been put forward to explain the relationship between maternal mental health and maternal sensitivity. There are a range of theories that can explain the relationship, but two cognitive theories that focus on processing of infant-related information will be discussed as these are the most relevant to this thesis.

These theories mainly provide explanations for the lack of interactive contingency or regulation displayed by mother-infant dyads in mothers with postnatal mental health difficulties. Interactive contingency or regulation refers to how each individual's behaviour modifies, and is modified by, the changing behaviour of the partner (Beebe, Lachmann, Markese, & Bahrack, 2012). The theories that will be outlined are: 1) a cognitive theory about the attributions a parent makes to their child's behaviour; 2) a cognitive theory related to a mother's ability to infer mental states in her child and in herself. Finally, a new theory will be put forward that is based on previous research and can be used to inform the cognitive model: processing of infant-related information.

1.6.1 Attributions

One theory that could explain maternal sensitivity in mothers with postnatal PTS and depression symptoms is the attributions a mother makes about her child's behaviour. Lieberman (1999) defines attributions as a parent's fixed beliefs about their child's "existential core", which they "perceive as objective, accurate perceptions of their child's essence" (p.738). Attributions that are far from being accurate or age appropriate (such as saying "s/he likes to hurt others" about a 6-month-old) are thought to reflect the parent's own projections and defence mechanisms (Lieberman, 1999; Schechter et al., 2006). In line with this proposal, Schechter et al. (2015) found that the severity of mothers' trauma-related psychopathology (PTS, depressive and dissociative symptoms caused by interpersonal trauma) predicted the degree of negativity of mothers' attributions towards their preschool age children. The authors argued that the infants' communication, gestures, or appearance can serve as traumatic reminders to the mother. These reminders during interactions may lead to a mother avoiding, rather than approaching her child when the child needs comfort and support the most, thus influencing maternal sensitivity.

1.6.2 Reflective Functioning

Maternal reflective functioning or 'Mentalization' is the capacity for a mother to infer mental states in her child and in herself (Fonagy, Steele, Steele, Moran, & Higgitt, 1991). Mentalization develops in childhood and is often called "theory of mind" in the developmental literature (Sharp et al., 2009). This can be measured using the Parenting Reflectivity Scale or the Reflective Functioning Scale (RFS; Fonagy, Target, Steele & Steele, 1998). Individuals who score highly on this are able to perceive and understand their own and their babies mind in terms of beliefs, desires, plans, thoughts and feelings. Individuals scoring low on this will be unable to, or very rarely, acknowledge feelings or mental states (Rosenblum, McDonough, Sameroff, & Muzik, 2008). Fonagy, Steele, Steele, et al.

(1991) found that the capacity of the mother to recognise and to reflect upon her own mental experience was correlated with her own attachment history, and her infant's attachment to her (Fonagy, Steele, & Steele, 1991; Fonagy, Steele, Steele, et al., 1991). This finding has been replicated by other studies which have found that maternal reflective functioning is associated with maternal behaviour and child attachment security (Grienenberger, Kelly, & Slade, 2005; Slade, 2005).

Mind-Mindedness

Mind-mindedness refers to a mother's tendency to "treat her infant as an individual with a mind" (Meins et al., 2001; Meins et al., 2002, p.1716). Rosenblum et al. (2008) argued that conceptually, mind-minded comments may be considered a type of reflective functioning in action (p.364), in that both measure a mother's ability to treat her infant as having their own mind, but reflective functioning is measured using a questionnaire, whereas mind-mindedness is measured during mother-infant interactions. To support this, Rosenblum et al. (2008) found a positive correlation between parenting reflectivity and mind-minded comments. However, it has been argued that mind-mindedness does not address the capacity to link mental states and behaviour, which reflective functioning does, and thus differs slightly from reflective functioning (Slade, 2005). Parental mind-minded comments during interaction with 6-month-old infants are associated with parental sensitivity, and dyadic synchronicity (Lundy, 2003; Meins et al., 2001). Lower mind-related comments have been associated with parenting stress (Walker, Wheatcroft, & Camic, 2012) and depression (Pawlby et al., 2010).

Empathic understanding

Another type of reflective functioning is empathic understanding. Empathic understanding looks at a mother's ability to consider her child's perspective; engage with her child; be aware of how her own feelings could influence her child's behaviour; describe her child's emotions, and describe her own emotions. The authors found that mothers who were higher in empathic understanding were more likely to show sensitivity when interacting with their infant (Coyne, Low, Miller, Seifer, & Dickstein, 2007). The authors also found that maternal depression was negatively related to empathic understanding. The authors discussed possible reasons for this in that mothers may have more difficulty being empathic when they are vulnerable to experiencing negative emotions (Dix, Gershoff, Meunier, & Miller, 2004), therefore they may avoid these difficult feelings. Hayes, Strosahl, and Wilson (2011) suggest that when people engage in avoidance, they do not get to learn about what might happen if they were to approach the situation they are concerned about rather than avoid it. This means

people can become stuck in a vicious cycle of being preoccupied with what they need to avoid, rather than living in the present. Therefore, mothers' attempts to limit/minimize their own negative emotions may mean the mother does not allow herself to fully empathise with her infant, and therefore may not respond in a sensitive way to her child.

1.6.3 Processing of infant-related information

Each theory discussed has supporting research for specific mental health difficulties. For example, mind-mindedness has been found to be related to parenting stress, and maternal attributions are associated with PTS and depression. However, postnatal mental illnesses are often comorbid with one another (Reck et al., 2008; Sharma, Khan, Corpse, & Sharma, 2008; White et al., 2006) therefore these theories currently do not have supporting research for individuals with comorbid mental health difficulties, or anxiety.

A theory that has yet to be explored relates to the way mothers process information about their infant's emotions. Infant-related information could refer to how easily a mother is able to look away from certain infant emotional expressions, or her accuracy when categorising infant emotional expressions. These may affect maternal sensitivity because biases towards certain stimuli implicitly guide attentional allocation, meaning we are more likely to encode and process the stimulus that we have allocated our attention to (Cisler & Koster, 2010). These biases affect the way we remember and understand the world. Therefore, if a mother is more accurate at identifying sadness, but also quicker to disengage from it, a mother may view her infant as particularly difficult, and also not respond appropriately to her infant's distress, either through ignoring the distress, or responding in a non-concordant way. Infant-related information could also refer to the way a mother sees her child, or perceives her relationship with her child. As discussed above in the reflective functioning literature, a mother who sees her infant as having their own mind, may be less controlling in their interactions, allowing the infant to set the pace and do as they wish. A mother's perception of her relationship with her infant could also influence maternal sensitivity. For example, a mother who feels anger towards her baby may respond in a hostile way to her infant's cries. Alternatively, a mother who feels anxious when looking after her baby may respond in an intrusive way, to try and overcompensate for her anxiety.

Research in both the perinatal and non-perinatal population support the suggestion that affective symptoms are associated with certain biases when processing faces. For example, people with depression are more likely to have their attention captured by negative faces (Gotlib, Krasnoperova, Yue, & Joormann, 2004; Joormann & Gotlib, 2007), and are less likely to recognise happiness in ambiguous faces (Bourke, Douglas, & Porter, 2010;

Joormann & Gotlib, 2006). Conversely, people with anxiety have been found to display attentional biases towards threatening or fearful faces (Fox, 2002; Georgiou et al., 2005; Gilboa-Schechtman, Foa, & Amir, 1999; Pishyar, Harris, & Menzies, 2004). People with anxiety are also better at recognising fear (Surcinelli, Codispoti, Montebanocci, Rossi, & Baldaro, 2006) and have difficulty recognising positive emotions such as happiness (Silvia, Allan, Beauchamp, Maschauer, & Workman, 2006). Less research has examined cognitive biases when interpreting emotion in PTSD. Poljac, Montagne, and de Haan (2011) found that war veterans with PTSD were worse at recognising fear and sadness than controls. Additionally, Mazza et al. (2012) found that participants with PTSD, who had been exposed to war, were significantly worse at identifying emotions from only looking at people's eyes, compared to controls.

There is less research examining cognitive biases in face processing during the perinatal period, but the results are mainly in line with research in other populations. For example, in terms of accuracy Arteche et al. (2011) and Stein et al. (2010) found that mothers with a diagnosis of depression were worse at identifying happiness in infant faces compared to controls. Gil et al. (2011) also found a similar pattern, reporting that mothers with high trait anxiety were more likely to rate sad infant faces as being sadder, and mothers high in depressive symptoms were more likely to rate neutral infant faces as being sad. In terms of attentional biases away from infant emotion, Pearson et al. (2010) and Pearson et al. (2013) found that pregnant women with diagnosed depression disengaged faster from infant distress than controls, suggesting differential processing abilities between these groups.

It is possible that these cognitive biases when identifying and interpreting infant emotional expressions could impact on the way a mother interacts with her infant. This is because recognising and interpreting infants' emotional cues successfully is key to maternal sensitivity (Eisenberg et al., 1998; van Doesum et al., 2007). It could therefore be suggested that mothers with postnatal mental health difficulties might display differing levels of maternal sensitivity because of their cognitive biases. For example, if a mother is less likely to have her attention captured by infant emotion (Pearson et al., 2010) she may fail to notice emotional changes in her infant leading to a more withdrawn or flat interaction style and less sensitivity towards infant distress. On the other hand, if a mother is more likely to have her attention captured by threatening stimuli, such as a fearful expression, the mother may be particularly sensitive to infant distress, providing fast responses to her infant.

It is also possible that the cognitive biases associated with affective symptoms vary depending on whether a woman is pregnant or has given birth. For example, during

pregnancy women's brains go through physiological changes. One study found that pregnant women consistently showed a loss of gray matter volume in parts of the brain associated with social tasks such as reading the desires and intentions of others (Hoekzema et al., 2017). Additionally, pregnancy has been found to be associated with an enhanced ability to encode emotional faces (Pearson, Lightman, & Evans, 2009). Whereas after birth, mothers show preferential attention to infant faces compared to non-mothers (Thompson-Booth et al., 2014a). Furthermore, after birth, mothers show increased brain activation in the reward processing regions of their brain when looking at photos of their own infant, as opposed to another unknown infant (Lenzi et al., 2009; Strathearn, Li, Fonagy, & Montague, 2008). This suggests that during pregnancy women may start to become more sensitive to others' emotional expressions and signals, and that after birth this sensitivity may become more specific towards their own infant, after they have seen their face. However, research is needed to specifically test this before this can be added as a hypothesis within the model.

Another infant-related processing factor that may influence maternal sensitivity is a mother's perception of her infant and her relationship with her infant. For example, mothers with elevated depressive symptoms are less likely to perceive 4-month old infants as being intentional, than mothers with less depressive symptoms (Zeedyk, 1994). Additionally, depressive symptoms have been found to be correlated with the mother-baby bond (Moehler, Brunner, Wiebel, Reck, & Resch, 2006; Taylor, Atkins, Kumar, Adams, & Glover, 2005), as have PTS symptoms (Parfitt & Ayers, 2009). Furthermore, one study found that postnatal depression and PTSD were associated with the mother-baby bond, which was in turn associated with observed parenting behaviours at six months (Muzik et al., 2013).

Overall, this research shows the impact postnatal mental health difficulties can have on the processing of infant-related information (such as identifying infant emotion, interpreting infant emotion, and perception of the infants' behaviour and of the mother-baby bond). It is therefore possible that these cognitive biases could influence a mothers' sensitivity when she is interacting with infant, but this has not yet been tested empirically. This thesis therefore aims to address this gap in the literature by testing this.

1.7 Summary, cognitive model and aims

1.7.1 Summary

In summary, evidence shows that postnatal mental health difficulties are associated with certain interaction patterns between mothers and their babies. These patterns have been associated with negative outcomes for families. Several theories have been put forward to

explain the mutual dysregulation shown when mothers with mental health difficulties interact with their infants. Cognitive theories suggest that maternal attributions a mother has towards her infant, or a mother's ability to infer mental states in her child and in herself may influence a mother's behaviour towards her infant. However, these theories are based on research with individuals with PTSD and depression, none look at comorbidity or anxiety symptoms. Furthermore, the theories do not consider the relationship of infant-related processing which have been found to be associated with maternal mental health difficulties.

1.7.2 A cognitive model of maternal sensitivity

Therefore, a model which aimed to explain the relationship between anxiety, depression and PTSD and maternal sensitivity was developed. This model was developed based on previous research and incorporates recent literature of maternal processing of infant emotion. The development of this model means that cognitive mechanisms underlying the relationship between maternal affective symptoms and maternal sensitivity can be explicitly defined and tested, and the model revised based on the results from this study.

The cognitive model is shown in Figure 1-1 and has the following hypotheses:

- 1) Hypothesis 1: Maternal affective symptoms will be associated with lower levels of maternal sensitivity.
- 2) Hypothesis 2: Maternal infant-related information processing will be associated with maternal sensitivity. These infant-related information processes include:
 - Attentional biases:
 - Selective attention to infant emotional expressions
 - Disengagement from infant emotional expressions
 - Perceptual biases:
 - Sensitivity/accuracy when categorising infant emotions
 - Bias when categorising infant emotion
 - Perceptual strategy
 - Regions of interest (i.e. eyes, mouth) focused on during infant emotional categorisation
 - Mental state attributions
 - Maternal perception of bond with infant (infant-focused anxiety, anger and rejection)
 - Beliefs about infant's behaviour (infant intentionality)

Table 1-3 provides some examples of the processing of infant-related information, and the potential behavioural outcomes associated with this type of processing.

3) Hypothesis 3: The relationship between maternal affective symptoms and maternal behaviour will be partially explained by infant-related processing factors. Table 1-4 provides some examples of the interplay between postnatal affective symptoms, maternal processing of infant related factors and maternal behaviour.

4) Hypothesis 4: Maternal sensitivity and infant behaviour will be associated with one another

Table 1-3. *Processing of infant related information and possible behavioural outcomes*

Processing of infant related information	Possible outcomes
1. Mother attends to positive face and does not disengage until she has processed it 2. Mother accurately categorises face as positive 3. Mother feels confident in taking care of infant 4. Mother believes infant is smiling for an intentional reason	Mother smiles back and engages with infant
1. Mother selectively attends to only negative faces, and does not disengage until she has processed it 2. Mother accurately categorises face as negative	Ignores positivity in infant Begins to see infant as a negative/difficult baby. This may lead to infant-focused anxiety in caring for the baby (i.e. I can't make my baby happy).
1. Mother attends to positive face, but disengages too quickly 2. Is unable to categorise emotion	Responds in a discordant manner.
1. Mother attends to negative face, and does not disengage until she has processed it 2. Mother accurately categorises face as negative 3. Mother does not feel confident in coping with infant negativity 4. Mother believes infant is crying for an intentional reason	Mother responds in an overcompensating way, perhaps causing the infant to cry more. Mother does not respond Mother responds in a discordant manner
1. Mother attends to negative face, and does not disengage until she has processed it 2. Mother accurately categorises face as negative 3. Mother feels confident in coping with infant negativity 4. Mother believes infant is crying for attention rather than an intentional reason (i.e. hunger)	Mother does not respond

Note. The processing stage where a less helpful type of infant-related processing is highlighted in grey. These examples are hypothetical and not exhaustive.

Table 1-4. *Examples of how maternal affective symptoms may influence processing of infant related information, and in turn maternal sensitivity.*

Maternal affective symptoms	Processing of infant related information	Possible outcomes
Maternal anxiety	Research suggests mothers with anxiety may be more likely to interpret neutral faces as negative (Webb & Ayers, 2015)	Mother ignores positivity in infant Mother begins to see infant as a negative/difficult baby.
Maternal depression	Research suggests mothers with anxiety may be more likely to see their infant as less intentional (Zeedyk, 1994). Therefore, mother may believe the infant is smiling/crying for attention rather than an intentional reason (i.e. hunger)	Mother does not respond

Note. These examples are hypothetical and not exhaustive.

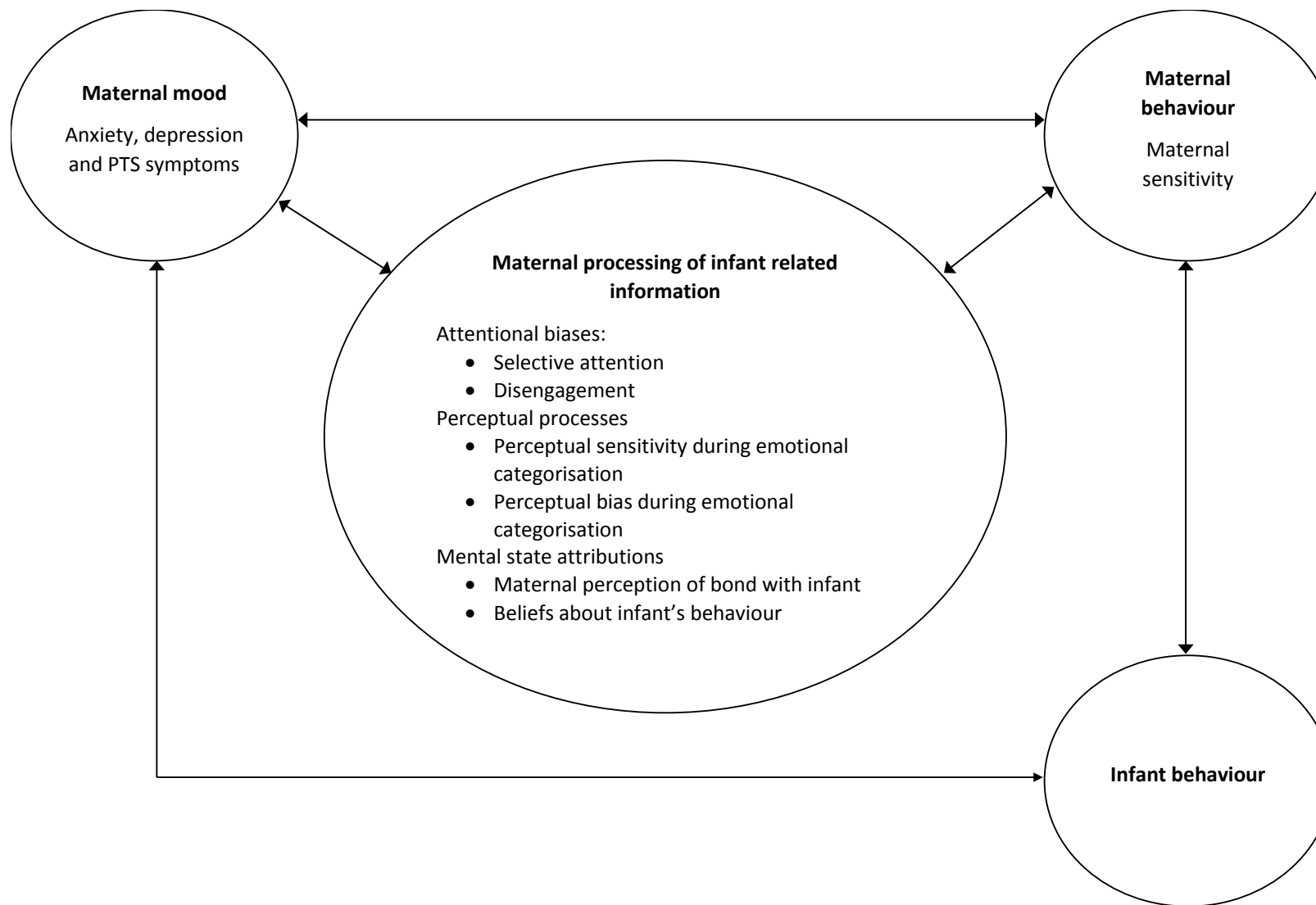


Figure 1-1. Proposed cognitive model of maternal sensitivity

1.7.3 Aims and Objectives

This PhD thesis aimed to test this model through three studies reported in five articles:

1. Cognitive biases in postnatal mental health problems (Article 1): This article aimed to systematically review the literature on cognitive biases when processing emotional expressions in pregnant women/mothers with perinatal mental health difficulties. This article informed the development of the cognitive model. The research questions for this article were as follows:

1.1. Are women with perinatal mental health difficulties less accurate than mothers without perinatal mental health difficulties at categorising emotional facial expressions?

1.2. Are women with perinatal mental health difficulties faster or slower to disengage from emotional facial expressions compared to mothers without mental health difficulties?

2. Development of a validated set of infant emotional expressions (Article 2): This database of infant faces was developed to use as the stimuli for articles 3-5. The aims for this article were as follows:

2.1. To develop and validate a set of infant facial expressions for research.

3. Maternal categorisation of infant emotions and disengagement from infant emotions (Article 3): This article assessed whether postnatal affective symptoms were associated with mothers' accuracy when categorising infant emotional expressions, and ability to disengage from infant emotional expressions. Research questions for this article were as follows:

3.1. Are mothers with postnatal mental health difficulties (symptoms of anxiety, depression and PTS) more or less sensitive than controls at identifying positivity in ambiguous facial expressions?

3.2. Are mothers with postnatal mental health difficulties more or less likely to have their attention captured by infant's facial expressions in comparison to controls?

4. Maternal attentional biases towards infant emotion (Article 4): This article assessed whether postnatal mental health difficulties were associated with certain gaze patterns when mothers were categorising infant facial expressions. This article also investigated whether mothers displayed attentional biases towards certain infant expressions. The research questions for this article were as follows:

- 4.1. Do mothers with postnatal mental health difficulties display different gaze patterns to controls when categorising infant facial expressions?
- 4.2. Do mothers with postnatal mental health difficulties display attentional biases towards certain infant facial expressions?
5. Cognitive model of maternal sensitivity (Article 5): This article assessed whether postnatal mental health difficulties were associated with maternal sensitivity, and whether this relationship is partially explained by maternal processing of infant-related information.
- 5.1 Are mothers with postnatal mental health difficulties less sensitive to their infant's needs during play?
- 5.2. If so, is the variance in maternal sensitivity partially explained by processing of infant-related information?

Table 1-5. *Overview of research questions and studies*

Research question/aim	Study	Participants (N)	Article	Chapter
1.1, 1.2	A systematic review of cognitive biases in women with perinatal mental health problems		1	2
2.1	Development of validated set of infant faces	71	2	3
3.1, 3.2	Maternal categorisation of, and disengagement from infant emotion	70 ^a	3	4
4.1, 4.2	Maternal attentional biases towards infant emotional expressions	70 ^a	4	5
5.1, 5.2	Cognitive model of maternal sensitivity	70 ^a	5	6

Note. a denotes the fact that the same women participated in all of these studies.

1.8 Methodology overview

A systematic review of the literature largely informed the development of the cognitive model (Article 1). To enable testing of the proposed cognitive model of maternal sensitivity, infant face stimuli were needed. The City Infant Face Database was therefore developed - more information about this can be found in Article 2. Here, a brief overview of

the method used to test the cognitive model is provided. More detail can be founded in Articles 3, 4 and 5.

1.8.1 Design

A mixed-method design was employed, using three computer-based tasks (1. selective attention and dwell time on infant faces; 2. disengagement away from infant faces; 3. categorisation of infant emotions); two questionnaire measures (1. perception of infant intentionality; 2. perception of a mother's relationship with her infant); and one maternal sensitivity and infant behaviour task (mother-infant free play). Each measure was used to reflect an individual component within the model (see Table 6-1) with the aim of identifying which components influence maternal sensitivity.

1.8.2 Participants

Convenience sampling was used to recruit mothers with or without affective symptoms. Inclusion criteria were that mothers were aged 18 or over and had an infant aged between 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 to take part in all aspects of the study.

Mothers with affective symptoms were recruited if they had current symptoms of anxiety or depression as measured by the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) or symptoms of PTS as measured by the PTSD Diagnostic Scale (PDS; Foa, 1995) (Appendix 5). These questionnaires were completed by 228 mothers and 204 left contact details. However, eligibility and attrition meant only 47 mothers without affective symptoms, and 23 mothers with affective symptoms were included in the final analysis. Please see Figure 1-2 for more detail.

Maternal age ranged from 23 to 50 ($M = 34.01$, $SD = 4.57$) and infant age ranged from 3 to 8 months ($M = 5.04$, $SD = 1.24$). The majority of women breastfed their infant ($n = 41$; 58.57%) and most women were first time mothers ($n = 43$; 61.43%).

1.8.3 Materials

Symptoms of post-traumatic stress were measured using the Post-traumatic stress disorder diagnostic scale (PDS) (Foa, 1995). Symptoms of anxiety and depression were measured using the Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983). Beliefs about infant's behaviour was measured using the Infant Intentionality Questionnaire (IIQ) (Feldman & Reznick, 1996). Maternal perception of her bond with her

infant was measured using the Postpartum Bonding Questionnaire (PBQ) (Brockington et al., 2006). Maternal sensitivity was measured using the National Institute for Child Development Infant Interaction Tool; (NICHD Early Child Care Research Network, 1996; van Bakel et al., 2010).

1.8.4 Procedure

All mothers participated in all of the tasks. Mothers were asked to complete questionnaires via an online survey platform, Qualtrics (Qualtrics, 2015). This survey included the PDS, HADS, IIQ, PBQ and demographic questions. Mothers were asked to leave their contact details at the end of the survey if they wanted to take part in the computer and the mother-infant interaction tasks. If participants met eligibility criteria they were invited to come to the university to take part in the tasks. Mothers who consented completed three computer-based tasks, questionnaire measures, and a mother-infant interaction task, each of which reflected a component of the cognitive model:

After all the tasks were completed mother's travel expenses were reimbursed. Mothers were given a £25 gift voucher to thank them for taking part and a certificate for their infant. More details of the method can be found in Article 5.

1.8.5 Ethical approval

Ethical approval was not required for the systematic review (Article 1). Ethical approval was given by City, University of London School of Health Sciences Ethics committee for articles 2-5 (see Appendix 1). Ethical approval was also obtained from the NHS ethics committee for articles 3-5 (see Appendix 2).

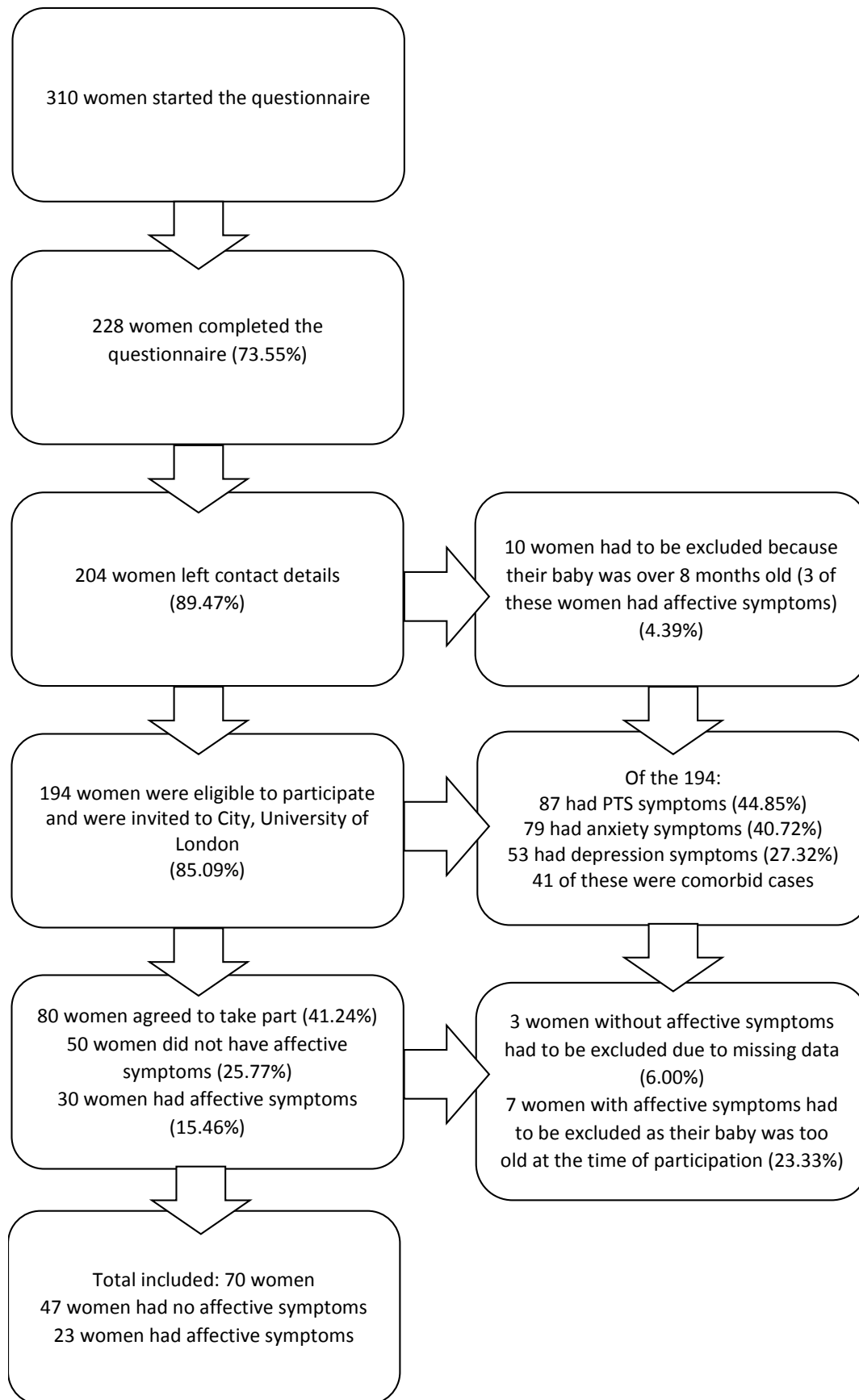


Figure 1-2. Flow diagram of participant recruitment and selection

2 Processing of infant emotions by women with symptoms of anxiety, depression or PTSD in pregnancy or after birth: a systematic review (Article 1)

Webb, R., & Ayers, S. (2015). Processing of infant emotions by women with symptoms of anxiety, depression or PTSD in pregnancy or after birth: a systematic review. *Cognition and Emotion*, 29(7), 1278-1294, doi: 10.1080/02699931.2014.977849

2.1 Abstract

Perinatal psychological problems such as postnatal depression are associated with poor mother–baby interaction, but the reason for this is not clear. One explanation is that mothers with negative mood have biased processing of infant emotion. This review aimed to synthesise research on processing of infant emotion by pregnant or post-natal women with anxiety, depression or post-traumatic stress disorder (PTSD). Systematic searches were carried out on 11 electronic databases using terms related to negative affect, childbirth and perception of emotion. Fourteen studies were identified which looked at the effect of depression, anxiety and PTSD on interpretation of infant emotional expressions ($k = 10$), or reaction times when asked to ignore emotional expressions ($k = 4$). Results suggest mothers with depression and anxiety are more likely to identify negative emotions (i.e., sadness) and less accurate at identifying positive emotions (i.e., happiness) in infant faces. Additionally, women with depression may disengage faster from positive and negative infant emotional expressions. Very few studies examined PTSD ($k = 2$), but results suggest biases towards specific infant emotions may be influenced by characteristics of the traumatic event. The implications of this research for mother– infant interaction are explored.

Keywords: Anxiety; Major depression; Perinatal period; Cognitive bias; Face perception.

2.2 Introduction

Pregnancy and birth are significant life events that are predominantly positive experiences for the majority of women. However, a proportion of women suffer from psychological problems during this time. Reviews and meta-analyses suggest 10–15% of women report depression (Gavin et al., 2005) and 3% develop post-traumatic stress disorder (PTSD) afterbirth (Grekin & O'Hara, 2014). Population studies of anxiety in pregnancy and afterbirth suggest up to 16% of women report severe anxiety in the postnatal period (Woolhouse et al., 2009).

These psychological problems can have negative consequences for women and their infants. For example, Murray et al. (1996) investigated mother–infant interactions in women with and without depression, and found that mothers with depression were more likely to respond in a rejecting or an emotionally discordant way to their infant. Mothers with co-morbid anxiety and depression are more likely to have an infant with an insecure attachment (Carter et al., 2001). Furthermore, women with PTSD afterbirth are more likely to report their infant as being less warm, more invasive and more difficult in temperament (Davies et al., 2008).

The evidence demonstrates that maternal mental illness can have a negative impact on the mother–baby relationship. Research on post-natal depression suggests that this may be due to women with depression being less able to perceive and respond appropriately to their infant's emotional state (Field, 2010). This ability is key to maternal sensitivity (Eisenberg et al., 1998; van Doesum et al., 2007); however, it is unclear why women with perinatal psychological problems are less able to achieve this. One reason may be due to information processing biases in mothers with mental illness. There is evidence to support this from research in non-pregnant or post-natal samples. For example, a recent meta-analysis concluded that people with mental illness display biased attention towards material that matches the concerns of the individual, such as threat-related stimuli for people with anxiety (Yiend, 2010). Research on perception of emotions also supports this idea, showing that people with depression are more likely to have their attention captured by negative faces (Gotlib et al., 2004; Joormann & Gotlib, 2007) and are less likely to recognise happiness in ambiguous faces (Bourke et al., 2010; Joormann & Gotlib, 2006). People with anxiety have been found to display attentional biases towards threatening or fearful faces (Fox, 2002; Gilboa-Schechtman et al., 1999; Pishyar et al., 2004); are better at recognising fear (Surcinelli et al., 2006) and have difficulty recognising positive emotions such as happiness

(Silvia et al., 2006). Furthermore, people with PTSD have been found to be worse at recognising fear and sadness compared to controls (Poljac et al., 2011).

Biases when processing emotions in others are likely to impact on relationships. Correlational research has found that the ability to accurately identify a facial emotion is associated with being more likely to see oneself as having warm and satisfying relationships with others (Carton, Kessler, & Pape, 1999). Therefore, it could be speculated that women with antenatal and postnatal psychological problems may have difficulty interpreting their infant's emotion because of mood-related cognitive biases, leading them to be less sensitive to their infant's needs. If a mother does experience difficulty in interpreting her infant's emotions, a secure attachment may be threatened (Cassidy, 1994) and could lead to negative consequences, such as poor developmental outcomes (Carter et al., 2001; Glasheen et al., 2010; Murray et al., 1996; Parfitt, Pike, & Ayers, 2014).

A number of research paradigms can be used to investigate cognitive biases when interpreting infant emotions for women in the perinatal period. These include biases interpreting infant emotion and reaction time (RT) paradigms. Paradigms which investigate interpretation of emotion require participants to label the emotion of a given face, and RT paradigms require participants to ignore a distracting image. By understanding whether women have any unconscious biases when processing infant emotion, and seeing whether these differences still occur when processing adult emotion, we can begin to understand the relationship between women's interpretation of their infant's emotional expressions, and its impact on their relationship with their infant. It is also important that cognitive biases in both pregnancy and the post-natal period are investigated. A woman's relationship with her baby is already forming in pregnancy and research has found that women who show greater attentional bias towards infant distress during late pregnancy report more successful mother–infant relationships afterbirth (Pearson, Lightman, & Evans, 2011).

However, research using the above paradigms with perinatal women, to understand cognitive biases is disparate and there are no reviews summarising available evidence. The aim of this paper is therefore to synthesise the evidence on the cognitive biases that pregnant and post-natal women with mental health difficulties exhibit when processing emotion in infant and/or adult faces.

2.3 Method

2.3.1 Eligibility criteria

Inclusion criteria were that: (1) The sample was a group of either (or both) pregnant or post-natal (up to one year, to ensure inclusion of as many studies as possible) women with

naturally occurring (i.e., not induced) depression, anxiety or PTSD symptoms or diagnosis; (2) used a procedure in which the interpretation or processing of emotion in human adult or infant faces was measured behaviourally and (3) the main language of the article was English. Exclusion criteria were: (1) animal studies.

2.3.2 Identification of relevant papers

Studies were identified by searching electronic databases, forward and backward searching, and searching through the grey literature. Limits of language (English only) and human research only were applied when databases allowed for this. The search was applied to the following databases: Academic Search Complete (1887–present), CINAHL Plus (1937– present); E-Journals (1885–present), EMBASE (1974–present), Gender Studies Database (1972– present);Health and Psychosocial Instruments Database (1985–present), MEDLINE (1946–present); PubMed (1996–present), PsychARTICLES (1894– present), PsycINFO (1597–present), SCOPUS (1823–present) and Web of Science (1900–present). Boolean search terms included but were not limited to: *bias or emotion* orexpress* anddepress* ordysphor* and “generalised anxiety disorder” or GAD and post traumatic stress disorder or PTSD*. Please see supplementary materials for full list of search terms (Appendix 3). Searches were carried out in July 2014. **Study selection and data extraction**

Duplicates were removed and studies were screened by abstract and title by one researcher for eligibility. Studies that were not eligible were excluded (see Figure 2-1). Full text of studies that appeared to meet criteria or where it was not clear was then examined by two researchers to determine whether they should be included in the review. Data extraction sheets were designed and piloted for the purposes of this systematic review. One review author extracted the following data from the full text of the 14 studies: (1) participant demographics; (2) the country in which the research took place; (3) recruitment procedure; (4) sample characteristics; (5) inclusion/exclusion criteria of the study; (6) measure used for diagnosis; (7) whether a diagnosis was made; (8) experimental methods used; (9) results; (10) study limitations; and (11) any funding relevant to the aims of the study. This was then checked by a second author and any disagreements resolved through discussion.

2.4 Results

2.4.1 Study selection and characteristics

The literature search provided a total of 152,581 citations. After screening through the abstracts, titles and full text 14 studies remained for inclusion. Literature identified and reasons for exclusions are shown in Figure 2-1. Papers included in the review examined anxiety symptoms ($k = 1$), depression ($k = 5$), PTSD ($k = 2$), anxiety and depression ($k = 3$)

or general distress symptoms ($k = 3$). Sample sizes ranged from 45 to 195 with a total sample size of $N = 1255$. Studies were conducted in the UK ($k = 6$), the USA ($k = 4$), Croatia ($k = 1$), France ($k = 1$), the Netherlands ($k = 1$) and South Africa ($k = 1$). A broad range of methodologies were used that could be categorised into two groups: (1) studies that looked at women's interpretation of facial emotion and (2) studies that looked at women's RTs when asked to ignore emotional faces (Table 2-1).

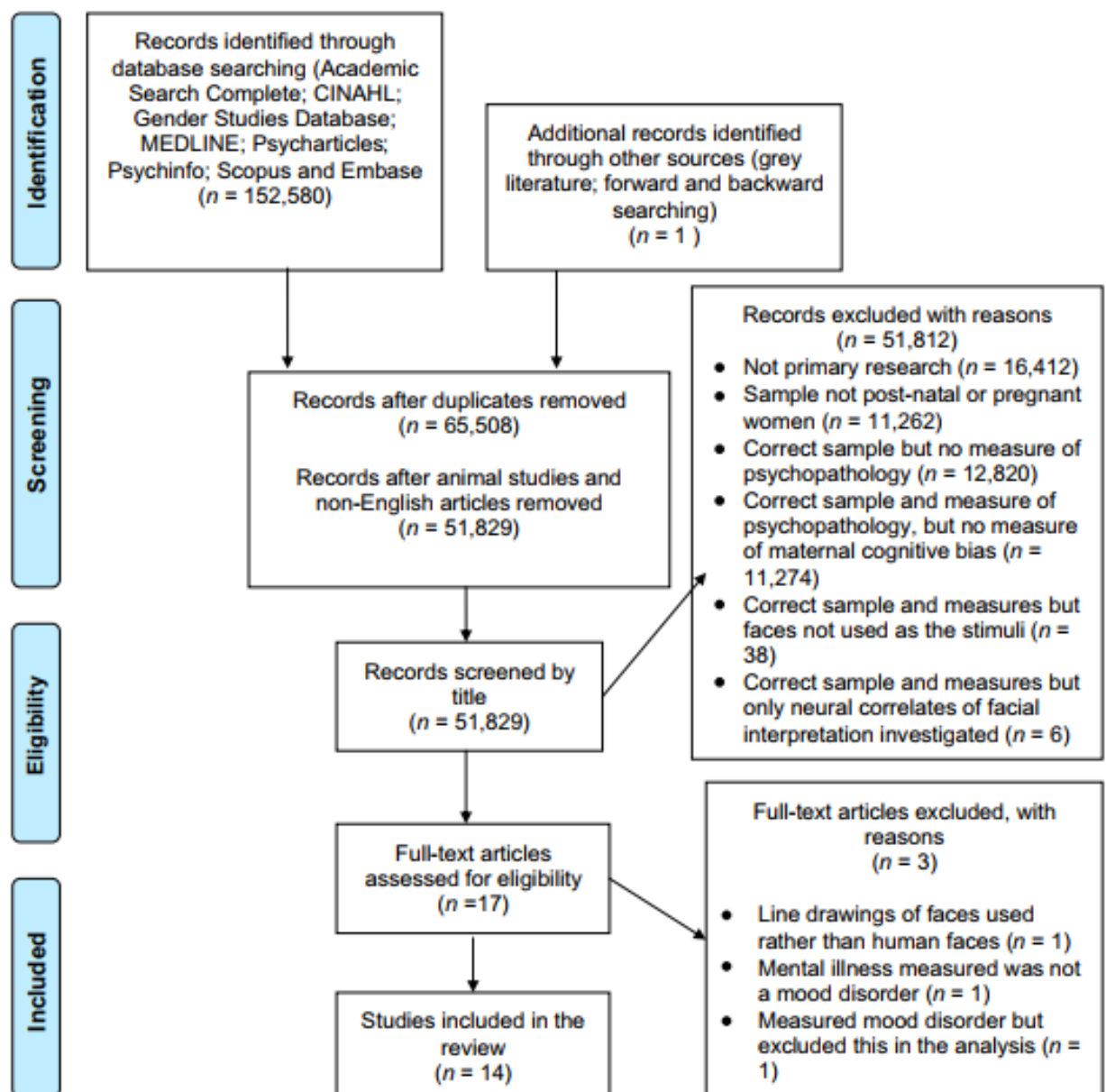


Figure 2-1. Diagrammatical representation of study search and selection

2.4.2 Interpretation of emotion

Ten studies included a task designed to measure women's interpretation of facial emotion. These studies suggest women with depressive or anxious symptoms show

differential accuracy in identifying emotions compared to controls. In both cases, women with anxiety or depressive symptoms appear to be biased towards identifying negative emotional expressions in infant faces and may possibly be quicker at identifying negative emotions. For example, Stein et al. (2010) found that women with diagnosed depression rated negative and muted negative faces as more negative than controls. Additionally, Gil et al. (2011) found that mothers with high state anxiety were more likely to rate sad infant faces as being sadder, and mothers high in trait anxiety were more likely to rate neutral infant faces as being sad. There was also a trend for those with both anxiety and depression to be able to identify sadness in infant faces, when it was morphed with a happy face, before controls (Arteche et al., 2011). These biases appear to be specific to infant faces and are not observed when studies use stimuli with adult faces with depressed women (Flanagan et al., 2011) or anxious women (Pearson et al., 2009).

Three studies used the Infant Facial Expressions of Emotion from Looking at Pictures (IFEEL Pictures; Butterfield, Emde, & Osofsky, 1987) to look at perceptual biases when interpreting infant emotions in mothers with depression or a high level of negative affect. The IFEEL Pictures is made up of 30 pictures of infants taken in a naturalistic setting. Participants are asked to label the emotions displayed using free response format. These responses are then encoded using a lexicon of emotion-related words (Butterfield & Ridgeway, 1993). Each word is placed into 1 of the 12 categories: surprise-interest-joy-content-passive-sad-cautious/shy-disgust-dislike/ anger-distress-fear-other. These results are then either compared to a reference sample (Applebaum, Butterfield, & Culp, 1993) or control groups. The results of these studies are consistent with the previous studies in that women with depression were more likely to label faces as negative compared to controls and reference samples (Broth, Goodman, Hall, & Raynor, 2004; Zahn-Waxler & Wagner, 1993). Higher levels of negative affect were also associated with mothers labelling more infant faces as negative (van Bakel et al., 2013).

With regards to identifying positive emotions the results are inconsistent. For example, Stein et al. (2010) and Gil et al. (2011) found no effect of depressive symptoms on identifying positive emotions. However, Arteche et al. (2011) found that women with depression were less accurate at identifying happiness in infant faces. Similar results are found for anxiety with Arteche et al. (2011) and Stein et al. (2010) finding a trend for mothers with diagnosed anxiety to be less accurate at identifying happy infant faces than controls. However, Gil et al. (2011) and Pearson et al. (2009) found that anxiety symptoms had no influence on the identification of happiness in either adult or infant faces.

Two studies looked at the effect of PTSD when interpreting infant emotions. Both studies used the IFEEL Pictures and results suggest characteristics of the trauma may affect women's processing of emotion. Bernstein, Tenedios, Laurent, Measelle, and Ablow (2014) found women who experienced traumatic events involving betrayal in adulthood and had PTSD symptoms rated less infant faces as being sad when using the IFEEL Pictures. On the other hand, Knežević and Jovančević (2004) found that women who had experienced interrogations or had witnessed violence were less likely to perceive infant faces as being passive. Conversely women who had been wounded or who had a war-related illness were more likely to perceive fear in infant faces. These results suggest the type of trauma exposure influences emotional perception.

2.4.3 Reaction time paradigms

Four studies investigated women's RT when asked to ignore emotional faces (Pearson et al., 2010; Pearson et al., 2013; Roos et al., 2012; Thompson-Booth et al., 2014b). Two studies (Pearson et al., 2010, 2013) used a go/no-go paradigm, which required participants to look at a distracting image on the centre of the screen and disengage from this to identify a vertical line elsewhere on the screen. The remaining two studies used a measure to assess how distracted participants were by the emotional stimuli. For example, Roos et al. (2012) used a Stroop paradigm, where adult faces were displayed using different colours, and participants were required to ignore the face and label the colour it was presented in. Thompson-Booth et al. (2014b) used a visual search task, in which participants were required to identify the target blue-eyed face, out of an array of three faces, and state which way round the face was rotated.

Both disengagement paradigms recruited pregnant women with depressive symptoms and found that these women were faster at identifying the vertical line when the distracting image was a distressed (i.e., actively crying) infant face (Pearson et al., 2010, 2013). This was interpreted as reflecting the fact that women with depressive symptoms during pregnancy have a diminished attentional bias towards distressed infant faces.

The remaining studies recruited women with symptoms of distress in pregnancy or in the postnatal period. Roos et al. (2012) found that distressed pregnant women reacted faster to fearful adult faces than controls. On the other hand, Thompson-Booth et al. (2014b) found no differences in terms of parenting distress when suppressing attention from adult faces compared to controls. However, they did find women with high levels of parenting distress were faster to label the rotation of an emotional infant face.

2.4.4 Antenatal and post-natal differences in cognitive biases

Identifying patterns across the antenatal and postnatal period is difficult due to the small number of studies available. However, when comparing across emotions some interesting patterns emerge. For example, pregnant anxious women are more accurate at labelling anger in adult faces (Pearson et al., 2009) and react faster to angry adult faces (Pearson et al., 2009) than post-natal women (Gil et al., 2011). Additionally, a pattern was found for women with negative affect to be less easily distracted by infant emotion in both the antenatal and post-natal period, with three studies finding that pregnant and post-natal women with symptoms of distress were faster to disengage attention from infant emotional expressions than controls (Pearson et al., 2010; Pearson et al., 2013; Thompson-Booth et al., 2014b). This suggests that women with depression and negative affect in both pregnancy and the post-natal period are less distracted by infant emotion.

Table 2-1. *Overview of studies*

Article citation	Country	<i>n</i>	Sample	Measure of psycho-pathology	Diagnosis	Bias measured	Stimuli used	Emotion used	Experimental Methods	Attentional biases reported	P-value
Arteche et al. (2011)	United Kingdom	89	Postnatal	EPDS	34 GAD	Interpretation of Emotion	Infant ^a	Happy	Five sad and five happy faces, morphed together from neutral to 100% at increments of 2%.	Women with post-natal MDD were significantly less accurate at identifying happy faces, than controls.	0.005
				GAD-Q SCID CSR	21 MDD 34 Control			Sad			
Bernstein et al. (2014)	USA	105	Pregnant	CESD	Elevated	Interpretation of Emotion	Infant ^b	Range of emotional expressions ^c	Participants were presented with the IFEEL picture system ^b digitally.	High adulthood betrayal trauma (i.e. rape from a known person), labeling infant faces as negative, and labeling more faces as sad or angry predicted subsequent infant attachment.	<.05
				BBTS TSC	levels of depression Trauma symptoms						
									Participants were instructed to indicate when they could identify the emotion, and what the emotion was.	Women with postnatal GAD identified happy faces at a lower intensity than controls.	0.005
									Participants were required to state which emotion they felt each face portrayed, and record their responses in	Trauma symptoms, and adulthood betrayal	<0.05

[illegible]

35	Controls	Disgust	Anger	Emotion Hexagon task ^g : morphed facial expressions depicting happiness-surprise-fear-sadness-disgust-anger.	happiness in both paradigms. Those with postnatal MDD were worse than controls at recognizing fear, happiness, and disgust in the both tasks.	≤0.05
				Participants were instructed to indicate which emotion the face represented.	Those with postnatal MDD were worse than those with MDD at labeling anger and disgust in both tasks.	≤0.05

Gil et al. (2011)	France	79	Postnatal	EPDS	Depression	Interpretation	Adult and	Happy	Participants were	Those high in state	
				GAD-Q	and	of Emotion	infant ^h	Sad	instructed to judge infant	anxiety were more likely	
				STAI	anxiety			Neutral	and adult emotions on a	to:	
				TAS-20	symptoms.			Angry	7-point scale.	Evaluate neutral infant	<0.01
					30.38% met EPDS cut off for MDD.				.	Evaluate neutral adult	<0.05
										Evaluate angry infant	<0.05
										Evaluate angry adult	<0.01
										faces as disgust	

Those high in trait
anxiety were more likely

to:

Evaluate sad infant faces <0.05
as being more sad than
all other groups

Those scoring high on
the EPDS were more
likely to:

Evaluate neutral infant <0.05
faces as being sad

[illegible]

					104 preterm mothers				and state which emotion they felt each face was portraying. This was analysed using the extensive lexicon ^d , and through counting how many times participants endorsed a negative emotion.	more likely to interpret infant facial expressions as being negative This effect was particularly pronounced in mothers of term infants	<0.05
Zahn-Waxler and Wagner (1993)	USA	98	Postnatal	SADS POMS	42 well mothers 61 depressed mothers: 36 mothers had unipolar depression 25 had bipolar depression	Interpretation of Emotion	Infant ^b	Range of facial expressions ^c	Participants were asked to look through the IFEEL picture booklet ^b and state which emotion they felt each face was portraying. This was analysed using the extensive lexicon ^d	Depressed mothers saw fewer joy expressions than well mothers Depressed mothers were more likely to see fear, anxiety and sorrow, than well mothers	<0.05 <0.05
Pearson et al. (2010)	United Kingdom	101	Pregnant	CIS-R	31 participant s with depressive symptoms	Reaction Time	Adult ⁱ and infant ^k	Infant: Happy Distress Neutral Adult:	Go/ no-go paradigm ^l with an emotional infant or adult face in the center as a distracter.	Non depressed women were slower to disengage from distressed than non-distressed infant faces.	<0.001

		25 never pregnant women.		significant levels of distress. Anxiety symptoms.				Participants were instructed to name the colour of the face.	fearful faces than controls. There were no significant differences in selective attention in pregnant women with anxiety.	>0.05
Thompson -Booth et al. (2014b))	United Kingdom	69	BDI PSI	31 Mothers 38 non mothers	Reaction Time	Adult ^o and Infant ^p	Neutral Distressed/sad Happy/content	Participants viewed an array of either adult or infant faces. One of these faces had blue eyes and was the target image. The target image was titled either left or right and participants had to identify which way it was tilted by pressing a labeled keyboard button ^q	Reaction times to infant faces were slower than RT's to adult faces. This effect was more pronounced in mothers. All participants were significantly slower to respond when the target face was an emotional one. Scores on the BDI did not significantly correlate with RT. Mothers who reported high levels of distress had faster RTs when an emotional infant face was the target	<.001 <.001 <.001 >.05 <0.05

Note. For postnatal outcome measure: BBTS = The Brief Betrayal Trauma Survey (Goldberg & Freyd, 2006); BDI = Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961); CESD = Centre for Epidemiological Studies Depression Scale (Radloff, 1977); CIS- R= Clinical Interview Schedule Revised (Lewis, Pelosi, Araya, & Dunn, 1992); CSR = Clinician Severity Rating (Di Nardo, O'Brien, Barlow, Waddell, & Blanchard, 1983); DSM = Diagnostic and Statistical Manual of Mental Disorders; Edinburgh Postnatal Depression Scale (Cox, Holden, & Sagovsky, 1987); GAD-Q = Generalized Anxiety Disorder Questionnaire (Newman et al., 2002); K-10 = Screening Tool to Assess Distress (Kessler et al., 2003); POMS = Profile of Mood States (McNair, Lorr, & Droppleman, 1981); PSI –SF = Parenting Stress Index – Short Form (Abidin, 1995); SADS = Schedule for Affective Disorders and Schizophrenia (Endicott & Spitzer, 1978); SCID = Structured Clinical Interview for DSM (First, Spitzer, Gibbon, & William, 2002); STAI = State Trait Anxiety Inventory (Spielberger, 1983); TAS-20 = The Toronto Alexithymia Scale (Bagby, Parker, & Taylor, 1994); TSC = The Trauma Symptoms Checklist (Briere & Runtz, 1989); UMACL = UWIST Mood Adjective Checklist (Matthews, Jones, & Chamberlain, 1990); Whooley Questions (see Whooley, Avins, Miranda, & Browner, 1997).

For diagnosis: MDD = major depressive disorder; GAD = generalized anxiety disorder; Control = participants who do not meet criteria for mental illness.

For experimental method: ^a see Kringelbach et al. (2008); ^b Butterfield et al. (1987) ^c An emotional lexicon was developed (see d) which groups the infant faces into 12 emotional categories: Surprise, Interest, Joy, Content, Passive, Sad, Shy, Shame, Disgust, Anger, Distress and Fear; ^dButterfield and Ridgeway (1993); ^e Applebaum et al. (1993); ⁱsee Ekman and Friesen (1976); ^g see Sprengelmeyer et al. (1997); ^hAuthors developed their own measure by having adults act out emotions, and spontaneously capturing infant emotion. This was then pre-tested on 25 undergraduates (see Gil et al., 2011 for more detail); ⁱHiltunen, Moilanen, Szanjberg, and Gardner (1999); ^j Szajnberg, Skrinjaric, Vidovic, and DeZan (1994); ^kAuthors created their own by taking a total of 60 infant faces from the internet and shown to a convenience samples of 22 students and staff at Bristol University, the faces most consistently rated as happy, distressed, and neutral were used in the study (see Pearson et al., 2010 for more detail); ^lsee (Bindemann, Burton, Hooge, Jenkins, & de Haan, 2005); ^mCBT (cognitive behavioural therapy) involved

between 9-12 weekly one on one sessions, usual care involved routine midwife appointments (for more information see Pearson et al., 2013);
"see van Honk, Schutter, d'Alfonso, Kessels, and de Haan (2002) and van Honk, Peper, and Schutter (2005); ° Tottenham et al. (2009);
Strathearn, Fonagy, Amico, and Montague (2009); ° task adapted from Hodsoll, Viding, and Lavie (2011).

2.5 Discussion

The results from this review suggest perinatal symptoms of anxiety, depression and PTSD are associated with cognitive biases in recognising emotional expressions. Post-natal women with depressive and anxiety symptoms appear to be more sensitive towards sad infant faces (Arteche et al., 2011; Gil et al., 2011; Stein et al., 2010) compared to happy infant faces (Arteche et al., 2011; Stein et al., 2010). This sensitivity is less apparent when adult faces are used as stimuli (Flanagan et al., 2011; Gil et al., 2011; Pearson et al., 2009; Stein et al., 2010). In terms of perceptual biases, mothers with symptoms of depression or negative affect are more likely to interpret infant faces as being negative compared to controls (Broth et al., 2004; van Bakel et al., 2013; Zahn-Waxler & Wagner, 1993). Additionally, both pregnant and post-natal women seem to be less easily distracted by infant emotional expressions (Pearson et al., 2010; Pearson et al., 2013; Thompson-Booth et al., 2014b) and differential patterns emerge when processing angry adult faces across the antenatal (Pearson et al., 2009; Roos et al., 2012) and post-natal period (Gil et al., 2011).

The results can inform our understanding of the poor sensitivity displayed by mothers with post-natal mental health difficulties (Carter et al., 2001; Davies et al., 2008; Murray et al., 1996). For example, maternal sensitivity is dependent on a mother's ability to perceive and respond appropriately to her infant's emotional displays (Eisenberg et al., 1998; Shin et al., 2008; van Doesum et al., 2007). This review suggests that mothers with depression are more likely to perceive negativity in infant faces, and those with depression and anxiety symptoms have a heightened sensitivity towards negative emotions, as well as have difficulty identifying positive emotions. Women may be more likely to recognise and respond to their baby's negative emotions leading them to act in an emotionally concordant way. Therefore, it could be speculated that the infant is more likely to display sadness, as their mother is more responsive to this, reinforcing expression of sadness by the infant. Therefore, these cognitive biases may be influential in problems in the mother–infant interaction.

Two findings from this review have important implications; however, with limited findings only tentative conclusions can be drawn. First, the results suggest that biases found in the perinatal period in women with psychological problems are specific to infant emotion (Arteche et al., 2011; Gil et al., 2011; Pearson et al., 2010, 2013; Stein et al., 2010). These findings imply that biases when interpreting infant emotion could lead to difficulty in forming or maintaining relationships with infants but not adults. However, very few studies examined biases on adult faces in the perinatal period (Flanagan et al., 2011; Gil et al., 2011; Pearson et al., 2009, 2010; Thompson-Booth et al., 2014b), therefore more research is needed

before conclusions can be drawn. The findings with regard to the impact of PTSD in interpreting infant emotion also have important implications. These results suggest that biases for women with PTSD are different to those observed not only in anxiety and depression but also may be dependent on the trauma type or characteristics (Bernstein et al., 2014; Knežević & Jovančević, 2004). The results suggest that mothers may be more biased towards perceiving certain emotional expressions which may then play out when a mother is interacting with her infant, again leading to less sensitivity towards her infant's needs. However, more research is needed to confirm any patterns.

Before drawing conclusions some general limitations need to be considered. First, only 14 relevant studies were identified and included in this review, and they differ widely in the methodology and sampling. For example, some studies used structured clinical interviews to diagnose psychological problems, whereas others used questionnaire designs to assess symptoms. Additionally, only two studies controlled for differences between anxiety and depression (Arteche et al., 2011; Stein et al., 2010) and only one drew a distinction between major depressive disorder with and without a post-natal onset (Flanagan et al., 2011). Furthermore, the stimuli used in each study differed in terms of both the photos and the emotion displayed. For example, all but one study used happy faces, whereas only two studies used surprise. Finally, even though the studies could be categorised into accuracy and disengagement tasks, different cognitive tasks were used within these categories. For example, two accuracy tasks used morphing paradigms, whereas the others did not. These differences in methodology are likely to have influenced the findings in some way.

These limitations show the need for future research to address a number of issues. First, research should focus on standardising the diagnostic tool used, such as whether a clinical interview or diagnostic questionnaire is implemented. Second, more research should examine cognitive biases during pregnancy and afterbirth, including controlling for the onset of mental illness. Third, stimuli and methodology should be standardised so studies are comparable and conclusions can be drawn. Finally, research on women with PTSD needs to consider the role of trauma characteristics in biases in the perception of infant emotions so this can be clarified. Addressing these limitations could provide key insights into the attentional biases displayed by mothers allowing firmer conclusions to be drawn.

In conclusion, this review provides preliminary evidence that pregnant or post-natal women with anxiety or depression have difficulty identifying positive infant emotions, yet are more accurate at recognising negative infant emotion. Additionally, mothers with depression display a perceptual bias in interpreting infant emotion, in that they perceive more

negative emotions than controls. Furthermore, the results provide some evidence that pregnant women with depressive symptoms are faster to disengage from infant emotional expressions. These biases may partially explain the reduced sensitivity displayed by mothers with depression, anxiety or PTSD when interacting with their infant. The bias towards recognition of negative emotions may mean mothers reinforce these emotions in their infants. This interaction may then become circular leading to difficulties in the mother–infant interaction. Although there are many methodological issues to consider when drawing conclusions, the results suggest the need for further research in this area in order to inform treatment of perinatal depression, anxiety and PTSD and poor mother–infant interactions.

3 The City Infant Faces Database: A validated set of infant facial expressions (Article 2)

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3.1 Abstract

Adults need to be able to process infants' emotional expressions accurately to respond appropriately and care for infants. However, research on processing of the emotional expressions of infant faces is hampered by the lack of validated stimuli. Although many sets of photographs of adult faces are available to researchers, there are no corresponding sets of photographs of infant faces. We therefore developed and validated a database of infant faces, which is available via e-mail request. Parents were recruited via social media and asked to send photographs of their infant (0–12 months of age) showing positive, negative, and neutral facial expressions. A total of 195 infant faces were obtained and validated. To validate the images, student midwives and nurses ($n = 53$) and members of the general public ($n = 18$) rated each image with respect to its facial expression, intensity of expression, clarity of expression, genuineness of expression, and valence. On the basis of these ratings, a total of 154 images with rating agreements of at least 75% were included in the final database. These comprise 60 photographs of positive infant faces, 54 photographs of negative infant faces, and 40 photographs of neutral infant faces. The images have high criterion validity and good test–retest reliability. This database is therefore a useful and valid tool for researchers.

Keywords: Infant faces, Emotional expression, Face database, Stimuli

3.2 Introduction

The survival of human infants depends on appropriate care by adults (Bjorklund, 1997). Therefore, successful early relationships between infants and their primary caregivers are critical to ensuring the appropriate development, and even the survival, of an infant (Lorenz, 1943). Lorenz argued that the stereotypical features of an infant (large foreheads, large eyes, close-set features positioned low on the face) trigger an innate response in human adults, which encourages care-taking behavior, affective orientation toward the infant, and decreased aggression (Lorenz, 1943), a proposal that has received considerable empirical support. For example, Alley (1981) manipulated the head shapes of infants and asked participants to rate the images on perceived cuteness. The results showed that as the head shape changed as it would with aging, perceived cuteness decreased. In a functional magnetic resonance imaging study, participants were asked to view images of infant faces in which the faces had been manipulated to have either low or high baby schema. These results showed that baby schema activated the nucleus accumbens, a brain structure that has been found to mediate reward processing and appetitive motivation (Glocker, et al., 2009). Additionally, undergraduate students who were asked to rate the cuteness of infants and their desire to look after the infant were more likely to want to look after an infant they had rated as being cute (Glocker, et al., 2009). Furthermore, it has been found that, when adults perform tasks that require focused attention, they do such tasks more carefully after looking at images of babies, suggesting that viewing images of infants can increase careful behavior (Nittono, Fukushima, Yano, & Moriya, 2012). This research has shown the importance of adult processing of infant faces to enabling the survival of the species.

The perception of cuteness orients adults' attention toward infants, but it does not inform them about an infant's current needs. As a result, parents must also be able perceive their infant's emotional cues successfully to ensure their infants psychological needs are met. Indeed, parents who are attuned to their infant's behavioral and emotional cues are more likely to have securely attached infants than parents who are less sensitive (Ainsworth, 1973). Furthermore, females (who are usually the primary caregiver of an infant across primates and in humans; Marlowe, 2000) are more accurate at identifying infant emotional states (Proverbio, Matarazzo, Brignone, Zotto, & Zani, 2007) and mothers are more distracted by infant faces than nonmothers (Thompson-Booth et al., 2014a). Further, evolutionary theories posit that the development of infant facial expressions has been designed by natural selection to communicate important information to the caretaker about the emotional state of the infant, arguably increasing the infant's chance of survival (Babchuk, Hames, & Thompson, 1985).

This shows the importance of being able to accurately identify facial expressions to develop a strong parent–infant bond and secure attachment, and therein perhaps to increase the chances of infant survival.

The perception of infant emotional expressions is therefore an important research area that might provide important insights into infant facial communication and its influence on others. For example, biased or accurate perception of infant emotion might predict a number of outcomes, such as parent-infant interaction, parental mental health or infant perception of peer emotion. However, currently only one set of infant images is available to researchers (Pearson, Cooper, Penton-Voak, Lightman, & Evans, 2010; on request from the authors). This image set has been previously validated on 29 students with high agreement ratings for the images (between 95% and 100%). This image set is restricted to 30 images and does not include images of the same infant showing different emotions. Developing a database with more images to choose from can aid research into the relationship between perception of infant emotion and mother infant interaction, maternal mental health and infant perception of other-infant emotion. Additionally, the availability of different emotions from the same infant reduces other types of variability such as differences in infant attractiveness that would arise when emotions are shown on faces of different infants. Furthermore, having a normed set of infant faces provides researchers with a valuable tool that has the potential to improve aspects of research. For example, these images will facilitate replication across studies and reduce error variance. Therefore, the aim of this study was to develop and validate a standardized database of infant faces that is freely available to authors by e-mailing cityinfantfacedatabase@gmail.com.

3.3 Method

The baby faces database was developed and validated in three stages.

3.3.1 Stage 1: Development of the database

Collection of stimuli

Parents were approached via various social media sites such as Facebook and were asked whether they would be willing to help with research investigating the perception of infant emotion. If parents showed interest and had an infant under the age of 12 months, they were sent an information sheet and consent form. Parents were asked to respond with a minimum of three photographs of their infant showing at least one positive, one negative, and a neutral emotion, as well as their completed consent form. Parents were asked to take the photographs all at the same time of the day and to try to have their baby’s head at the same

angle for each photograph. A total of 68 parents consented, and 195 photographs were received.

Image processing

All images were edited in Photoshop 2014. The original backgrounds were removed and replaced with a blank background (white for color images and black for black-and-white images). The images were resized to $800 \times 1,100$ pixels and were saved as color versions. Then the images were converted to black and white and saved again. The color versions are available; however, these have not been fully validated. Sample black-and-white images from the database can be seen in Figure 3-1.



Figure 3-1. Examples from the City Infant Faces Database. Examples show (from left to right) negative, neutral, and positive expressions.

3.3.2 Stage 2: Validation of the database

Participants

A total of 71 participants took part in the validation of the database. The participants consisted of 41 midwifery and 12 neonatal nursing students from City University London, as well as 18 members of the general public. These were six males, 63 females, and two of undisclosed gender, with a mean age of 28 years ($SD = 8.52$).

Measures

Ratings of images. The images were rated on six dimensions adapted from (Langner et al., 2010), as follows:

- *Expression*—that is, the expression the participants felt the face was portraying (negative, neutral, positive);
- *Clarity*—that is, how clear this expression was (1 unclear; 5 clear);
- *Genuineness*—that is, how genuine the participant felt the expression was (1 fake; 5 genuine);

- *Affective response*—that is, what emotion the participant felt while viewing the image (negative, neutral, positive);
- *Strength of affective response*—that is, how strongly the participant felt this emotion (1 weak; 5 strong).

Criterion validity. Validity was measured by asking participants to rate the faces from the Pearson image set. This set consists of ten positive facial expressions, ten negative facial expressions, and ten neutral facial expressions. In this dataset validation, the mean accuracies for the images were 99% for positive images, 95% for neutral images, and 100% for negative images (Pearson et al., 2010).

Agreement ratings. The images were categorized as either positive, negative, or neutral on the basis of their average rating. The numbers of images that were rated differently for each emotional category were summed, and percent changes between the groups were calculated.

Coding data

Since two of the rating scales produced categorical data (Expression and Affective Response), the researcher assigned a number to each emotional category for analysis in IBM SPSS (Version 22) and R (Version 3.3.1): negative expression/affective response was coded as 1, neutral expression/affective response was coded as 2, and positive expression/affective response was coded as 3.

Apparatus

For the students, the images were presented in the classroom using Microsoft Office PowerPoint 2007 and were projected onto an 80-in. projector screen using the projector available. For members of the general public, the study was Internet based, using the Qualtrics survey software (Qualtrics., 2015).

Procedures

A total of 255 images were tested: 195 black-and-white images from the database, as described above; 30 of the same images, selected at random, presented in color, to test for any differences between the black-and-white and color images in the perception of emotional expression; and the 30 images from the Pearson image set.

These images were rated by the midwifery and neonatal nursing students. To ensure that all the images were rated, and to minimize the burden on participants, different participants rated different images. This was done in a series of group sessions, and the images were randomly selected for each group. Each image was rated by at least 26

participants. Information on the average validation scores for each individual image is available in online supplemental materials (Appendix 4).

All images for the midwifery and neonatal nursing students were presented using Microsoft Office PowerPoint 2007 and projected onto an 80-in. projector screen in the classroom. Each image measured (height $\times$ width) 14 cm $\times$ 10.6 cm in Microsoft Office PowerPoint. Each image was shown for 20 s. In the top left-hand corner was the image number (i.e., Image 1), so participants could match the image up with the answer booklet he or she had been given.

The members of the general public were recruited through a psychology graduate mailing list, a university mailing list, social media sites such as Facebook, and snowball recruitment. All 255 images were randomized and uploaded to the Qualtrics online survey software (Qualtrics., 2015). As before, the images were presented for 20 s, and then participants rated them. Participants were given two practice trials at the beginning of the testing session; one of these was untimed, so that participants could ask for clarification on the rating scales, if needed, or review the instructions.

Criteria for inclusion in the database

The criteria for inclusion were based on the proportions of participants who classified each image as positive, negative, or neutral. Only images with interrater agreement of the emotion of at least 75% were retained in the database, even if this meant that only one or two images were left in the database per infant. (However, in our comparisons to Pearson's database, we also include images from the latter database that have agreement ratings of less than 75%.) This cut-off was based on the average percentage agreements found in other studies of images of adult emotional expressions (i.e., the percentage of people who correctly identified the emotion of the image), which range from 71.87% to 82% (Ebner, Riediger, & Lindenberger, 2010; Goeleven, De Raedt, Leyman, & Verschuere, 2008; Langner et al., 2010). This meant that 41 images were removed from the database, with rejected images having poorer agreement that ranged from 46.5% to 70%.

After we had removed the images with poor participant agreement, the percentages of participant agreement for each image were averaged across all images and across each emotional category.

3.3.3 Stage 3: Test-retest reliability

Test-retest reliability was measured four weeks later with the midwifery students. Participants were invited to take part in the retest study, in which they viewed a subset of 25

of the images they had originally viewed. A total of 41 midwifery students completed the ratings at Time 1, and 19 completed the ratings at Time 2.

3.3.4 Analysis

To analyze the database, we asked whether a number of factors affected the ratings of the images. These factors were Rater Gender, Infant Gender, Color of the Image (color vs. black/ white), and Age of the Infant (infants below 7 months old vs. infants of 7 months and above). We asked these questions for all rating scales—that is, expression, intensity, clarity, genuineness, internal emotion, and strength of internal emotion.

Our analysis strategy was as follows. For each factor and rating scale, we conducted a two-way analysis of variance (ANOVA) with the within-subjects factor Image Category (positive vs. negative vs. neutral) and the within- or between-subjects factor under investigation (e.g., Color).

In the analyses below, we do not apply any correction for repeated comparisons. This is because our goal was to flag factors that might potentially affect image quality, rather than to confirm hypotheses. The following variables were used in the ANOVAs, to investigate their impacts on the rating scales: color vs. black-and-white images, female vs. male infants, male vs. female raters, younger vs. older infants, and differences in the group ratings (midwives vs. neonatal nurses vs. general public). Criterion validity was also assessed by comparing the ratings on the City Database with those on the Pearson image set.

For the within-participant analysis, not all participants completed all the cells of the design; for example, in a two way ANOVA with the factors Image Category and Color, participants needed to complete $2 \times 3 = 6$ cells. In the analyses below, we exclude those participants who did not complete all cells and note how many participants have been excluded. It should be noted that for the Strength scale, a large proportion of the data were missing. This was due to many participants rating their internal emotion as being neutral. As a result, rating the strength of a neutral emotion was inappropriate, and this field was left blank by participants.

3.4 Results

Overall, the percentage of raters agreeing on the emotion displayed in the images was 91.76%, with negative images in the database having a 94.87% agreement rate, positive images having a 95.73% agreement rate, and neutral images having an 84.7% agreement rate. Descriptive statistics for the different groups can be found in the online supplementary materials (Appendix 4).

Table 3-1. *Descriptive statistics of each group of images by Expression*

Image Expression	No. Images in each group	Percentage Agreement
Positive	60	95.73
Neutral	40	84.7
Negative	54	94.87

3.4.1 Black-and-white and color images

When black-and-white versus color images were used as the independent variable (IV), we observed a significant interaction between color and expression category, $F(2, 114) = 4.55$, $p = .013$, $\eta^2 = .074$. Follow-up ANOVAS revealed that the effect of image category was stronger with black-and-white than with color pictures; $F(2,114) = 4109$, $p < .00001$, $\eta^2_p = 0.986$, than with color pictures, $F(2,114) = 1855$, $p < .00001$, $\eta^2_p = 0.97$, but in both cases the positive images were rated as being more positive than the neutral images, which were rated as more positive than the negative images. For more details, please see the supplementary results (Appendix 4). When clarity was the IV, we observed a main effect of color, $F(1, 57) = 8.26$, $p = .007$, $\eta^2 = .127$, suggesting that the clarity ratings were higher for the black-and-white images ($M = 3.47$, $SD = 0.69$) than for the color images ($M = 3.33$, $SD = 0.87$). We also observed a main effect of image category, reflecting that the negative and the positive images were rated as being clearer than the neutral images (see the supplementary materials, Appendix 4); similar (unsurprising) main effects were found in other analyses as well, and will be presented only in the supplementary materials (Appendix 4).

3.4.2 Difference between male and female raters

The analysis of the intensity rating revealed a significant interaction between the category of the image and the gender of the rater of the images, $F(2, 132) = 3.44$, $p = .04$, $\eta^2 = .025$. Follow-up analysis showed that females rated the negative and positive images as being more intense than the neutral ones, whereas the males did not vary in their mean intensity ratings across image categories (though their means showed numerically the same tendency as those of females). The same pattern was found with the analysis of clarity, with females rating positive and negative images as being clearer than neutral ones. (Numerically, male raters showed the same tendency, but it did not reach significance). No effects were found for expression, genuineness, affective response and strength of affective response.

3.4.3 Female and male infants

There was a significant effect of gender on the intensity ratings of the images, $F(1, 70) = 5.55$, $p = .02$, $\eta^2 = .0735$, showing that female infants received significantly more positive ratings ($M = 3.41$, $SD = 0.70$) than did male infants ($M = 3.33$, $SD = 0.69$). The gender of an infant also affected the strength of the affective response when looking at that infant, $F(1, 44) = 4.07$, $p = .05$, $\eta^2 = .085$, reflecting that female infants triggered stronger emotions ($M = 2.86$, $SD = 0.94$) than did male infants ($M = 2.73$, $SD = 0.89$).

3.4.4 Younger versus older infants

The analysis of the genuineness ratings yielded a significant main effect of infant age, $F(1, 70) = 9.87$, $p = .002$, $\eta^2 = .124$, suggesting that younger infants were rated as being more genuine ($M = 3.77$, $SD = 0.71$) than were older infants ($M = 3.67$, $SD = 0.72$). When affective response was used as the dependent variable, a significant interaction between the category of the image and the age of the infant was found, $F(2, 138) = 4.21$, $p = .017$, $\eta^2 = .057$. Follow-up analyses showed that younger infants elicited internal emotions closer to those intended (i.e., negative emotions for negative images) for all image categories, as compared to the older infants (see Table 3-2)

3.4.5 Criterion validity

In the analysis of the expression ratings, we observed a significant effect of source, $F(1, 58) = 13.33$, $p < .001$, $\eta^2 = .187$, suggesting that the ratings were somewhat higher (i.e., more positive) for the City database ($M = 1.97$, $SD = 0.77$) than for the Pearson image set ($M = 1.91$, $SD = 0.77$).

When intensity was used as the dependent variable, we again observed a significant effect of source, $F(1, 58) = 4.16$, $p = .046$, $\eta^2 = .0669$, showing that the Pearson images ($M = 3.47$, $SD = 0.83$) were rated as being more intense than the City images ($M = 3.40$, $SD = 0.62$). There was also a significant interaction between source and image category, $F(2, 116) = 18.94$, $p < .0001$, $\eta^2 = .246$. Follow-up analyses revealed that, for both databases, negative images were rated as being more intense than positive images, which in turn were rated as more intense than neutral images. However, this effect was somewhat more pronounced for the Pearson image set, especially for negative images. A similar pattern was found when clarity was used as the DV, where the negative images in the Pearson image set were rated as being the clearest among the three categories, whereas negative images did not differ in clarity from positive images in the City database.

For analysis of the genuineness rating, we found an interaction between image category and source, $F(2, 114) = 12.83$, $p < .00001$, $\eta^2 = .184$. Follow-up analyses revealed

that, for the City database, the positive images were rated as being the most genuine, whereas neutral and negative images did not differ in genuineness. In contrast, for the Pearson image set, the neutral images were rated as being the least genuine, with no difference between the positive and negative images. Our analysis of the ratings of affective response revealed a significant effect of source, $F(1, 57) = 17.19$, $p < .001$, $\eta^2 = .232$, suggesting that the ratings were more positive for the City database ($M = 2.06$, $SD = 0.58$) than for the Pearson database ($M = 1.98$, $SD = 0.61$). See Table 3-3.

Table 3-2. *Descriptive statistics of younger and older infants by expression*

Image category	Younger infants		Older infants	
	M	SD	M	SD
Negative	1.40	0.31	1.43	0.35
Neutral	2.04	0.29	2.06	0.23
Positive	2.78	0.22	2.72	0.25

Table 3-3. Comparison between City Baby Face Database and Pearson image set for positive, negative and neutral images by rating scale

	Negative images				Neutral images				Positive images			
	City Database		Pearson Image set		City Database		Pearson image set		City Database		Pearson image set	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Expression	1.06	0.09	1.05	0.10	1.90	0.15	1.82	0.32	2.94	0.07	2.85	0.24
Intensity	3.74	0.41	4.17	0.60	2.91	0.65	2.87	0.73	3.54	0.43	3.37	0.58
Clarity	3.74	0.48	4.15	0.72	2.92	0.72	2.77	0.81	3.76	0.42	3.48	0.59
Genuineness	3.66	0.64	3.92	0.90	3.73	0.55	3.58	0.69	4.11	0.47	4.02	0.58
Affective Response	1.45	0.31	1.38	0.34	2.03	0.23	1.93	0.30	2.72	0.22	2.64	0.33

Note. In terms of Expression and Internal Emotion 1= negative, 2 = neutral, 3 = positive

3.4.6 Reliability testing

To measure how much the perception of each picture changed over time, the midwifery students were asked to rate a subset of the pictures on two occasions. An average rating per image for Time 1 and Time 2 was then calculated. Spearman's correlation coefficient was calculated from these averages. Excellent test-retest reliability was found for the negative ($r = .954$) and neutral ($r = .965$) images, and good test-retest reliability was found for the positive images ($r = .655$).

Percent change analysis. To assess how likely participants were to change their minds about the images between Time 1 and Time 2, the number of occasions was counted on which a participant changed her or his mind for the images, and the percentage of changes was calculated relative to the total number of ratings (changed and unchanged). For negative images, participants changed their minds on 1.89% of the ratings; for neutral images, they changed on 18.75%; and for positive images, the ratings changed for 8.76%. The relationship between these variables was significant, $\chi^2(2) = 15.88, p < .01$.

3.4.7 Participant group ratings

We compared the ratings across the three groups (midwives, neonatal nurses, and general public) on all rating scales. A main effect of image category was found for all analyses, and will not be reported further. The analysis of the expression ratings yielded a main effect of group, $F(2, 68) = 3.59, p = .03, \eta^2 = .095$. A post-hoc test (Tukey's HSD) revealed that the neonatal nurses had higher ratings than either the midwives or the general public, whereas midwives and the general public did not differ significantly. The analyses of the intensity rating revealed a significant interaction between group and image category, $F(4, 136) = 4.72, p = .001, \eta^2 = .061$. Follow-up analyses revealed that, for the midwives and the general public, the negative images were rated as more intense than the positive images, which in turn were rated as more intense than the neutral images. For the neonatal nurses, in contrast, the positive images were rated as the most intense.

The analyses of the clarity rating revealed a significant interaction between group and image category, $F(2, 68) = 2.28, p = .11, \eta^2 = .063$. Follow-up analyses revealed that the midwives and the general public rated the positive and negative images as being clearer than the neutral images, with no difference between the positive and negative images. In contrast, the neonatal nurses rated the positive images as being clearer than the neutral images (see Table 3-4). When genuineness was used as the DV, a main effect of group, $F(2, 68) = 11.85, p < .001, \eta^2 = .258$, was found, showing that neonatal nurses rated all images as being less

genuine than did the other groups. An interaction of group and image category, $F(4, 136) = 4.13$, $p = .003$, $\eta^2 = .072$, was also found. Follow-up analyses showed that the positive images were rated as being more genuine than the neutral or negative images, with no difference between the latter two categories. This effect was most pronounced for midwives.

The analysis of the rating of affective response revealed an interaction between image category and group, $F(4, 136) = 3.69$, $p = .007$, $\eta^2 = .014$. Follow-up tests showed that, whereas the images generally elicited the internal emotions expected from the image category (i.e., negative emotions for negative images), this relationship was strongest for the neonatal nurses. The ratings of the strength of the affective response were marginally lower in the general public than in the other groups.

Table 3-4. *Comparison between Midwives, Neonatal Nurses and general public for positive, negative and neutral images by rating scale*

	Negative images						Neutral images						Positive images					
	Midwives		Neonatal nurses		General public		Midwives		Neonatal nurses		General public		Midwives		Neonatal nurses		General public	
Rating Scale	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Expression	1.08	0.96	1.08	0.09	1.04	0.05	1.89	0.17	2.00	0.18	1.93	0.09	2.94	0.07	2.99	0.18	2.93	0.08
Intensity	3.78	0.33	3.23	0.73	3.66	0.53	2.87	0.60	2.64	0.68	3.00	0.77	3.60	0.37	3.73	0.56	3.40	0.53
Clarity	3.75	0.42	3.16	0.73	3.63	0.54	2.77	0.73	2.65	0.79	3.25	0.64	3.81	0.36	3.74	0.61	3.63	0.54
Genuineness	3.55	0.60	2.82	0.57	3.90	0.67	3.64	0.53	2.85	0.87	3.93	0.55	4.11	0.43	3.79	0.60	4.13	0.56
Affective Response	1.46	0.29	1.29	0.31	1.46	0.37	2.04	0.25	2.18	0.19	2.01	0.17	2.74	0.19	2.96	0.04	2.63	0.32
Strength of affective response	2.92	0.73	2.97	0.61	2.73	0.89	2.40	0.90	2.91	0.89	2.15	0.97	3.32	0.66	3.53	0.48	2.78	0.70

3.4.8 Description of the validated database

The database and norming data can be accessed on request by e-mailing cityinfantfacedatabase@gmail.com. The database contains 154 portrait images, with both black-and-white and color versions available (though the color versions have not been fully validated; researchers should take this into account if considering using a mix of the black-and-white and color images). Black-and-white versions of the images are available in two sizes: 150×198 pixels or $800 \times 1,100$ pixels. Color images have not been resized or normalized in terms of their luminosity or hue. In all, 30 of the infants have photographs showing positive, negative, and neutral expressions. In the case of this database, the positive facial expressions are defined as smiling, laughing, or excited; the negative facial expressions are defined as sad, angry, worried, scared, or distressed. There are a total of 60 positive images, 54 negative images, and 40 neutral images to choose from. Images of 35 girls and 33 boys are included in this database, all from 0 to 12 months of age. Sixty-two of these babies are Caucasian, three are Asian, two Arab, and one Indian. Descriptive statistics, including percentages, can be found in Table 3-5. For more demographic information about the infants included in this database, please see the online supplemental materials (Appendix 4).

Table 3-5. *Description of the City database*

Variable	N	Range	Mean	SD
Age	69	0-12 months	6.57	2.72

Variable	N	Percentage
Gender		
Male	33	47.8%
Female	36	52.2%
Ethnicity		
Caucasian	63	91.3%
Asian	3	4.3%
Arab	2	2.9%
Indian	1	1.4%

3.5 Discussion

This article reports the development and validation of the City Infant Faces database. The results suggest that this database has excellent face validity, with an average agreement rate of 91.76%, which is higher than that reported in validation studies of adult faces (Ebner et al., 2010; Goeleven et al., 2008; Langner et al., 2010). The database is comparable to other image sets of infant faces (Pearson et al., 2010) in terms of agreement ratings, suggesting good criterion validity. Test–retest reliability was also good for all images, although neutral images showed a somewhat higher rate of changes in ratings across time. Additionally, the results showed that neonatal nurses rated the images as being the least genuine and the most positive and as eliciting the internal emotions they expected from the image category, as compared to midwives and the general public. This suggests that the images should be used with caution in groups of individuals exposed to high levels of extreme infant emotion. Furthermore, it is unclear whether there are consistent differences between the black-and-white and color images with regard to the rating scales. The majority of the color and black and white images had no significant differences between their ratings. This is in line with previous research that has found no benefit of color over black-and white images in terms of the recognition of stimuli (Marx, Hansen-Goos, Thrun, & Einhäuser, 2014). ANOVAs indicated that the black-and-white images were rated as clearer. However, this analysis was only carried out on a small number of color images ($n = 30$); therefore, the results may be different if all of the color images were analyzed. This should be taken into account if researchers are considering using a mixture of the color and black and white images in their research.

With regard to the effect of infant characteristics on ratings, female infants' emotions were rated as more intense and as eliciting a stronger affective response. Some research has found that female infants smile more than male infants (Cossette, Pomerleau, Malcuit, & Kaczorowski, 1996) and cry for longer than boys in response to hearing another infant cry (Sagi & Hoffman, 1976); therefore, when female infants display emotions, they arguably do so in a more intense way. However, there are many inconsistencies in this literature. For example, one study showed that male infants showed more joy and anger than female infants (Weinberg, Tronick, Cohn, & Olson, 1999). Additionally, Geangu, Benga, Stahl, and Striano (2010) found that male infants between 1 and 9 months of age cried for longer and more intensely than did female infants. Therefore, it is not clear why this result was found, and future research should look into this.

Another interesting finding is that younger infants' expressions were rated as being more genuine and as eliciting the internal emotions expected on the basis of the expression of the image. This is in line with previous research that has revealed that the younger an infant is, the more likely an adult is to rate the infant as cute and likeable, and the more likely the adult is to want to take care of the infant (Luo, Li, & Lee, 2011; Volk, Lukjanczuk, & Quinsey, 2007). Eliciting stronger internal emotions and adults seeing the emotion expressed by the infant as more genuine may help the infant to survive. This is because the only way that an infant can survive is through the care of adults, and evoking positive reactions from adults is likely to increase caregiving behavior by the adult (Lorenz, 1943; Luo et al., 2011).

A few limitations should be taken into account when using this database. One of the main limitations is that the images were not specifically validated on parents. Although some of the participants who took part may have been parents, this was not measured. Furthermore, because only six males contributed to the ratings for this image set, it is unclear whether this database is valid for use with males. This is because research has shown that women's attentional bias toward infants is stronger and more stable than men's (Cárdenas, Harris, & Becker, 2013). Furthermore, females are more consistent at choosing cuter infant faces than are males (Lobmaier, Sprengelmeyer, Wiffen, & Perrett, 2010). The results from this database support this showing that females rated the images as more intense and clearer. As a result, caution should be taken if researchers wish to use this database with males.

Another limitation of the database is that the majority of the infants are Caucasian. Although significant efforts were made to try and recruit babies of different ethnicities, this was unfortunately not successful. Furthermore, due to the naturalistic way these images were taken, not all images were taken at the same time. Therefore, although this could be a possible drawback to the database, it is something that could not be overcome when producing such naturalistic images.

The images in this database are arguably more naturalistic than the images from other databases. This is due to the production of the images, which were taken by parents of their infants' spontaneous facial expressions in naturalistic environments. On the other hand, most adult face databases are produced by recruiting professional models to act out certain emotional expressions that are in line with the Ekman and Friesen Facial Action Coding System (FACS; Ekman & Friesen, 1978). Furthermore, these images are often taken by a professional photographer under controlled conditions (e.g., the same lighting and the same background).

The differences in how the images in different databases were produced may explain the findings from this study in terms of the negative images. It could be suggested that all of the negative images in this set were rated as less intense and less clear because of the selection process and production of the images. For example, the negative images selected by Pearson et al. (2010) were defined as an infant actively crying (p. 625), whereas the definition of negative facial expressions in this database was broader. Crying provides a very powerful message to adults about the needs of an infant (Smith et al., 2003), and both photographs and tape recordings of infant crying has been found to alter physiological responses in adults (Boukydis & Burgess, 1982). This could, therefore, be the reason behind the lower ratings for the negative images in this database.

Despite this, the naturalistic nature of these images may be more reflective of infant emotion during parent-infant interaction. This is a clear advantage of the database, since before infants are able to communicate verbally, their facial expressions are one of their main methods of communication. For example, infants will smile in response to attention or to a familiar voice (Trevvarthen, 1979) and will show distress if their mother's face suddenly becomes unresponsive (Adamson & Frick, 2003). Having naturalistic facial expressions in the database may enable researchers to learn more about the processing of infant emotions that parents are likely to see on a day-to-day basis, rather than extreme emotions that may not be seen as often. These images may therefore provide researchers with a new way to investigate maternal sensitivity. Thus, despite the limitations of this database, it has many benefits, and therefore can provide a useful tool for researchers to use when researching infant emotion.

4 Attentional and perceptual biases to infant emotions in postnatal mental health difficulties (Article 3)

Webb, R., & Ayers, S. (submitted). Attentional and perceptual biases to infant emotions in postnatal mental health difficulties. *Journal of Reproductive and Infant Psychology*

4.1 Abstract

Introduction: To react appropriately to an infant's emotions, a mother must first attend to them, and then interpret them correctly. Diagnoses of antenatal and postnatal depression have been found to affect attentional allocation and interpretation of infant emotions. However, it is unknown whether symptoms of anxiety, depression and post-traumatic stress (affective symptoms), as well as co-morbidity have the same impact.

Aim: Therefore, the aim of this study was to examine the association between postnatal affective symptoms and attentional capture of infant emotional expressions, and accuracy of emotional categorisation.

Method: Mothers with (n=23) and without affective symptoms (n=47) were asked to take part in two computer-based tasks. One measured attentional capture towards infant emotion using a go/no-go paradigm, and the second measured the accuracy with which mothers' categorised emotional expressions.

Results: No differences were found between groups in attentional capture towards infant emotions or accuracy of interpretation of infant emotion. All participants were slower to disengage from infant faces with negative emotion. A non-significant relationship between anxiety scores and categorisation of emotion was found, in that as anxiety scores increased mother's sensitivity at categorising emotions decreased.

Discussion: These findings are inconsistent with previous research so possible reasons for this are discussed.

Keywords: Attentional bias; emotional processing; postnatal mental health, infant faces

4.2 Introduction

Before infants can speak, infants and mothers use a wealth of non-verbal cues for interaction, including non-verbal vocalizations (Hane, Fox, Henderson, & Marshall, 2008), eye gaze and joint attention (Senju & Csibra, 2008; Tomasello & Farrar, 1986) and emotional cues such as facial expressions (Bornstein, Suwalsky, & Breakstone, 2012). Despite the importance of these emotional forms of communication, women differ in their sensitivity to such cues. Mothers with high levels of maternal sensitivity perceive their infant's emotional cues better, and respond more appropriately (Eisenberg et al., 1998; van Doesum et al., 2007). They are more likely to bond with their infant, and their infant is more likely to form a secure attachment with their mother in turn (Juffer et al., 2005; Meins et al., 2001).

Pearson et al. (2010) argue that to react appropriately to an infant's emotions, a first step is to attend to them. Previous studies have used reaction time paradigms to investigate attention capture. Evidence suggests that mothers are more likely than non-mothers to allocate their attention to infant facial expressions over adult facial expressions. For example, Thompson-Booth et al. (2014a) used a search task where participants (mothers and non-mothers) were asked to find an infant or adult face with blue eyes, out of a series of brown eyed babies and adults. The study found that mothers were slower to identify a blue-eyed infant face out of a series of brown eyed babies than a blue-eyed adult face out of a series of brown eyed adults. The authors argued that the infant faces may have engaged more attention, therefore interfering with task performance (p. 42) leading to slower reaction times (Thompson-Booth et al., 2014a).

Research suggests that perinatal mental health difficulties may too alter this attentional allocation. For example, Pearson et al. (2010) and Pearson et al. (2013) investigated the influence of depression on processing infant emotions by using a go/no-go paradigm in pregnant women. Participants were required to move their attention away from an emotional infant face and identify the vertical line. They found that pregnant women with depression were faster to disengage their attention from infant distress than non-depressed pregnant women. This suggests that pregnant women with depression were less likely to have their attention captured by infant distress and therefore task interference was minimised, leading to the faster reaction times. Furthermore, in a facial search task where mothers were asked to find a target infant or adult face with blue eyes, out of a series of brown eyed infant or adult faces Thompson-Booth et al. (2014b) found that, when the target face was an emotional infant, reaction time was faster for mothers with high levels of parenting stress, compared to parents without parenting stress (Thompson-Booth et al., 2014b). Interestingly,

Thompson-Booth et al. (2014b) did not find this pattern in mothers with high scores on the Beck Depression Inventory (Beck, Steer, & Brown, 1996). These findings suggest that pregnant women with depression or mothers with parenting stress may be less likely to have their attention captured by infant expressions, than mothers without these difficulties.

Research on attentional allocation to, and disengagement from, infant emotion has so far focused only on depression (Pearson et al., 2010; Pearson et al., 2013) or parenting stress (Thompson-Booth et al., 2014b). No studies have investigated the impact of postnatal PTSD or anxiety on disengagement from infant emotion. It is possible that anxiety and PTSD may also have an impact on a mothers' attentional allocation and disengagement towards infant emotion as previous studies carried out in non-perinatal samples have found that both these can impact attentional allocation (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van, 2007; Beck, Freeman, Shipherd, Hamblen, & Lackner, 2001; El Khoury-Malhame et al., 2011).

Overall, research suggests that individuals with affective symptoms have an altered attentional allocation to different types of stimuli. This altered attentional allocation could affect how a mother interacts with her infant. Mothers with postnatal mental health difficulties display less maternal sensitivity when interacting with their infants (Feldman et al., 1997; Field et al., 2007; Ionio & Di Blasio, 2014; Muller-Nix et al., 2013; Murray et al., 1996; Stanley et al., 2004). As perceiving an infant's emotional cues is key to maternal sensitivity (Eisenberg et al., 1998; van Doesum et al., 2007), mothers with postnatal mental health difficulties might display differing levels of maternal sensitivity because of their attentional biases.

Maternal sensitivity is also likely to be influenced by the accuracy with which a mother interprets her infant's cues after she has noticed them, and mental health difficulties can affect this. A systematic review found that women with perinatal mental health difficulties, such as anxiety and depression, were worse at recognising happiness and better at recognising sadness than women without perinatal mental health difficulties (Webb & Ayers, 2015). For example, Stein et al. (2010) found that mothers with diagnosed depression rated negative and muted negative faces as more negative than controls. Additionally, Gil et al. (2011) found that mothers with high trait anxiety were more likely to rate sad infant faces as being sadder, and mothers high in depressive symptoms were more likely to rate neutral infant faces as being sad. Furthermore, when happy and sad infant faces were morphed together to create ambiguous emotions, Arteche et al. (2011) found a trend for those with

both anxiety and depression to be able to identify sadness faster than women without anxiety and depression.

A few studies have investigated the impact of perinatal PTSD on interpretation of infant emotion. Two studies Bernstein et al. (2014) and Knežević and Jovančević (2004) used the IFEEL picture system (Butterfield et al., 1987) to assess interpretation of infant emotion. Participants are asked to label the emotions displayed using free response format. These responses are then encoded using a lexicon of emotion-related words (Butterfield & Ridgeway, 1993). Bernstein et al. (2014) found women who experienced traumatic events involving betrayal in adulthood and had PTSD symptoms rated less infant faces as being sad when using the IFEEL pictures. On the other hand, Knežević and Jovančević (2004) found that women who had experienced interrogations or had witnessed violence were less likely to perceive infant faces as being passive.

Overall, this research suggests that women with antenatal depression and postnatal parenting stress suffer from less task interference when identifying target stimuli, compared to women without perinatal affective symptoms. This pattern however has not been found in women with increased symptoms of postnatal depression (Thompson-Booth et al., 2014b). The literature also suggests that mothers with a diagnosis of depression and symptoms of anxiety are more accurate at identifying negative emotional expressions. Previous attentional capture studies have only focused on antenatal mental health conditions and have not investigated the effects of postnatal affective symptoms on reaction time towards emotional infant faces. Furthermore, only one previous accuracy study investigated the impact of symptoms rather than diagnoses on emotional interpretation (Gil et al., 2011). It is important that research focuses on attentional biases in both diagnoses and symptoms, because a survey of over 1,500 women found that 2 in 5 had symptoms of perinatal mental illness despite not having a formal diagnosis (Russell, Lang, Clinton, Adams, & Lamb, 2013). Furthermore, no studies have looked at whether comorbidity is associated with differential processing of infant emotion. This is also important to focus on because comorbidity is common amongst this group (Agius, Xuereb, Carrick-Sen, Sultana, & Rankin, 2016; Dikmen Yildiz, Ayers, & Phillips, 2017). This suggests that researching attentional biases in women with formal diagnoses, ignoring comorbidity, may not give an accurate picture of all those with perinatal mental illness.

Therefore, the aim of this study was to investigate whether postnatal symptoms of anxiety, depression and post-traumatic stress (affective symptoms) influence attentional capture of infant emotional expressions, and accuracy of emotional categorisation. To do this

mothers with and without affective symptoms were asked to take part in two computer-based tasks. One measured attentional capture towards infant emotion using a similar paradigm used by Pearson et al. (2010). The second measured the accuracy with which mothers' categorised emotional expressions by using a similar paradigm to the one used by Arteche et al. (2011). Based on the earlier literature (Pearson et al., 2010; Pearson et al., 2013), we hypothesised that mothers with affective symptoms would be faster to disengage from infant emotional expressions than controls. For the emotional categorisation study, based on previous research (Arteche et al., 2011; Flanagan et al., 2011; Gil et al., 2011; Stein et al., 2010), we predicted that mothers with affective symptoms would be less accurate at categorising ambiguous infant faces, rating a higher proportion of them as negative.

4.3 Method

4.3.1 Design

Two tasks were carried out with a group of mothers with and without symptoms of anxiety, depression and PTS. The first task aimed to investigate mothers' attentional capture towards infants' emotional expressions using a go-no go paradigm as used by Pearson et al. (2010) and had a 2 (Group: mothers with affective symptoms vs mothers without affective symptoms) x 3 (Image valence: Positive vs Negative vs Neutral) repeated measures design.

The second task aimed to investigate mothers' ability to categorise ambiguous infant emotional expressions accurately using a morphed faces paradigm similar to the one used by Arteche et al (2011) and had a 2 (Group: mothers with affective symptoms vs mothers without affective symptoms) x 2 (Emotional Category: Positive vs Negative) repeated measures design.

4.3.2 Participants

A convenience sample of mothers was recruited through: (i) community sources such as National Childbirth Trust groups and children's centres; and (ii) online (e.g. Facebook, Twitter). Inclusion criteria were that mothers were aged 18 or over and had an infant aged between 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 et al., 1979), and by 8 months specific attachment is already beginning to form (Schaffer & Emerson, 1964).

Mothers were assigned to the affective symptoms group if they had current symptoms of anxiety, depression or post-traumatic stress as measured by the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) and the PTSD Diagnostic Scale (PDS; Foa, 1995). 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 ($M = 34.01$, $SD = 4.57$) and infant age ranged from 3 to 8 months ($M = 5.04$, $SD = 1.24$). Thirty-eight (55.1%) of the infants were female, and 31 (44.9%) were male. The majority (62.9%) of women were first-time mothers. The majority of women had completed an undergraduate degree (42.9%) or a postgraduate degree (42.9%), were married (68.6%) and white (87%). Most women (48.3%) and their partners (44.7%) fell into occupational class 2 (Office for National Statistics, 2010). There were no significant differences in demographic characteristics between the groups (see Table 4-1). As expected, mothers in the affective symptoms group had significantly higher levels of PTS, anxiety and depression symptoms (see Table 4-2). Within the affective symptoms group, 47.82% had moderate to severe symptoms of PTS after a traumatic birth. Only one mother had PTS after a traumatic birth, and after other-traumatic events. 39.13% had moderate to severe symptoms of anxiety, and 13.05% had moderate to severe symptoms of depression. The majority (65.22%) had comorbid symptoms. Participants in the affective symptoms group mainly had mild to moderate symptoms of anxiety and PTS, and mild symptoms of depression. Table 4-3 shows this in more detail.

Table 4-1. *Demographics of mothers with and without affective symptoms*

	Mothers with no affective symptoms n (%)	Mothers with affective symptoms n (%)	χ^2	<i>p</i>
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)		
Feelings about pregnancy			11.57	.003
Very happy	37 (78.7)	9 (39.1)		
Generally positive	10 (21.3)	13 (56.5)		
Indifferent	0 (0)	1 (4.3)		
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)		
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)		

Table 4-2. *PTSD and HADS scores for the mothers with and without affective symptoms*

	No affective symptoms (n = 47)	Affective symptoms (n = 23)		
	M (SD)	M (SD)	t	p
PTS symptoms	2.36(2.44)	11.09(7.16)	-5.69	<.001
HADS Anxiety	3.64(1.94)	9.83(3.08)	-8.81	<.001
HADS Depression	2.26(1.52)	7.35(3.92)	-6.02	<.001

Table 4-3. *Symptom severity of mothers in the affective symptoms group*

PTSD symptom severity ¹	PTSD ¹ N (%)		HADS symptom severity ²	HADS Anxiety N (%)		HADS Depression N (%)	
	n	%		n	%	n	%
0 (non-case)	1	4.35	0-7 (non-case)	5	21.74	10	43.48
1-10 (mild)	11	47.82	8- 10 (mild)	9	39.13	10	43.48
10-20 (moderate)	8	34.78	11-14 (moderate)	8	34.78	1	4.35
21-35 (moderate to severe)	3	13.04	15-21 (severe)	1	4.35	2	8.7

Note. 1. Scoring taken from Foa (1995); 2. Scoring taken from Stern (2014)

4.3.3 Materials

Screening questionnaires (Appendix 5). To assess mother's eligibility brief demographic information was taken regarding participants' age, ethnicity, level of education, infant's age and number of other children. To assess mother's mental health, two questionnaires were used:

Post-traumatic stress disorder diagnostic scale (PDS) (Foa, 1995). The PDS measures PTSD according to the criterion set out in the DSM-IV (American Psychiatric Association, 1994). 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 $\alpha = 0.97$). Participants were asked to complete the PDS 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. This cut off was used because a score of 11 or more reflects moderate to severe symptoms of PTS (Foa, 1995)

Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983). The HADS has two subscales of depression and anxiety and was designed for use in clinical populations. The HADS had high internal consistency for this sample (Whole scale: Cronbach's $\alpha = .89$, anxiety subscale: Cronbach's $\alpha = 0.70$, depression subscale Cronbach's $\alpha = 0.89$ for depression). For this study, 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).

Stimuli. For the attentional capture task 90 infant faces were used, these were not repeated to avoid learning effects. Thirty of the faces portrayed positive expressions, thirty negative and thirty neutral. Stimuli were taken from two validated databases of infant emotional faces. One of which was from Pearson et al. (2010). These consisted of 30 infant faces, 10 showing distress expressions, 10 happy and 10 neutral expressions. For more detail on how these were developed please see Pearson et al. (2010). The second source was from the City Infant Faces Database, a validated set of infant emotional expressions (Webb, Ayers, & Endress, 2017).

To assess participants' accuracy at identifying emotions, 50 images were selected from a set of infant faces, developed by the authors for a previous study (Ayers, Kling, Hole, & Wright, 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.

Apparatus. Both experiments were viewed on a 23", 1920x1080 widescreen monitor. E-Prime version 2.0 was used to present the stimuli. Participants were sat approximately

60cm from the screen. For the attentional capture task, each image was 150 x 198 pixels. For the categorisation task, each image was 224 x 274 pixels.

4.3.4 Procedure

Mothers who consented were assessed for symptoms of anxiety, depression and PTSD via an online survey platform, Qualtrics (Qualtrics., 2015). Mothers were asked to leave their contact details at the end of the survey if they wanted to take part in the computer tasks. If mothers reached eligibility criteria, they were asked to come to the University to take part in the tasks. Mothers who consent completed two computer based tasks, the order of the presentation of these were counterbalanced.

Attentional capture to infant emotion

To measure mothers' ability to disengage from an infant face and identify a target, a go/no-go paradigm was used, as described in Pearson et al. (2010) and illustrated in Figure 4-1 and Figure 4-2. This task involved subjects focusing on a central go/no-go signal for 2000ms. Next, the stimulus display appeared for 240ms. The stimulus display included a picture of an infant's face in the centre, and a horizontal and vertical line on either side of the screen. On "go" trials (i.e. green cross) participants were required to indicate whether the vertical line was on the right or left-hand side of the screen by pressing a button on the keyboard (A=Left, L= Right) (see Figure 4-1). A blank screen then appeared until the response was given. Participants were asked to ignore the pictures in the centre of the screen and just look for the vertical line. During no-go trials (i.e. a red cross) participants were required to press the spare bar. These were included to ensure participants were focusing on the centre before responding (see Figure 4-2). A practice block of 30 trials was given, with no picture in the centre of the screen. Once participants understood the instructions they were given three blocks of 30 trials (20 go, 10 no-go). The side that the line was displayed on was counterbalanced and trial order was randomised within the blocks, however all positive, negative and neutral faces were shown within the same block to reduce "pop out" (Bindemann et al., 2005). Reaction time between the appearance of the stimulus presentation and the response was recorded

Categorisation of infant emotion

The procedure for this task was similar to the procedure used by Arteché et al. (2011). 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. Two practice trials, using adult faces, were given to ensure participants understood the task. Accuracy and response time were measured by E-Prime (Psychology Software Tools, 2012).

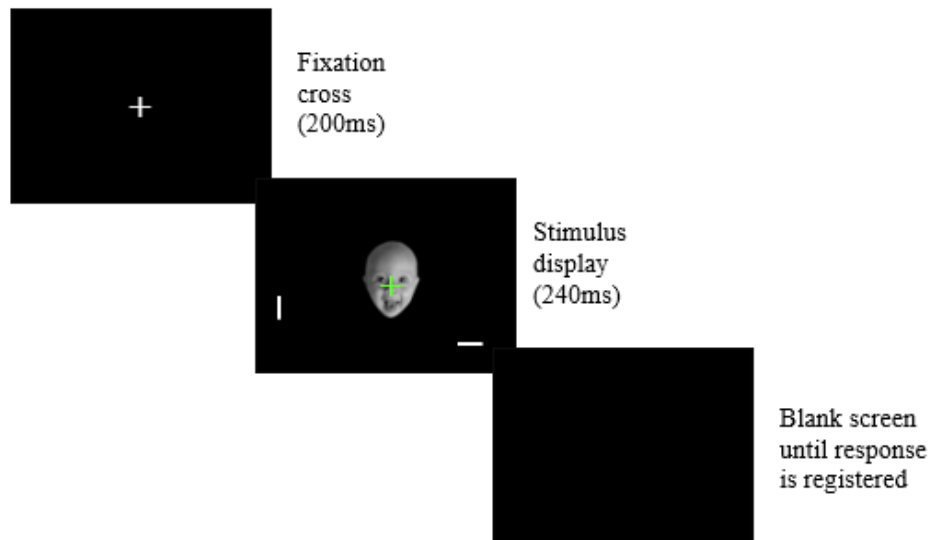


Figure 4-1. Presentation sequence of a 'go' trial

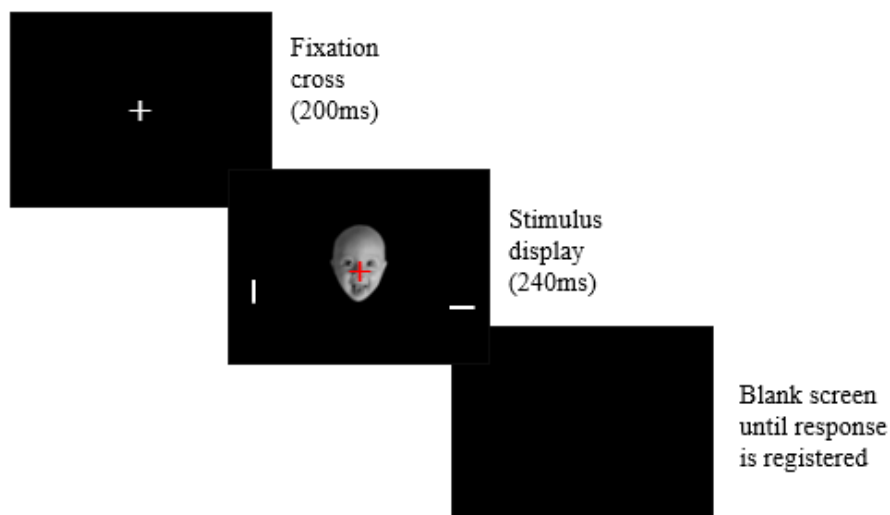


Figure 4-2. Presentation sequence of a “no - go” trial (trials where participants are required to press spacebar).

4.3.5 Data Analysis

Attentional capture to infant emotion

Data were cleaned using R version 3.4.1. Exclusions were made based on the following 2 criteria: 1) To assess whether participants had a side bias, we compared the proportion of left/right responses (in go trials) to chance using a one-tailed binomial test. With 80 go trials, responding on one side on 60% of the trials would be significant. As a result, participants were excluded from analysis if they responded on the same side on more than 60% of the go trials; 2) For “no-go” trials, we identified and excluded participants with accuracy of less than 80%, as this suggests that they were not focusing on the centre of the screen at the start of trials. This resulted in a total of four participants ($n = 3$ for the no affective symptoms group, $n = 1$ for the affective symptoms group) being excluded from analysis. Next, trials where reaction time was under 200ms and above 1000ms were removed. The decision to remove trials where reaction time was under 200ms and above 1000ms was based on the literature that suggests fixations tend to range from 200 – 400ms depending on the task being carried out (Salvucci & Goldberg, 2000; van der Lans, Wedel, & Pieters, 2011). The average reaction time (RT) was calculated for each participant. Trials where RT exceeded two standard deviations from a participant’s RT mean were excluded. If more than 20% of trials were excluded for a participant, this participant was excluded from analysis. This resulted in a total of four participants being removed ($n = 1$ for no affective symptoms group, $n = 3$ for affective symptoms group). This left a total of 43 participants for the no affective symptoms group and 19 participants for the affective symptoms group. Participants’ reaction time was log-transformed and an average log reaction time was calculated for each participant by trial type (positive images, negative images, neutral images).

Analysis using Participant Groups as categorical predictor. A 2(Group: affective symptoms vs no affective symptoms) x 3(valence of image: positive vs negative vs neutral) ANOVA was used to assess whether mothers’ ability to disengage from the infant face and identify the vertical line differed by group (no affective symptoms vs affective symptoms) and valence of the image (positive, negative, neutral). Reaction time data were log transformed to ensure a normal distribution and were used as the outcome variable. To calculate the likelihood ratio for the interaction of group and trial type, mean reaction times were calculated for each group for each trial type. The difference in RT was then calculated for negative vs neutral trials, positive vs neutral trials and positive vs negative trials, leaving a total of three mean difference scores per group. From the mean differences both Bayesian Information Criterion and the Akaike Information Criterion were calculated. Finally, based

on previous research, we predicted that negative trials would have a slower response time than positive or neutral trials, therefore the difference between negative RT and the average RT of neutral and positive images were calculated and compared to 0 using a t-test.

Analysis using symptoms as continuous predictors. This was assessed using the symptom score from the HADS and PDS questionnaires as described above. Kendall's Tau correlations were used to see if there was an association between individual symptom scores and RT. Response time for negative trials compared to positive and neutral trials was also correlated with symptom severity. Effect sizes for non-parametric tests were calculated in SPSS using the syntax provided by (Walker, 2003).

Categorisation of infant emotion

All participants' data was used in this analysis (Women with affective symptoms $n = 23$, women without affective symptoms $n = 47$). Signal detection theory was used to analyse the data. The percentage of positivity within the image was used to calculate hit rates and false alarms. In the context of this study, hits were defined as a successful classification of the more positive face as more positive. False alarms were defined as the erroneous categorisation of the less positive image as more positive. Sensitivity (A') i.e. how many faces participants correctly identified as positive, and detection bias (b) i.e. how likely the participant was to rate images as positive, was calculated using the formulas put forward by (Zhang & Mueller, 2005).

Analysis using participants groups as categorical predictor. To see if there was a significant difference in the way mothers with and without affective symptoms categorise emotions, two separate ANOVAs were carried out using sensitivity (A'), and detection bias (b) as separate outcome variables and group (no affective symptoms vs affective symptoms) as the predictor variable. Likelihood ratios using the Akaike Information Criterion were calculated.

Analysis using symptoms as continuous predictors. This was assessed using the symptom score from the HADS and PDS questionnaires as described above. Kendall's Tau correlations were used to see if there was an association between individual symptom scores and sensitivity and bias scores.

Post-hoc power analysis was carried out on marginally significant results using the "pwr" library in R.

4.4 Results

4.4.1 Attentional Capture to Infant Emotion

Analysis using participants groups as categorical predictor. The 2(Group: affective symptoms vs no affective symptoms) x 3(valence of image: positive vs negative vs neutral) ANOVA did not support the hypothesis. There was no interaction between group and image valence ($F(2, 120) = 0.014, p = .99$). The likelihood ratios confirmed this (Negative vs Neutral trials: Null hypothesis BIC: 7.78 AIC: 2.98; Positive vs Neutral trials: Null hypothesis BIC: 7.87, AIC: 3.02; Positive vs Negative trials: Null hypothesis BIC: 7.8, AIC: 2.99).

The ANOVA showed there was no main effect of group in relation to reaction time ($F(1,60) = 0.113, p = .738$) However, there was a main effect of image valence ($F(2,120) = 3.86, p = .02$), which was confirmed by the t-test analysis, where the difference between RT for negative images and RT positive images were compared to 0 ($t(61) = 2.77, p = .007$). Means show that RT was slower for the negative images ($M = 625.97$) compared to neutral images ($M = 599.09$) and positive images ($M = 576.8$).

Analysis using symptoms as continuous predictors. The Kendall's tau analysis, revealed that there were no associations between RT and anxiety symptoms, depression symptoms, PTS symptoms, or individuals with a combination of anxiety, depression and/or PTS symptoms.

4.4.2 Categorisation of Infant Emotion

Analysis using participants groups as categorical predictor. The hypothesis that mothers with affective symptoms would display less accuracy when categorising infant emotional expressions was not supported. No significant differences were found between groups for sensitivity ($F(1,68) = 1.095, p = 0.299, \eta_p^2 = .016$), or detection bias ($F(1,68) = 0.019, p = .89, \eta_p^2 = <.001$). The likelihood ratio using the Bayesian Information Criterion showed that the chances of the null hypothesis being correct was more likely (4.784) than the alternative hypothesis (0.209). The same pattern was found when using the Akaike Information Criterion (Null = 1.705).

Analysis using symptoms as continuous predictors. Kendall's Tau associations revealed no significant associations between symptom severity and sensitivity or detection bias. There was a non-significant ($r_T = -0.155, p = 0.07, \eta_p^2 = .06, d = .5, \beta = 0.13$) trend for sensitivity scores to decrease as anxiety scores increased (Figure 4-3).

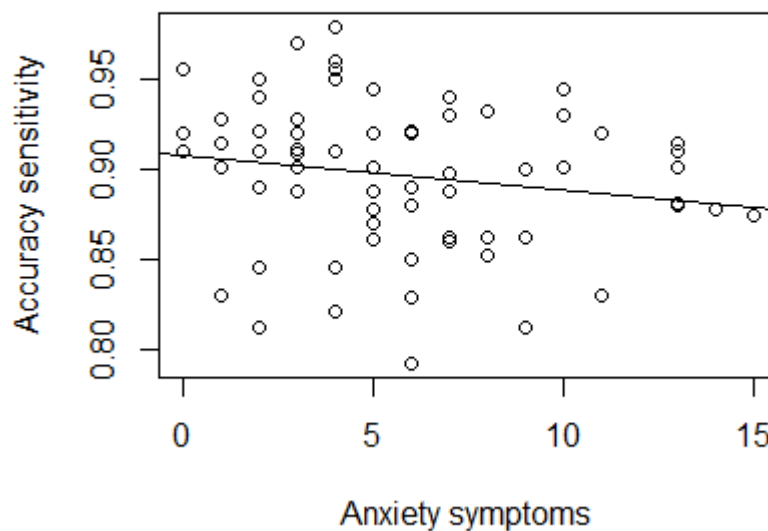


Figure 4-3. Relationship between anxiety symptoms and sensitivity for the categorisation study.

4.5 Discussion

This study aimed to identify whether there was an association between postnatal affective symptoms and a mother's ability to disengage from infant emotions. The results are inconclusive given the non-significant findings. It is therefore possible that mothers with affective symptoms do not disengage faster from infant faces in comparison to controls (however this suggestion counters previous research: Pearson et al., 2010; Pearson et al., 2013; Thompson-Booth et al., 2014b), or methodological issues prevented the finding of a significant result. The second aim of this study was to identify whether mother's affective symptoms were associated with her ability to accurately categorise infant emotional expressions. Again, results were inconclusive, although there was a non-significant trend towards mothers with anxiety being less sensitive at categorising emotions. The results shown in Figure 4-3 suggest this trend may have been driven by the few mothers with high levels of anxiety symptoms, however this needs further exploration.

Given that previous research suggests that mothers with affective symptoms display certain biases when disengaging from (Pearson et al., 2010; Pearson et al., 2013), and categorising infant emotions (Arteche et al., 2011; Stein et al., 2010) the results from this study are somewhat surprising. There are four main methodological differences between this

study and previous literature that may have contributed to the null results found. Firstly, this paper focused solely on the postnatal period, whereas other studies have focused on the entire perinatal period. For example, Pearson et al. (2010) found that pregnant women with depression were faster to disengage their attention from infant distress than non-depressed pregnant women when using the same go/no-go paradigm used in this study. On the other hand, Thompson-Booth et al. (2014b) used an attentional capture paradigm in the postnatal period and found that depression scores were not associated with RTs. Based on the results from this study and Thompson-Booth et al. (2014b) it could be suggested that symptoms of postnatal depression may not influence attentional biases towards infant emotional expressions, whereas antenatal depression might. However, with very few studies in this area, conclusions are difficult to draw, and more research is needed.

Secondly, four previous studies found that it was depression only that influenced perception and processing of infant emotion. For example, Pearson et al. (2010) found women with a diagnosis of antenatal depression had altered RT to infant faces. Further, Arteché et al. (2011), Flanagan et al. (2011) and Stein et al. (2010) found that it was the mothers with depression only who had altered responses when viewing infant faces. The proportion of mothers with depression in this study was low (4.35%). It is therefore possible that it is mothers with depression only who display specific biases towards faces. Therefore, it could possible that if the proportion of depressed mothers in this study had been larger, the findings would have been different, however again research is needed to clarify this suggestion.

The third way this sample differs from other samples is that previous experimental studies have focused on diagnoses of specific disorders whereas this study has focused on symptoms. Arteché et al. (2011), Flanagan et al. (2011), Pearson et al. (2010), Pearson et al. (2013) and Stein et al. (2011) all used diagnostic measures to identify depression and anxiety., whereas this study used questionnaires to measure symptoms of anxiety, depression and PTSD, not diagnostic disorders. It is therefore possible that biases may only be observed in clinically-significant (i.e. severe) cases of disorders, whether depression or anxiety, and not in mothers with mild to moderate symptoms such as in this sample.

This suggestion fits with the finding in this study that as anxiety levels increased, there was a trend for sensitivity in identifying positivity in faces to decrease. The effect size for this finding was small-medium, yet the power was small ($\beta = .13$). This suggests that with larger sample sizes a significant effect may have been found. Other research also supports this. For example, a meta-analysis of 14 studies found that the more severe an individual's

symptoms of depression were, the higher their impairment in executive function, processing speed and episodic memory (McDermott & Ebmeier, 2009). Additionally, Lawrence, Roy, Harikrishnan, Yu, and Dabbous (2013) asked participants to rate their perception of the cognitive functioning abilities and found that perceived cognitive functioning worsened with increasing severity of depression symptoms. Furthermore, in a study of 108 patients with remitted and current depression, Air, Weightman, and Baune (2015) found that severity of depressive and anxious symptoms predicted performance on social cognition subscales, including facial affect recognition. Future research should therefore focus on replicating this study, but with larger sample sizes to increase statistical power.

The fourth way this sample differs from other similar studies is the high level of individuals with a mixture of symptoms within this sample. Within this study, 65.22% of mothers in the affective symptoms group had a mixture of anxiety, depression and/or PTS symptoms. It is possible that comorbidity may obscure biases i.e., a bias observed in depressed women may be countered if the woman also has anxiety. For example, individuals tend to have their attention captured by disorder specific information (such as fear related stimuli for anxiety) (Yiend, 2010) and perception of emotion has been found to differ across diagnoses (Demenescu, Kortekaas, den Boer, & Aleman, 2010; Torro-Alves et al., 2016). Therefore, the presence of comorbidity may alter these biases. There is some support for this. For example, a study by Mogg, Millar, and Bradley (2000) did not find evidence for an attentional bias to sad faces in individuals with depression and suggested this was due to the comorbid diagnosis of generalised anxiety disorder in 13 of the 15 participants. Furthermore Grant and Beck (2006), found that individuals with comorbid depression and social anxiety disorder did not display an attentional bias to social threat words, whereas those with social anxiety did. This suggests comorbidity could have played a part in the results of this study, however again, more research is needed.

Despite the methodological differences between this study and previous research, it is also important to note that the null results may have been found simply because mothers with affective symptoms do not show biases when disengaging from, or categorising infant emotional expressions. Clearly more research is needed to clarify the results from this study.

This study is the first to investigate the impact of postnatal affective symptoms on attentional allocation and emotional categorisation and therefore provides novel information about attentional biases in the postnatal period. However, this study is limited by several factors. Firstly, the sample sizes are small, especially the affective symptoms group with a total of 23 participants. This means that cognitive biases in specific symptom groups may

have been missed due to the small number of participants. Secondly, the sample was mainly white, well-educated women working in professional occupations. This suggests that the results from the study may not be generalizable to the wider population.

Overall, the results from this study suggest that affective symptoms in the postnatal period may not influence mothers' attentional allocation or emotional categorisation towards infant emotions. Anxiety symptoms may lead to less sensitivity when categorising emotions but more research is needed. The results from this study are not consistent with previous literature, which may be due to differences in methodology and sample type, in particular that this study looked at mothers with mild to moderate affective symptoms. Therefore, future research should focus on attentional biases across the perinatal period and in women with both diagnoses and/or symptoms.

5 Postnatal mental health and mothers' processing of infant emotion: An eye-tracking study (Article 4)

Webb, R., & Ayers, S. (submitted). Postnatal mental health and mothers' processing of infant emotion: An eye-tracking study. *Anxiety, Stress & Coping*

**The full text of this article has been
removed for copyright reasons**

6 Exploration of a cognitive model of maternal sensitivity (Article 5)

Webb, R., & Ayers, S. (in prep). Exploration of a cognitive model of maternal sensitivity.

6.1 Abstract

During the postnatal period mothers may suffer from affective symptoms such as anxiety, depression and post-traumatic stress. Mothers with and without postnatal affective symptoms tend to show differing levels of maternal sensitivity, however the mechanisms that underlie this relationship are not known. Therefore, this study developed and tested a cognitive model of possible mechanisms. Based on previous research the model had four hypotheses: 1) maternal affective symptoms would be associated with lower levels of maternal sensitivity; 2) maternal affective symptoms would be associated with maternal processing of infant-related information, which in turn would be associated with maternal sensitivity; 3) Maternal sensitivity and infant behaviour would be associated with one another; and 4) negative affect in mothers would be associated with more infant negative affect. These hypotheses were tested by recruiting mothers with ($n = 23$) and without ($n = 47$) affective symptoms and asking them to complete a series of tasks and questionnaires. Maternal infant-related information processing was assessed using two questionnaires 1) infant intentionality; 2) postnatal relationship, and three computer tasks 1) selective attention and dwell time on infant faces; 2) disengagement away from infant faces; 3) categorisation of infant emotions. Maternal affective symptoms were assessed using two questionnaires, and maternal sensitivity and infant behaviour were assessed using a free-play paradigm. Hypotheses 1, 3 and 4 were supported which is in line with the literature. Hypothesis 2 was partially supported with the linear regression showing that maternal affective symptoms and specific infant-related processing factors were associated with maternal sensitivity in 3 cases (first fixation to more positive image, faster disengagement from more positive image and infant intentionality). Exploratory correlation analyses also found that certain other infant-related information processing factors within the model were associated with maternal sensitivity. Further research is needed to explore these relationships further and try to identify the mechanisms underlying the relationship between maternal affective symptoms and maternal sensitivity.

Keywords: cognitive biases; infant faces; maternal sensitivity; affective symptoms

6.2 Introduction

During the postnatal period mothers may experience affective symptoms such as anxiety, depression and post-traumatic stress disorder (PTSD). Research suggests that postnatal affective disorders can influence a mother's sensitivity towards her infant during interaction. For example, research suggests mothers with anxiety show less sensitive responses towards their infant (Nicol-Harper et al., 2007) such as overly intense vocalisations and acknowledgements (Kaitz et al., 2010). Reviews and meta-analyses have found that mothers with postnatal depression tend to be controlling and over-stimulating in their interactions, or withdrawn and passive (Field, 2010; Lovejoy et al., 2000). Further, some studies have found that post-traumatic stress (PTS) symptoms after a traumatic birth have been associated with intrusive (Ionio & Di Blasio, 2014) or controlling (Forcada-Guex et al., 2011) interactions. However, the association between maternal PTSD and maternal sensitivity is less clear (Cook, Ayers, & Horsch, 2018).

Insensitive mother-infant interactions associated with perinatal affective symptoms may lead to negative outcomes for the infant such as an insecure attachment (Carter et al., 2001; Lyons-Ruth & Block, 1996; van Ee, Kleber, Jongmans, Mooren, & Out, 2016), psychosocial problems (van Ee et al., 2012), developmental difficulties (Murray et al., 1996; Parfitt, Pike, & Ayers, 2014) or childhood mental health difficulties (Carter et al., 2001; Glasheen et al., 2010; Talge et al., 2007). It is therefore important that the causal mechanisms underlying the relationship between perinatal affective symptoms and maternal sensitivity is understood.

Previous theories and research can provide some explanations for this relationship. For example, the fixed beliefs (attributions) a mother makes about her child may influence the way she interacts with her baby (Lieberman, 1999). Research has found that higher symptoms of PTS and depression are associated with more negative maternal attributions of a mothers' infant (Schechter et al., 2015). The authors argued that the infant's communication, gestures, or appearance can serve as traumatic reminders to the mother leading to the mother avoiding, rather than approaching her child thus influencing maternal sensitivity.

Another theory relates to a mother's ability to understand the mental state of herself and others (Mentalization or Reflective Functioning; Bateman & Fonagy, 2006). Fonagy et al. (1991) found that the capacity of a mother to recognise and reflect upon her own mental experience was correlated with her own attachment history, and her infant's attachment to her (Fonagy, Steele, & Steele, 1991; Fonagy, Steele, Steele, et al., 1991). This finding has been replicated by other studies which have found that maternal reflective functioning is associated

with maternal behaviour and child attachment security (Grienemberger et al., 2005; Slade, 2005).

Conceptually similar is mind-mindedness which is a parent's tendency to comment appropriately on their infant's internal states (Meins et al., 2001). Greater mind-mindedness at six months has been found to be an independent predictor of secure attachment in both mothers (Meins et al., 2001) and fathers (Arnott & Meins, 2007). On the other hand, lower levels of mind-mindedness have been found in parents with high levels of parenting stress (Demers, Bernier, Tarabulsky, & Provost, 2010; Walker et al., 2012).

The theories described above have evidence suggesting that they may explain the relationship between affective symptoms and maternal sensitivity in mothers with depression, PTS or parenting stress. However, very little research has looked at potential reasons for poorer maternal sensitivity in mothers with anxiety, or comorbid affective disorders. These theories also do not take into account other aspects of cognition or specific cognitive processes that recent research suggests may be associated with postnatal affective disorders. For example, studies have found that pregnant women with depression are faster to disengage from infant emotional expressions (Pearson et al., 2010) and are worse at recognising happiness in infant faces compared to controls (Arteche et al., 2011; Stein et al., 2010). Furthermore, research has found that the way a mother perceives her relationship with her infant in terms of general bonding, anxiety about her infant and anger and rejection towards her infant, is associated with maternal affective symptoms (Moehler et al., 2006; Taylor et al., 2005), which has in turn been associated with observed parenting behaviours at six months (Muzik et al., 2013). This research suggests that aspects of cognition other than attributions and reflective functioning, could be influential in predicting maternal sensitivity.

With this in mind, a cognitive model of maternal sensitivity was developed based on previous research.

6.2.1 The Proposed cognitive model

The proposed cognitive model is shown in Figure 6-1 and has four hypotheses, each of which relate to one another and are outlined below. An example will be provided throughout to aid understanding of the model. The development of this model will enable researchers to systematically test the components and increase understanding of the possible mechanisms through which a mother's affective state may influence her sensitivity towards her infant. This could in turn inform the development of effective interventions to improve maternal sensitivity and infant outcomes

Hypothesis 1: Maternal affective symptoms will be associated with lower levels of maternal sensitivity.

The first hypothesis is based on the large body of research described above that has found that maternal affective disorders and/or symptoms are associated with reduced levels of maternal sensitivity (Forcada-Guex et al., 2011; Ionio & Di Blasio, 2014; Kaitz et al., 2010; Lovejoy et al., 2000; Nicol-Harper et al., 2007).

Hypothesis 2: Maternal affective symptoms will be associated with maternal processing of infant-related information, which will in turn be associated with maternal sensitivity.

The model predicts that maternal infant-related information processing will be associated with maternal affective symptoms and maternal sensitivity. The infant-related information processing factors included in the model are: 1) a mother's attentional biases towards and away from certain infant emotions; 2) a mother's perceptual processes when categorising infant emotions; and 3) a mother's cognitions about her infant's behaviour, and her relationship with her infant. Each of these factors will now be discussed in detail, with an explanation for their inclusion in the model.

6.2.1.1.1 Infant-related-information factor 1: Attentional biases

An attentional bias can be defined as facilitated selective attention towards stimuli, difficulty disengaging attention away from certain stimuli, or avoidance of certain stimuli (Cisler & Koster, 2010). Therefore, both mothers' facilitated attention towards, and disengagement from, emotional infant faces is included in the model. Attentional biases implicitly guide attentional allocation, meaning we are more likely to encode and process the stimulus which we have allocated our attention to (Cisler & Koster, 2010). Therefore, an attentional bias might lead mothers to miss relevant cues from their infant during interaction. This could lead to reduced maternal sensitivity as recognising infants' emotional cues successfully is a key aspect of maternal sensitivity (Eisenberg et al., 1998; van Doesum et al., 2007). For example, a mother who unconsciously avoids positive infant faces may be less likely to notice her baby smiling, meaning she may smile at her infant less.

6.2.1.1.2 Infant-related-information factor 2: Perceptual processes

These perceptual processes refer to a mother's accuracy and strategy used when categorising infant emotional expressions. As in standard signal detection theory, accuracy receives contributions from two sources: sensitivity to detect a target stimulus (perceptual sensitivity), and bias when detecting a target stimulus (perceptual bias). For this model, sensitivity to detect a target stimulus relates to a mother's sensory ability to discriminate

positive emotional expressions from other facial expression, in this case negative emotional expressions. Bias when detecting a target stimulus essentially refers to how intense the emotion had to be for a mother to rate it as positive. For example, a mother who needs her infant to be showing particularly strong levels of positivity before she categorises it as such, may perceive her infant as less positive, and therefore show less positivity towards her baby.

A mother's perceptual strategy when categorising infant emotions refers to the areas on an infant face she is looking out whilst categorising the emotions. If a mother is looking at an area of the face that is particularly reflective of a given emotion (such as the mouth for positivity; Dimberg & Petterson, 2000) then it is likely that her perceptual sensitivity will be higher. That is, she will correctly identify more positive images because she was looking at the most diagnostic area of the face. On the other hand, a mother who does not focus on areas of the face reflective of certain emotions may have low perceptual sensitivity. For example, a mother who spends her time looking at the eyes of a happy baby may struggle to identify the baby as being happy because the eyes are not particularly diagnostic of happiness, whereas the mouth is (Dimberg & Petterson, 2000; Schurgin et al., 2014).

6.2.1.1.3 Infant-related-information factor 3: Cognitions about infant

Research described above suggests that the way a mother perceives her infant's behaviour can influence the way she interacts with her baby (Arnott & Meins, 2007; Demers et al., 2010; Fonagy, Steele & Steele, 1991; Fonagy, Steele, Steele et al., 1991; Grienemberger et al., 2005; Lieberman, 1999; Meins et al., 2001; Schecter et al., 2015; Slade, 2005; Walker et al., 2012) and mothers with elevated depressive symptoms are more likely to perceive 4-month old infants as being less intentional, than mothers without depressive symptoms (Zeedyk, 1994).. Therefore, the attributions a mother makes about her infants behaviour is included in the model.

The other cognition a mother has around her infant that is likely to be associated with affective symptoms and maternal sensitivity is the way a mother perceives her relationship with her baby. Depressive and PTS symptoms have been found to be correlated with the mother-baby bond (Moehler et al., 2006; Parfitt & Ayers, 2009; Taylor et al., 2005). One study found that postnatal depression and PTSD were associated with the mother-baby bond, which was in turn associated with observed parenting behaviours at six months (Muzik et al., 2013). Therefore, a mother with affective symptoms may feel her bond with her baby is less strong, meaning she feels less motivation to care for her baby meaning she displays less maternal sensitivity.

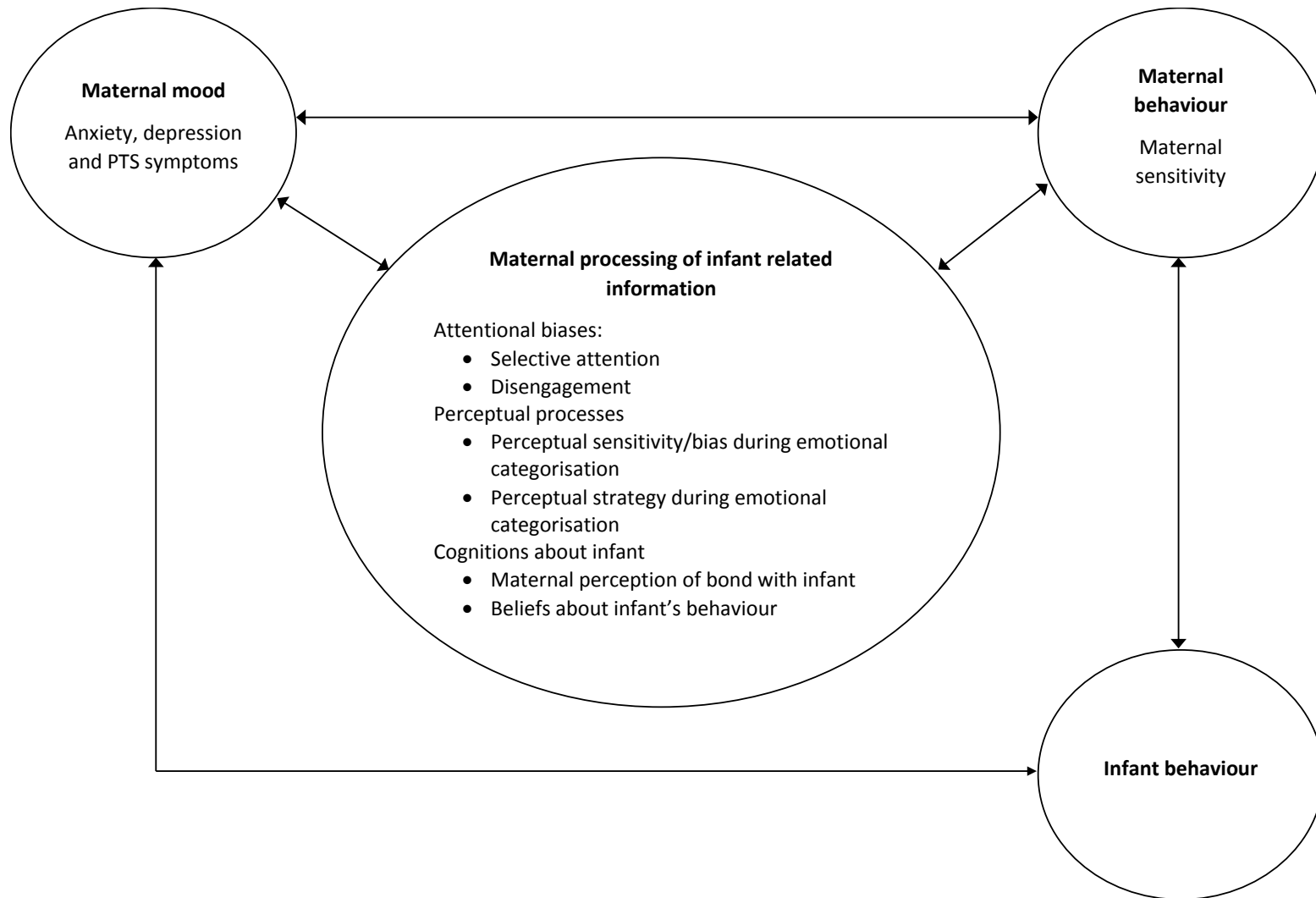


Figure 6-1. *Proposed cognitive model of maternal sensitivity*

Hypothesis 3: Maternal sensitivity and infant behaviour will be associated with one another.

The third hypothesis in the model is that both maternal sensitivity and infant behaviour will be related to one another. This hypothesis is based on previous research which suggests that maternal-infant interaction tends to be bi-directional (Van Egeren, Barratt, & Roach, 2001). An example of this would be if the infant is happy and relaxed, the mother may be more likely to be relaxed and more sensitive during the interaction. This in turn could improve the infant's mood, reinforcing positivity in the dyadic interaction

Hypothesis 4: Maternal affective symptoms will be associated with more infant negative affect.

The final hypothesis is that maternal affective symptoms will be associated with higher levels of infant negative affect as rated by the researcher. This is based on research evidence that maternal anxiety and PTS are associated with ratings of difficult infant temperament (Davies et al., 2008; Martini et al., 2017; McGrath, Records, & Rice, 2008; Radesky et al., 2013), therefore more difficult behaviour is expected to be found in infants of women with affective disorders or symptoms.

6.2.2 Summary and aim

Previous theories used to explain the relationship between postnatal affective symptoms and maternal sensitivity have focused on individual mental health problems. This model combines research from mothers with anxiety, depression and PTS in an attempt to explain the relationship in mothers with comorbid affective symptoms. To assess this, a preliminary test of the model was carried out with mothers with and without affective symptoms (anxiety, depression and PTS). Mothers completed a variety of measures and tasks aimed to reflect different components of the model.

The overall aim of this paper was to explore the validity of the proposed model and to generate further hypotheses and adapt the model based on the findings.

6.3 Method

6.3.1 Design

This study was a correlational design in which two groups of mothers (mothers with affective symptoms ($n = 23$) and mothers without affective symptoms ($n = 47$) were asked to complete three computer based tasks ((1) selective attention and dwell time on infant faces; (2) disengagement away from infant faces; (3) categorisation of infant emotions); two questionnaire measures ((1) perception of infant intentionality; (2) perception of mothers relationship with her infant); and one maternal sensitivity and infant behaviour task (mother-

infant free play). Each measure was used to reflect an individual component within the model, with the aim of identifying which components influence maternal sensitivity (See Table 6-1).

Table 6-1. *Hypothesis, component of the model and the measure of task reflecting this component*

Hypothesis	Component of Model	Measure/Task reflecting component	Variables included in the model (Predictor variable (P); Outcome variable (O))
1	Maternal Affective symptoms	HADS ¹ PDS ²	Affective symptoms vs No affective symptoms (P)
1	Maternal sensitivity	NICHD ³	Maternal sensitivity scale (O) Maternal sensitivity subscales (O): 1) sensitivity to distress; 2) sensitivity to non-distress; 3) intrusiveness; 4) detachment; 5) positive regard for the infant; 6) negative regard for the infant; and 7) flatness of affect
2	Attentional biases	Eye-tracking Go/No-Go task	Selective attention (P) •Proportion of time spent looking at the more positive face. •Proportion of trials where the first fixation was towards the more positive face. Disengagement (P) •Reaction time for negative trials relative to neutral trials. •Reaction time for positive trials relative to neutral trials.
2	Perceptual processes	Categorising morphed infant faces Eye-tracking whilst categorising morphed infant faces	Accuracy during categorisation (P) •Perceptual sensitivity (A') i.e. a measure of the mothers' sensory ability to discriminate positive faces from negative faces. •Perceptual bias (b) i.e. how intense an emotional expression has to be for the mother to rate the image as positive. Perceptual strategy during categorisation (P) •The proportion of time spent looking at the eyes in comparison to the eyes and mouth.
2	Cognitions about infant	PBQ ⁴	Maternal perceptions about relationship with infant (P) •Total score on the 'infant-focused anxiety' PBQ subscale.

		IIQ ⁵	• Total score on the ‘infant rejection and pathological anger’ PBQ subscale.
			Maternal perceptions about her infants’ behaviour (P)
	Maternal sensitivity	NICHD ³	• Total score on the IIQ
			Maternal sensitivity scale (O)
3	Maternal sensitivity	NICHD ³	Maternal sensitivity scale (P)
	Infant behaviour		
			Infant negative affect; infant positive affect; infant activity; infant sustained attention (O)
4	Maternal affective symptoms	HADS ¹	Maternal score on HADS and PDS (P)
		PDS ²	
	Infant behaviour	NICHD ³	Infant negative affect (O)

Notes. 1 = Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983); 2 = PTSD Diagnostic Scale (Foa, 1995); 3 = National Institute for Child Development Infant Interaction Tool; (NICHD Early Child Care Research Network, 1996; van Bakel et al., 2010), 4 = Postpartum Bonding Questionnaire (Brockington et al., 2006); 5 = Infant Intentionality Questionnaire (Feldman & Reznick, 1996).

6.3.2 Participants

Convenience sampling was used to recruit mothers with or without affective symptoms. Inclusion criteria were that mothers were aged 18 or over and had an infant aged between 3-8 months. Mothers with affective symptoms were recruited if they had current symptoms of anxiety or depression as measured by the Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) or symptoms of PTS as measured by the PTSD Diagnostic Scale (PDS; Foa, 1995) (Appendix 5). 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.

Furthermore, an additional 8 mothers ($n = 4$ without affective symptoms, $n = 4$ with affective symptoms) are missing data from the disengagement study, as their data was excluded due to poor accuracy, and reaction times more than two standard deviations from their RT mean for the disengagement task. This means that there is only disengagement data available for $n = 43$ mothers without affective symptoms and $n = 19$ mothers with affective symptoms. Missing data was coded as such in SPSS. Demographics for mothers with disengagement data and without disengagement data were assessed for statistically significant differences using chi-squared and independent samples t-tests and no differences were found ($p > .05$).

6.3.3 Materials

Post-traumatic stress symptoms

Symptoms of post-traumatic stress were measured using the Post-traumatic stress disorder diagnostic scale (PDS) (Foa, 1995). The PDS scale is a short checklist made of 40 items, which asks participants to rate their response to a traumatic event. The scale is made up of six subscales (A: event; B: re-experiencing; C: avoidance & numbing, D: arousal, E: duration, F: significant impact/impairment) and measure the criterion set out in DSM-IV (American Psychiatric Association, 1994). The PDS had high internal consistency in this sample (Cronbach's $\alpha = 0.97$). Mothers were asked to complete the PDS with regards to their most recent birth, and separately with regards to any other traumatic events they may have experienced. Mothers were classed as having PTS symptoms if they scored more than 11 on

the PDS symptom severity. A cut off of 11 was used, as a score of 11 or more reflects moderate to severe symptoms to PTS (Foa, 1995).

Anxiety and depression symptoms

Symptoms of anxiety and depression were measured using the Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983). The HADS is designed to detect states of depression and anxiety among medical patients or clinical populations. The HADS had high internal consistency in this sample (whole scale: Cronbach's $\alpha = .89$; anxiety subscale: Cronbach's $\alpha = 0.70$; depression subscale: Cronbach's $\alpha = 0.89$). A cut-off of eight or more on either subscale of the HADS was used as inclusion criteria for the experimental group (Stern, 2014). This cut-off has good sensitivity for depression (0.77 - 1; Bjelland et al., 2002; Silverstone, 1994) and anxiety (0.64 -.94; Bjelland et al., 2002; Razavi et al., 1992).

Beliefs about infant's behaviour

This was measured using the Infant Intentionality Questionnaire (IIQ) (Feldman & Reznick, 1996). The IIQ is a 42-item questionnaire designed to measure a mother's ability to see her infant as an intentional being. Responses are on a five-point scale (from never or not at all (1) to always or definitely (5)). Scores are totalled and higher scores indicate greater perception of the infant as having their own intentions. The IIQ had high internal consistency in this sample (Cronbach's $\alpha = .87$).

Maternal perception of bond with infant

This was measured using the Postpartum Bonding Questionnaire (PBQ) (Brockington et al., 2006). The PBQ measures a mother's perception of her bond with her baby. It is made up of four subscales (General, infant rejection and pathological anger, infant-focused anxiety and incipient abuse). The mothers respond on a 6-point scale from [1] 'Always' to [6] 'Never'. The infant rejection and pathological anger and infant-focused anxiety subscales were used for this study. Seven questions make up the infant rejection and pathological anger subscale, and 13 is the cut off to indicate a dysfunctional level of rejection and anger. Internal consistency was good for this subscale (Cronbach's $\alpha = .92$). Infant-focused anxiety is made up on four questions, and 10 is the cut off for this scale (Brockington et al., 2006). Internal consistency was good for this subscale (Cronbach's $\alpha = .80$).

Maternal sensitivity

Maternal sensitivity was measured using the National Institute for Child Development Infant Interaction Tool; (NICHD Early Child Care Research Network, 1996; van Bakel et al., 2010). The NICHD infant interaction tool is an observational tool used to assess maternal sensitivity and infant behaviour during interactions. Ratings are based on video-recordings of

a mother and her infant interacting for 10-15 minutes. This tool was adapted by researchers at Tillburg University to assess parent-infant interaction for infants as young as 1 week old. The tool has scales for both parent and infant behaviour. The parent scales are rated on a four-point scale (1 = not at all characteristic to 4 = highly characteristic) and includes seven scales: 1) sensitivity to distress which focuses on how the mother responds to her infant's cries, frets or other expressions of negative affect; 2) sensitivity to non-distress which focuses on how the mother responds to her infant's social gestures, expressions and signals; 3) intrusiveness which relates to adult-centred rather than infant-centred interaction; 4) detachment which measures the mothers emotional involvement during the interaction; 5) positive regard for the infant which is shown by the mother through warm tones, affection and smiling with the infant; 6) negative regard for the infant which is shown by the mother in terms of disapproval, negative voice, harshness towards the infant; and 7) flatness of affect which measures how animated the mother is during the interaction. Based on previous work (Early et al., 2002; Hall et al., 2015) and a concept analysis of maternal sensitivity (Shin et al., 2008) it was deemed as appropriate to combine the subscales into one overall measure of maternal sensitivity. To do this, intrusiveness, flatness, detachment and negative regard for infant were reverse coded and all subscales were totalled. The overall maternal sensitivity scale had a Cronbach's alpha score of .843.

The infant scales are rated on the same four-point scale and include: 1) infant positive mood which assesses the extent to which the infant appears satisfied and content with the overall situation; 2) infant negative mood which assesses the extent to which the infant cries, fusses, frowns or seems discontent during the interaction; 3) infant activity which looks at how physically active an infant is during the interaction; and 4) infant sustained attention which assesses infants' involvement with the world, including objects and people. Ratings were made by the lead researcher for all the mothers. Based on the different behaviours measured by each of the infant scales, and a low Cronbach's alpha score ($\alpha = .389$), the infant scales were not combined.

Two raters, blind to the group status of the mothers double coded the mother-infant play videos. Both raters were trained separately. Raters were asked to read the instructions and then one video was used for training. During training the rater and the first author rated mother and infant behaviour together. One rater coded 21 videos, and the second rater coded 16 videos. These videos did not overlap. Ratings were converted to z-scores and intraclass correlations were calculated. Inter rater reliability varied depending on the scale in question rather than the rater themselves. As can be seen from Table 6-2 the most reliable scales are

sensitivity to non-distress, intrusiveness and flatness of affect for maternal behaviour and infant positive affect, infant negative affect and infant sustained attention for infant behaviour.

Table 6-2. *Inter rater reliability for mother-infant play videos*

Scale	Rater 1 (21 videos rated) ICC	Rater 2 (16 videos rated) ICC
Maternal scales		
Sensitivity to non-distress	0.90	0.98
Sensitivity to distress	0.37	0.44
Intrusiveness	0.65	0.61
Detachment	0.48	0.20
Positive regard for infant	0.51	0.39
Negative regard for infant	0.36	0.41
Flatness of affect	0.52	0.57
Total	0.54	0.51
Infant scales		
Infant positive affect	0.65	0.74
Infant negative affect	0.92	0.86
Infant activity	0.42	0.39
Infant sustained attention	0.64	0.61
Total	0.66	0.65

6.3.4 Procedure

Mothers were asked to complete questionnaires via an online survey platform, Qualtrics (Qualtrics., 2015). This survey included the PDS, HADS, IIQ, PBQ and demographic questions. Mothers were asked to leave their contact details at the end of the survey if they wanted to take part in the computer and the mother-infant interaction tasks. If participants met eligibility criteria they were invited to come to the university to take part in

the tasks. Mothers who consented completed the following tasks, each of which measured a component of the cognitive model:

Infant-related-information factor 1: Attentional biases

Selective attention. This task measured mothers' selective attention towards infant emotional expressions. Mothers were asked to view two images of infant faces for 10 seconds at a time (see Figure 6-2), whilst their eye-movements were recorded. Each trial consisted of the same infant showing different emotional expressions, and there were three trial types (Positive/Negative; Positive/Neutral; Negative/Neutral).

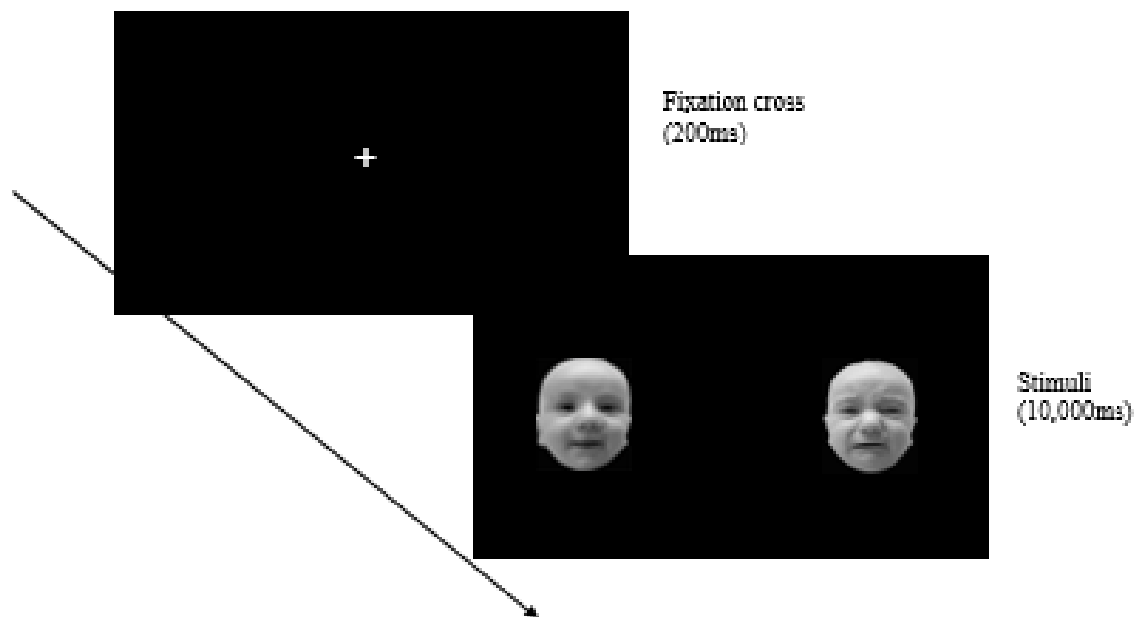


Figure 6-2. *Example trial of the mother's attention to emotional expressions task. Image not to scale.*

Disengagement. This task looked at mothers' ability to disengage away from infant emotional expressions. This was measured using a go/no-go task which required mothers to focus on a central fixation cross, which then turned red or green and an infant's face appeared behind it (see Figure 6-3). If the cross turned green (i.e. a 'go' trial) mothers were required to move their attention away from the face/fixation cross and asked to identify the vertical line which was located on one side of the screen. There were three trial types (positive, negative and neutral). All trial types appeared in the same block to prevent "pop-out" effect (Bindemann et al., 2005).

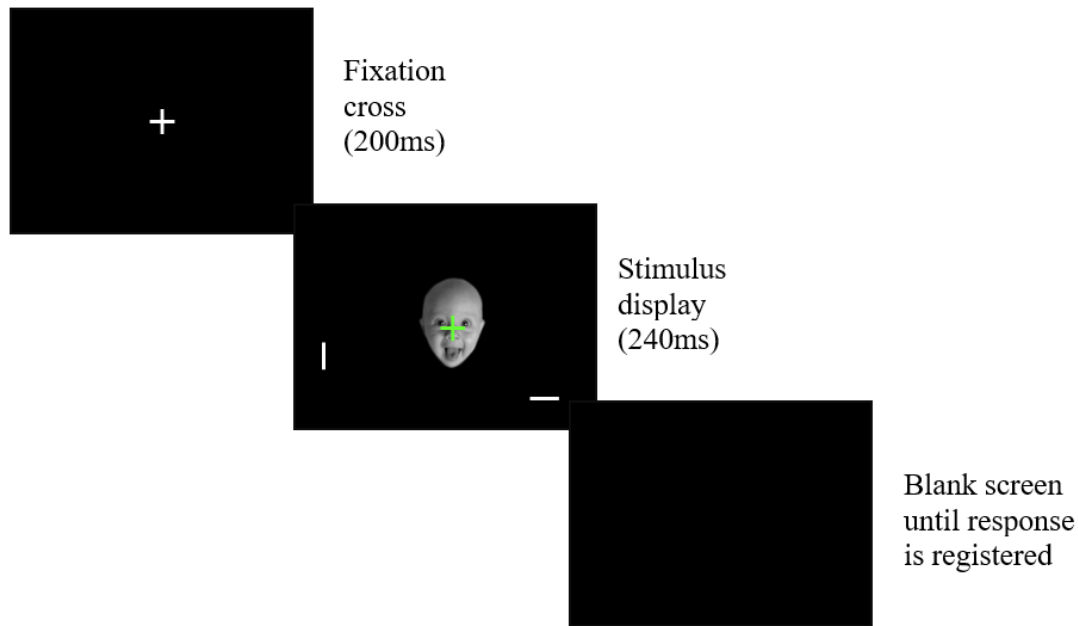


Figure 6-3. *Example of a stimulus display from a ‘go’ trial in a go/no-go task*

Infant-related-information factor 2: Perceptual processes

Categorisation of infant emotional expressions. This task required mothers to look at images of 5 different infants showing positive and negative expressions which were morphed together. Each image was created by taking a happy image of one infant, and morphing it with a sad image of the same infant. Positivity increased in increments of 11%. Mothers were asked to categorise the image as either positive or negative (examples of morphed images for one infant shown in Figure 6-4).



Figure 6-4. *Example of images used for the categorisation of infant expressions task from most positive (left) to most negative (right)*

Perceptual strategy. To measure which areas on the face mothers looked at whilst categorising emotional expressions, using eye-tracking. The time spent fixated on the eyes and the mouth were calculated.

Infant-related-information factor 3: Cognitions about infant

Maternal perception of relationship with infant. As described above mothers were asked to fill out the ‘infant-focused anxiety’ (items 19, 20, 22, 25) and ‘infant rejection and pathological anger’ (items 3, 4, 5, 11, 14, 21, 23) subscales from the PBQ. Scores for each subscale were totalled for each mother.

Maternal and infant behaviour

Maternal sensitivity. For this task, a similar procedure as the one carried out in Parfitt et al. (Parfitt et al., 2013) was used. Age appropriate toys and a baby blanket were provided. Each parent was asked to “play with their baby as they normally would, using the toys if they wish and to not worry about the camera”. The parents were also asked to speak in English. The mother and infant’s interaction was recorded for 10 minutes by a video camera in the corner of the room. The researcher was out of the room during recording. Coding of the interaction took place after the mother had finished testing.

Infant behaviour. This was measured using the same video recording described above.

Tasks were counterbalanced across participants and across groups. After all the tasks were completed mother’s travel expenses were reimbursed. Mothers were given a £25 gift voucher to thank them for taking part and a certificate for their infant.

6.3.5 Data Analysis

All outcome measures were converted into z-scores for inferential analyses. This was to allow for comparisons of variables that had different distributions. As all analyses are exploratory and the overall aim of this study was to explore the model and from this to generate hypotheses, significance values were not corrected. Raw scores are reported for descriptive statistics (e.g. means, SD).

Sample characteristics. Demographic data were normally distributed therefore standard parametric tests (t-tests; chi-squared) were used to identify any differences between groups.

Hypothesis 1: Maternal affective symptoms will be associated with lower levels of maternal sensitivity. The maternal sensitivity data were not normally distributed therefore a Mann-Whitney independent samples test was carried out with maternal affective symptoms group as the predictor variable, and maternal sensitivity as the outcome variable.

Hypothesis 2: Maternal affective symptoms will be associated with maternal processing of infant-related information, which will in turn be associated with maternal sensitivity. To test hypothesis 2, a hierarchical linear regression was run. The predictor variables were entered in two blocks 1) infant-related processing; 2) maternal affective

symptoms group. The outcome variable was maternal sensitivity. Based on the model, it was predicted that infant-related information processing would predict most of the variance of the model. The model predicts that maternal affective symptoms are the cause of these infant-related information processes, therefore it was predicted that adding the second step would not add any additional variance to the model. Firstly, diagnostics on the residuals were run and these indicated no violations of assumptions in terms of multicollinearity (VIF average = 1.44), linearity, homoscedasticity, dependence (Durbin Watson = 2.64) or outliers (only one outlier outside of 2SD from the mean). However, as expected, residuals for maternal behaviour were not normally distributed, therefore the regression was run again with bootstrapping (n = 1000 samples). Bootstrapped regressions were also run for each individual subscale of the NICHD coding tool to see if the model predicted a certain type of maternal behaviour which contributes to maternal sensitivity.

Hypothesis 3: Maternal sensitivity and infant behaviour will be associated with one another. As the maternal sensitivity data were not normally distributed Kendall's tau correlations were used to assess hypothesis 3, using the variables maternal sensitivity and infant behaviour.

Hypothesis 4: Negative affect in mothers will be associated with more researcher-rated infant negative affect. As the infant behaviour data were not normally distributed, a Mann-Whitney independent samples test was carried out, with maternal affective symptoms group as the predictor variable, and infant behaviour as the outcome variable. Non-parametric correlations were used to see if there were any relationships between specific affective symptoms (i.e. anxiety, depression, PTS) and infant behaviour.

Exploratory correlational analysis. A Kendall's tau correlational analysis was carried out on all outcome measures to see which variables within the model were associated and to identify target relationships for more detailed future experimentation.

6.4 Results

6.4.1 Sample characteristics

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).

Mothers without affective symptoms were more likely to be married or cohabiting. Furthermore, mothers without affective symptoms were more likely to report positive

feelings about their pregnancy. There were no other significant differences in demographic characteristics between the groups. As expected, the group of mothers with affective symptoms had significantly higher levels of anxiety, depression and post-traumatic stress symptoms (see Table 6-3).

Table 6-3. *Sample demographic characteristics*

	Mother's without affective symptoms n (%)	Mother's with affective symptoms n (%)	χ^2	<i>p</i>
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)		
Infant feeding choices				
Breast	28 (59.6)	13 (56.5)	2.13	.345
Mixed	9 (19.1)	4 (17.4)		
Bottle	5 (10.6)	6 (26.1)		
	M (SD)	M (SD)	<i>t</i>	<i>p</i>
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)	-6.02	<.001
Infant rejection	2.66 (2.32)	6.48 (4.01)	-4.24	<.001
Infant-focused anxiety	2.66 (1.74)	4.26 (2.85)	-2.48	.019
Infant intentionality total	130.15 (14.35)	130.26 (15.88)	-.03	.977

6.4.2 Hypothesis 1

Hypothesis 1 that maternal affective symptoms would be associated with lower levels of maternal sensitivity was confirmed. There was a significant difference in maternal sensitivity scores between women with affective symptoms and with no affective symptoms ($U = 260.5, p < .001$).

6.4.3 Hypothesis 2

Hypothesis 2, that maternal affective symptoms would be associated with maternal processing of infant-related information, which in turn would be associated with maternal sensitivity was not confirmed. Step one (maternal processing of infant-related factors) explained 16.9% of the model predicting maternal sensitivity ($p = .44$). Adding affective symptom group status to the model improved the fit and explained 31.5% of the variance ($p = .002$). Similar results were found for the NICHD subscales sensitivity to non-distress, sensitivity to distress, detachment and negative regard for the infant (see Table 6-3).

Attentional bias in terms of perceptual sensitivity when categorising infant emotions ($\beta = -.35, p = .01$) was the only significant predictor of intrusiveness. NICHD flatness of affect was predicted by first fixation to more positive faces ($\beta = -.27, p = .037$), dwell time towards more positive faces ($\beta = -.32, p = .021$) and mental state attributions IIQ ($\beta = -.27, p = .041$). None of the factors within the model predicted NICHD positive regard for infant.

Table 6-4. *Hierarchical linear regression to test hypothesis 2 of the cognitive model of maternal sensitivity*

	Maternal sensitivity	NICHD: Sensitivity to distress	NICHD: Sensitivity to non-distress	NICHD: Intrusiveness	NICHD: Detachment	NICHD: Negative regard for infant	NICHD: Flatness of affect
Variable	β	β	β	β	β	β	β
Step 1							
Attentional bias: First fixation to positive face	-.33*	-.10	-.19	.13	.11	-.03	.29
Attentional bias: Dwell time on positive face	.23	.19	-.01	.10	-.14	-.13	-.31*
Attentional bias: RT Negative to Neutral trials	-.03	.08	-.14	.22	-.20	-.08	.17
Attentional bias: RT Positive to Neutral trials	-.19	-.27	-.05	-.06	.40*	.10	-.15
Perceptual sensitivity	-.03	.22	.21	-.35*	.20	.17	.20
Perceptual bias	-.17	-.14	-.13	.12	-.12	-.10	-.06
Perceptual strategy	.16	.37	.13	.12	-.08	.07	.04
Mental state attributions: IIQ	-.06	.04	-.10	.17	.10	-.09	-.26
Mental state attributions: PBQ Anger and Rejection	-.12	-.18	.03	-.12	-.06	.03	.22
Mental state attributions: Infant- focused anxiety	.12	.20	.04	.02	.15	-.13	-.19
Step 2							

Attentional bias: First fixation to positive face	-.30*	-.11	-.15	.11	.08	-.06	.27*
Attentional bias: Dwell time on positive face	0.25	.03	-.02	.08	-.16	-.15	-.32*
Attentional bias: RT Negative to Neutral trials	-.02	.15	-.13	.21	-.21	-.09	.16
Attentional bias: RT Positive to Neutral trials	-.22	-.34	-.09	-.04	.43*	.12	-.13
Perceptual sensitivity	-.07	.08	.17	-.33*	.23	.20	.22
Perceptual bias	-.15	-.05	-.12	.11	-.13	-.12	-.07
Perceptual strategy	.17	.28	.14	.12	-.08	.06	.03
Mental state attributions: IIQ	-.05	-.01	-.09	.16	.09	-.10	-.27*
Mental state attributions: PBQ	.12	.11	.22	-.26	-.26	-.15	.07
Anger and Rejection							
Mental state attributions: PBQ	.14	.30	.06	.01	.13	-.14	-.20
Infant-focused anxiety							
Group	-.47*	-.60*	.32*	.28	.39*	.36*	.29*

Note. Maternal sensitivity $R^2 = .17$ ($p = .443$), $\Delta R^2 = .15$ ($p = .002$); NICHD sensitivity to distress $R^2 = .23$ ($p = .797$), $\Delta R^2 = .15$ ($p = .043$); NICHD sensitivity to non-distress $R^2 = .16$ ($p = .472$), $\Delta R^2 = .16$ ($p = .002$); NICHD Intrusiveness $R^2 = .26$ ($p = .105$), $\Delta R^2 = .05$ ($p = .063$); NICHD Detachment $R^2 = .16$ ($p = .49$), $\Delta R^2 = .10$ ($p = .013$); NICHD Negative regard for infant $R^2 = .09$ ($p = .876$), $\Delta R^2 = .09$ ($p = .027$); NICHD Flatness of Affect $R^2 = .26$ ($p = .085$), $\Delta R^2 = .06$ ($p = .052$)

* $p < .05$

Table 6-5. *Relationship between maternal affective symptoms, maternal behaviour and infant behaviour*

	PTS symptoms	Anxiety symptoms	Depression symptoms	Perceptual sensitivity	NICHD: Maternal sensitivity to distress	NICHD: Maternal sensitivity to non- distress	NICHD: Intrusiveness	NIDCH: Detachment	NICHD: Pos regard for infant	Maternal sensitivity total
NICHD Infant Activity	.1	.02	.02	-.01	-.3	-.31	.3	.05	-.33	-.25
NICHD Infant sustained attention	-.24	-.14	-.06	.17	.52**	.69**	-.39*	-.51**	.48**	.6**
NICHD Infant positive mood	-.31*	-.27	-.16	.23	.43**	.2	-.02	-.32	.45*	.37*
NICHD Infant negative mood	.33*	.35*	.43**	-.33*	-.4*	-.17	.03	.19	-.22	-.17

Note. * = <.05; ** = <.01

6.4.4 Hypothesis 3

Hypothesis 3, that maternal sensitivity and infant behaviour would be associated with one another was supported. The Kendall's tau analysis showed that maternal sensitivity and infant behaviour were significantly related (see Table 6-4).

6.4.5 Hypothesis 4

Hypothesis 4, that negative affect in mothers would be associated with more infant negative affect was partially supported: group was not associated with infant behaviour ($p = .129$). However, when looking at specific symptoms, PTS, anxiety and depression symptoms were all positively correlated with infant negative mood (see Table 6-4).

6.4.6 Exploratory correlational analysis

Exploratory correlational analyses revealed that certain infant-related-information processing factors were associated with affective symptoms. For example, infant-focused anxiety and infant-related anger and rejection were positively associated with PTS, anxiety and depressive symptoms. Furthermore, accuracy sensitivity when categorising infant emotional expressions was negatively associated with anxiety and depressive symptoms (see Table 6-5).

Two infant-related processing factors within the model were associated with maternal behaviour. Infant intentionality scores were related to NICHD intrusiveness ($r_T = .33, p = .026$). PBQ infant-focused anxiety was related to NICHD negative regard for infant ($r_T = -.378, p = .018$).

Specific infant-related information processing factors were also associated with infant behaviour, for example sensitivity when categorising infant emotional expressions was associated with infant negative mood ($r_T = -.33, p = .025$).

Table 6-6. *Results of exploratory correlation analysis*

	PTS	Anxiety	Depression
Infant focused anxiety	.31*	.36**	.39**
Infant-related anger and rejection	.53***	.47***	.35*
Accuracy sensitivity when categorising infant emotional expressions	-.15	-.35**	-.30*

Note. * = $<.05$; ** = $<.01$; *** = $<.001$

6.5 Discussion

In this study a preliminary test of a model of maternal sensitivity was carried out to explore its validity. The results suggest that some aspects of the model are supported by research, whereas other aspects need further development.

Hypothesis 1, that maternal affective symptoms would be associated with lower levels of maternal sensitivity was supported. Group predicted negative regard towards the infant, and less maternal sensitivity to infant distress and non-distress. These results are consistent with earlier maternal sensitivity research which has found that mothers with postnatal affective disorders show less sensitivity when interacting with their infants (Feldman et al., 1997; Ionio & Di Blasio, 2014; Murray et al., 1996).

Hypothesis 2, that maternal affective symptoms would be associated with maternal processing of infant-related information, which would in turn be associated with maternal sensitivity was partially supported. Maternal affective symptoms and specific infant-related processing factors were associated with maternal sensitivity in 3 cases. Firstly, results suggest that if mothers are in the affective symptoms group and fixate first on more positive images in the attentional bias task, then they show less overall maternal sensitivity. Secondly, results suggest that if mothers are in the affective symptoms group, and look away faster from more positive images in the disengagement task, then they show more detachment. Thirdly, results suggest that mothers if mothers are in the affective symptoms group, fixate first on more positive faces, spend less time looking at positive faces and see their infant as being less intentional then they show more flatness of affect. This suggests that mothers with affective symptoms tend to look first at positive faces, but then disengage faster from them. This could mean that mothers may miss other infant emotional expressions (such as sadness) leading them to show less sensitivity overall. Their faster disengagement may also mean that they do not fully process positive emotions leading them not experience their infant as particularly positive, therefore showing detachment and flatness of affect during interactions.

These results suggest that affective symptoms, attentional biases towards positive infant faces and infant intentionality beliefs can influence maternal sensitivity and have potential implications if they can be replicated. For example, treatments that target particular attentional biases, such as attentional bias modification (Carnegie et al., 2016) can be tested specifically for its role in improving maternal sensitivity.

Certain types infant-related information processing, not related to maternal affective symptoms, were associated with maternal sensitivity. For example, the exploratory

correlations suggest that as infant focused anxiety increases, negative regard for the infant decreases. A mother who feels anxious about her ability to care for her baby may spend more time reflecting on this ability and coming up with solutions for this. The lack of negative regard may therefore be a reflection of this as the mother is more aware of the impact her actions can have on her infant, however, this idea needs to be researched.

Intrusiveness was predicted by perceptual sensitivity and correlated with a mother's score on the IIQ. The results suggest that the better mothers were at categorising emotions, the less intrusive they were. It could be that difficulty recognising emotions may lead to intrusiveness because a mother may over exaggerate her facial expressions in order to get her baby to mimic an over exaggerated expression back. Mothers may therefore need an infant to show an extremely positive/negative facial expression for it to be categorised as such. On the other hand, the results suggest that the higher a mother scored on the IIQ the more intrusive she was. This finding was not expected because research has found that mothers who see their infant as an intentional being are more likely to display maternal sensitivity when interacting with their infant (Feldman & Reznick, 1996). However, it could be suggested that mothers scoring particularly high on infant intentionality may want to help their infants achieve their goals more than mothers with moderate or low infant intentionality. Mothers scoring highly may therefore overcompensate and try to help their infant too much, thus leading to higher intrusiveness scores, but more research is needed.

Hypothesis 3 that maternal sensitivity and infant behaviour would be associated with one another was supported. This is consistent with the dyadic systems approach to mother-infant interaction. One aspect of this approach is that both the infant and the mother contribute to the interaction. Beebe et al. (2010) explains that interaction is 'bi-directional' in that both partners actively contribute to the exchange. Research has found that infant behaviour influences maternal behaviour. For example, Van Egeren et al. (2001) found that when infants were exploring objects their mothers decreased their responsiveness, suggesting mothers may try to avoid distracting their infant, perhaps to facilitate the infant's learning. Furthermore, a study carried out in 11 countries (Argentina, Belgium, Brazil, Cameroon, France, Israel, Italy, Japan, Kenya, South Korea, and the United States) found that when infants vocalised, mothers nearly always spoke to their infants in response (Bornstein, Putnick, Cote, Haynes, & Suwalsky, 2015). This research demonstrates that way in which maternal and infant behaviour interact with one another.

Hypothesis 4 that negative affect in mothers would be associated with more researcher-rated infant negative affect was partially supported. While group status itself was

not associated with infant behaviour, maternal symptoms of anxiety, depression and PTS were positively associated with more negative affect in the infant. This finding is consistent with research that has found mothers with postnatal affective disorders are more likely to experience their infant as having a more difficult temperament (Davies et al., 2008; Martini et al., 2017; McGrath et al., 2008; Radesky et al., 2013). It is not clear why maternal affective disorders have been found to be associated with infant temperament. It is possible that mothers with postnatal affective disorders rate their infant's temperament as being more negative because of their symptoms. However, in this study infant affect was not rated by mothers but measured by observer ratings. Therefore, more research is needed to investigate the reasons behind infant negative affect and temperament associated with maternal affective disorders.

This study is the first to develop and test the proposed cognitive model of maternal sensitivity and while some hypotheses were supported, others need more development. Some of the infant related information factors in the model explain some types of maternal sensitivity whereas others were of no explanatory value. For example, it is still unclear what the underlying mechanisms between maternal affective symptoms and sensitivity to distress, and sensitivity to non-distress are. Furthermore, many of the infant-related information factors predicted to be the underlying mechanism between affective symptoms and maternal sensitivity, such as perceptual bias, perceptual strategy and infant-related anger and rejection did not explain the relationship.

Based on the results the model can be further developed and refined. One potential way of developing the model would be to focus on identifying the mechanisms underlying the relationship between maternal affective symptoms and sensitivity to distress and non-distress. On the other hand, further development of the model could focus on identifying underlying mechanisms for maternal sensitivity that are not associated with maternal affective symptoms, such as the finding that accuracy of emotional categorisation predicted intrusiveness. There are a range of potential underlying mechanisms not included in this model that future research could focus on such as attributions, mind-mindedness, reflective functioning (Bateman & Fonagy, 2006; Fonagy et al., 1998; Lieberman, 1999; Meins et al., 2001; Schechter et al., 2006; Sharp et al., 2009), as well as baby schema, which refers to the facial structure which all infants have, including a high, slightly bulging forehead, large eyes, and rounded cheeks (Lorenz, 1943). Research suggesting that baby faces with a higher level of baby schema elicit a strong desire for caring (Brosch, Sander, & Scherer, 2007) suggests that this could be an underlying mechanism for maternal sensitivity.

Another potential development of the model would be to focus on its replicability in its current form, but in a different population. For example, this study recruited mothers with affective symptoms whereas previous research finding associations between affective disorders and cognitive biases recruited mothers with diagnosed mental health problems (Arteche et al., 2011; Flanagan et al., 2011; Pearson et al., 2010; Stein et al., 2010). It is possible that different results may have been found in mothers with diagnoses rather than symptom. Furthermore, this study recruited a large proportion of mothers with comorbid symptoms (65.22%), and it is possible that comorbidity may obscure biases. For example, a bias observed in depressed mothers may be obscured if the woman also has anxiety and there is some support for this from previous research (Grant & Beck, 2006; Mogg et al., 2000). Therefore, it is possible that the high level of comorbid symptoms within this study sample influenced the results. Future research could therefore focus on individual diagnoses or symptom groups, as well as co-morbid diagnoses. Researchers could also consider replicating this model with fathers to identify whether the underlying mechanisms between affective symptoms and parental sensitivity are similar in mothers and fathers.

The results from this study should be interpreted with caution due to some limitations. First, maternal sensitivity was assessed by a researcher who knew which group the mothers were assigned to. Although a second and third observer rated the observations blind to the group of the mothers, inter-rater reliability was only acceptable overall and some scales were more reliable than others, so there may be some bias in the outcome rating. It is therefore important to note that these results may not have been replicated if another scale of maternal sensitivity was used. Future research should focus on replicating this model with a more reliable scale of maternal sensitivity and infant behaviour. Second, it is possible that the measurement of maternal sensitivity may have influenced the results. Although every effort was taken to make the task feel as naturalistic as possible to the mothers, research has demonstrated that when people think they are being watched they act in a more pro-social way (Bateson, Nettle, & Roberts, 2006; Ekström, 2012; Ernest-Jones, Nettle, & Bateson, 2011). Therefore, the recordings of mother-infant interaction may have been affected by this, and it is possible that the mothers may interact with their infant in a different way when not being recorded. Third, there are statistical issues which make conclusions difficult to draw. The sample size for this study was small so analyses may have been under-powered, and the generalisability of results is reduced. Furthermore, exploratory correlational tests are likely to have led to high false positive rates, and as corrections were not applied results from these correlations need to be interpreted with caution.

Overall, a preliminary analysis of the proposed model of maternal sensitivity was carried out on a group of women with and without affective symptoms. Hypotheses 1, 3 and 4 were supported, however hypothesis 2 needs more development. Affective symptoms, first fixation to positive images, disengagement from positive images and infant intentionality predict overall maternal sensitivity, detachment and flatness of affect. However, it is still not clear what the underlying mechanisms are for the other subscales of maternal sensitivity. This study was a preliminary test, and had some methodological limitations, therefore future research should focus on developing the model further in order to provide a fully comprehensive understanding of the mechanisms underlying maternal affective symptoms and maternal sensitivity.

7 Chapter Seven: Discussion

7.1 Overview of thesis

Previous research has found that women with postnatal affective symptoms display less maternal sensitivity when interacting with their infant and cognitive experimental research has found that women with perinatal affective symptoms are faster to look away from infant distressed faces, and are more accurate at categorising infant negative emotions, such as sadness. This research informed the development of a cognitive model of maternal sensitivity. The aim of this thesis was to test this cognitive model of maternal sensitivity using a range of experimental, observational and questionnaire studies. This thesis therefore reported a series of studies that investigated whether maternal sensitivity was influenced by infant-related information processing factors.

Chapter 1 introduced the topic of maternal mental health and outlined the model that this thesis developed and tested. The model proposed that postnatal mental health difficulties would be associated with maternal sensitivity, and this relationship would be partially explained by maternal processing of infant-related information. Chapter 2 provided a synthesis of the literature on infant-related information processing in women with perinatal anxiety, depression and/or PTSD. Chapter 3 developed and validated stimuli to allow the proposed model to be tested, and the research study reported in chapters 4, 5 and 6 tested the model. The first section of this chapter provides a summary of the findings, explaining how they link together in the context of the overall aim of the thesis, as well as how the findings fit with the previous literature. The second section examines methodological strengths and limitations. The third section considers overall implications of these studies and identifies future investigations. The chapter ends with overall conclusions.

7.2 Summary of findings

This section provides a summary of the combined findings of the articles in this thesis and looks at the main themes.

7.2.1 Summary of the combined findings

The work of the thesis started with a systematic review of the current research on infant-related processing in women with perinatal mental health difficulties (Article 1). This systematic review included 14 studies and aimed to identify any patterns present in women when processing infant-related information. The review identified patterns in interpretation of emotion, and attentional biases when processing emotion in both the antenatal and postnatal period. Ten studies investigated interpretation of emotion and these studies suggested that women with depression or symptoms of anxiety have different levels of accuracy when

identifying emotions compared to controls. Women with depression or anxiety symptoms appear to be biased towards identifying negative emotional expressions in infant faces. These biases only appeared when women were observing infant stimuli and did not appear when women were interpreting adult faces. With regards to identifying positive emotions, the results were less clear. Three studies found that anxiety and depression had no impact on identifying positive emotions. However, one study found that women with depression were less accurate at identifying happiness in infant faces, and two studies found a trend for individuals with anxiety to show the same pattern, although this did not reach significance.

Only two studies looked at the impact of PTSD on interpreting infant emotions. Each study looked at PTSD caused by different traumas (betrayal in adulthood, interrogations or witnessing violence; war-related illness), and each found different patterns when women were interpreting infant emotions. For example, women who had experienced betrayal in childhood were less likely to label faces as sad, women who had experienced interrogation or witnessed violence were less likely to label faces as passive, and women who had been wounded, or had a war-related illness were more likely to label faces as fearful. These results could suggest that the type of trauma exposure may influence emotional perception.

With regards to attentional bias paradigms, two studies measured mothers' ability to disengage from infant emotional expressions, and found that women with depression were faster to disengage from a negative infant face than women without depression. Another two studies looked at mothers' task-related interference, and found that pregnant women with distress were faster at identifying fearful adult faces than controls, and women with high levels of parenting stress were faster at identifying a target infant face. These results suggest that when individuals are presented with emotional faces, perinatal mental health difficulties can reduce task interference and therefore speed up reaction time for certain stimuli.

Overall, the results from the review suggested that perinatal anxiety, depression and PTSD are associated with cognitive biases when recognising and processing infant emotional expressions. The review suggested that these biases in interpreting and processing infant emotional expressions could influence a mother's sensitivity when she is interacting with her baby. For example, the review suggested that mothers with depression are more likely to perceive negativity in infant faces, therefore women with depression may be more likely to recognise and respond to their baby's negative emotions leading them to act in an emotionally concordant way.

The results from Article 1 informed the development of the cognitive model. However, to test the model, validated stimuli of infant faces were needed. Therefore, Article

2 developed and validated a database of infant faces. The infant face database was created by asking parents to send photographs of their infants showing positive, negative and neutral expressions. The database was validated by asking midwives, neonatal nurses and members of the public to rate the images. The final database consisted of 154 portrait images of infants; 60 positive images, 54 negative images and 40 neutral images. Images were of 35 girls and 33 boys, all aged from 0-12 months. The majority of the infants included in the database were Caucasian ($n = 63$). The database was found to have excellent face validity, good criterion validity and good test-retest reliability. However, neonatal nurses rated the images as being less genuine and more positive, therefore it was concluded that the images should be used with caution in individuals who are exposed to high levels of negative infant emotion.

Once stimuli were available, the cognitive model was tested using a series of tasks completed by women with ($n = 23$) and without ($n = 47$) affective symptoms after birth (Articles 3-5). Article 3 investigated whether mothers with postnatal symptoms of anxiety, depression and/or PTS showed attentional (through disengagement from infant emotion) or perceptual (categorisation of infant faces) biases when viewing infant faces. The findings were inconsistent with previous research, in that perceptual and attentional biases were not found. It is possible that no relationship was found because the sample differed from previous studies. For example, the research in this thesis focused solely on the postnatal period, whereas other papers have focused on the perinatal period as a whole. This is potentially an important distinction to make because research has found that during pregnancy and after birth the brain changes its structure (Hoekzema et al., 2017), therefore cognitive biases may be different in the antenatal period in comparison to the postnatal period, regardless of mental health status. However, research is needed to test this.

Secondly, the sample included in this thesis were mothers with symptoms rather than diagnoses of anxiety, depression and PTS. This article did find a negative relationship between anxiety symptoms and sensitivity to identifying positive faces. Although this relationship was not significant, it did have a medium effect size, therefore it could be suggested that biases may only be observed in clinically significant populations as it is likely that those who have a formal diagnosis are likely to have stronger symptoms, and therefore show more cognitive biases in experiments. However more research would be needed to test this. Another way that the sample in this thesis differed from previous research is the high level of individuals with a mixture of symptoms within this sample. Around 65% of mothers in the affective symptoms group had a mixture of anxiety, depression and/or PTS symptoms.

It is possible that comorbidity may obscure biases i.e., a bias observed in depressed women may be countered if the woman also has anxiety. Therefore, comorbidity could have played a part in the results of this study, however again, more research is needed.

Article 4 looked at mothers' perceptual strategies when categorising infants' emotional expressions, and mothers' selective attention towards infants' emotional expressions through the use of eye-tracking. The article found that in a selective attention task mothers with affective symptoms fixate first on neutral images when presented with a choice of negative and neutral faces. This finding could suggest mothers with affective symptoms have a bias away from more negative stimuli, which is in line with research carried out on the non-perinatal population (Gamble & Rapee, 2010; Koster et al., 2006; Wald et al., 2010). However, if this was the case it would be expected for mothers to focus first on the positive image in positive negative trials, which was not found. Therefore, more research is needed to investigate the reasons behind this pattern. In contrast, there were no differences in perceptual strategy when categorising infants' emotional expressions between mothers with and without mental health difficulties.

The final article (Article 5) evaluated the cognitive model of maternal sensitivity described at the beginning of this thesis. This study found that mothers' affective symptoms were associated with maternal sensitivity. This finding is in line with Hypothesis 1 of the model, that maternal affective symptoms would be associated with lower levels of maternal sensitivity. The second hypothesis of the model, that maternal affective symptoms would be associated with maternal processing of infant related information, which in turn would be associated with maternal sensitivity, was partially supported. Maternal affective symptoms and specific infant-related processing factors were associated with maternal sensitivity in 3 cases. Firstly, results suggest that if mothers are in the affective symptoms group and fixate first on more positive images in the attentional bias task, then they show less overall maternal sensitivity. Secondly, results suggest that if mothers are in the affective symptoms group, and look away faster from more positive images in the disengagement task, then they show more detachment. Thirdly, results suggest that if mothers are in the affective symptoms group, fixate first on more positive faces, spend less time looking at positive faces and see their infant as being less intentional then they show more flatness of affect. This suggests that mothers with affective symptoms tend to look first at positive faces, but then disengage faster from them. This could mean that mothers miss other infant emotional expressions (such as sadness) leading them to show less sensitivity overall. Their faster disengagement may also mean that they do not fully process positive emotions leading them not experience their infant

as particularly positive, therefore showing detachment and flatness of affect during interactions.

Additionally, certain types infant-related information processing, not related to maternal affective symptoms, was associated with maternal sensitivity. For example, the exploratory correlations suggest that as infant focused anxiety increases, negative regard for the infant decreases. Furthermore, intrusiveness was predicted by perceptual sensitivity and correlated with a mother's score on the IIQ.

Hypothesis three was supported, in that maternal sensitivity and infant behaviour were associated with one another. Hypothesis four was partially supported in that symptoms of anxiety, depression and PTS were associated with greater observer ratings of infant negative affect, however affective symptoms group status was not.

7.2.2 Main themes

This section discusses the main themes that have emerged from the work in this thesis. These are: maternal mental health and infant-related information processing; infant-related information processing and maternal sensitivity; the interplay between attentional and perceptual factors in maternal sensitivity; and infant behaviour.

Maternal mental health and infant-related information processing

The first theme from this thesis relates to the null findings for some of the hypotheses presented throughout this thesis. For example, there was no support for the hypothesis that mothers with affective symptoms would disengage faster from negative infant faces and would be less accurate when categorising infant faces compared to mothers without affective symptoms in Article 3. Additionally, there was no support for the hypothesis that mothers with affective symptoms would fixate first on more negative images compared to mothers without affective symptoms in Article 4. Further, there was only partial support for hypothesis 2 of the cognitive model of maternal sensitivity presented in Article 5. There are a wide range of potential explanations for this, but one that has been discussed throughout this thesis relates to the sample recruited and their symptom presentation. Another potential explanation is the methodological approach taken when carrying out this research.

7.2.2.1.1 Symptoms vs diagnoses

The results from this thesis suggest that maternal symptoms of anxiety, depression and PTS are not associated with infant-related information processing in terms of categorising infant emotional expressions, perceptual strategy when categorising these emotions, disengaging from infant emotional expressions, dwell time when viewing infant faces, and perception of infants' intentionality. These results are inconsistent with the

previous literature and with the hypotheses of the thesis. One theme that has been discussed in Articles 3, 4 and 5, is that the way women were identified for this study may have influenced the results.

First, this thesis recruited a low proportion of women with symptoms of depression only and previous research suggests that depression was most associated with attentional biases when disengaging from infant emotional expressions (Pearson et al., 2010; Pearson et al., 2013) and categorizing infant emotional expressions (Arteche et al., 2011; Flanagan et al., 2011; Stein et al., 2010).

Second, the current results differ from earlier reports because women were included based on their symptoms of anxiety, depression and PTS and the sample was not restricted to formally diagnosed women. Previous research that found an association between depression and disengagement from, and categorisation of, infant emotional expressions used diagnostic measures to identify individuals with diagnoses rather than symptoms. This suggestion fits with the finding in Article 3 that as anxiety levels increased, there was a trend for sensitivity in identifying positivity in faces to decrease. Other research also supports this. For example, previous research has found that scores on the PBQ are associated with maternal sensitivity in mothers with depression admitted to the mother-baby unit (Noorlander, Bergink, & Van Den Berg, 2008) and mothers with depression and PTSD with a history of child abuse and neglect (Muzik et al., 2013). However, Edhborg, Hogg, Nasreen, and Kabir (2013) found that postnatal depressive symptoms (not diagnoses) were associated with PBQ scores but not maternal sensitivity. Therefore, symptom severity may need to be particularly high in order for a relationship between affective symptoms, infant-related processing and maternal sensitivity to be found.

Third, the sample in this thesis had a high proportion of women with comorbid anxiety, depression and/or PTS (65.22%) and all scores correlated with one another. Therefore, it could be suggested that comorbid symptoms may obscure biases associated with particular mental health conditions. There is some support for this, for example Grant and Beck (2006) found that individuals with comorbid depression and social anxiety disorder did not display an attentional bias to social threat words, whereas those with only social anxiety did. Therefore, it is possible that the high level of comorbid symptoms within this thesis influenced the results.

7.2.2.1.2 Methodological differences

There were some methodological differences between this study and previous studies that informed the work in this thesis. Article 3 aimed to investigate whether postnatal

symptoms of anxiety, depression and post-traumatic stress (affective symptoms) influenced attentional capture of infant emotional expressions, and replicated the method of Pearson et al. (2010; 2013). However, as described above, the hypotheses based on Pearson's studies were not supported. The differences in stimuli used across the studies could explain this. Pearson et al. (2010; 2013) used their own stimuli which they sourced from the internet and had very high agreement ratings (between 95% and 100%). For this study, both City Infant Faces and Pearson images were used. When validating the City Infant Faces database (Article 2), there were some differences between these images and Pearson's images which could have influenced the results. For example, Pearson's images were rated as being more intense and clearer, especially the negative images. On the other hand, the positive images from the City Infant Face database were rated as being more genuine. It could therefore be suggested that images need to be particularly clear and intense for any differences in disengagement time to be found. There is some evidence to support this. For example, Kousta, Vinson, and Vigliocco (2009) asked participants to identify whether strings of letters were words or non-words. Results showed that faster responses were given for negative and positive words, compared to neutral words. This suggests that emotional stimuli appear to have a preferential advantage over processing than neutral stimuli. Therefore, perhaps the more emotional stimuli is, the easier it is to be categorised as being emotional rather than neutral, and therefore be processed as such.

Article 3 also aimed to investigate whether postnatal symptoms of anxiety, depression and post-traumatic stress (affective symptoms) influenced the accuracy of emotional categorisation and replicated Arteché et al. (2011)'s study, in that morphed faces were used. However, the images were morphed at different increments across the studies. Arteché et al. (2011) morphed their images at increments of 2%, and they repeated 20 of their images, whereas the images in this thesis were morphed at increments of 11% and were not repeated. This therefore makes the results from the two studies difficult to compare. Mothers would have to show a much higher level of sensitivity when categorising faces which are morphed at such small increments as in Arteché et al. (2011), potentially making the task more difficult. On the other hand, the repetition of 20 images, and the similarity of the images may have led to practice effects and could therefore have made the task easier. This could potentially explain why mothers with anxiety identified happiness at a lower intensity than controls in Arteché et al. (2011). However, research would be needed to test this.

Infant-related information processing and maternal sensitivity

Article 5 found that the relationship between maternal mental health and maternal sensitivity was not completely explained by infant-related information processing. This goes against hypothesis 2 for the model that maternal affective symptoms would be associated with maternal processing of infant-related information, which in turn would be associated with maternal sensitivity. Despite this, the results from this thesis suggest that infant-related information processing factors, not associated with postnatal affective symptoms, may be related with certain types of maternal sensitivity. For example, the higher a mothers' perception of infant intentionality the higher her intrusiveness, and the more anxious a mother felt towards her baby the less negative regard she showed.

These findings suggest that in some cases the way mothers' process infant-related information, regardless of mental health difficulties, may influence their maternal sensitivity. Previous research has found that the way mothers process information about parenting and infant distress is associated with maternal sensitivity. For example, Kiang, Moreno, and Robinson (2004) found that maternal negative preconceptions about parenting were associated with more negative ratings of their infant and less maternal sensitivity at age 12-15 months. With regards to processing emotion, Leerkes (2010) asked pregnant women to view videos of infants' showing fear, and anger at a range of different intensities and rate the intensity of the distress. Mothers were then observed interacting with their infant six months after birth. Mothers who were more accurate at identifying distress and rated it as higher valence showed more maternal sensitivity. Furthermore, research has found that mothers' brain activation to their own infant's cry is positively correlated with greater maternal sensitivity (Kim et al., 2011; Musser, Kaiser-Laurent, & Ablow, 2012). This research, and the results from this thesis, suggest that specific infant-related information processing may be influential in predicting certain types of maternal sensitivity. However, more research is needed to confirm this.

The interplay between attentional and perceptual factors in maternal sensitivity

The results from Article 5 suggest that mothers with affective symptoms have facilitated attention to, and disengagement from more positive infant emotional expressions. The reasons for this facilitated attention to more positive infant faces in mothers with affective systems may be explained by Ohman's feature detection model (Öhman, 2000). This theory suggests that biologically prepared or high intensity stimuli (such as an infant face) will lead to facilitated attentional allocation without any conscious awareness. Research supports this theory. For example, people will show physiological responses to emotional

faces such as fear even when these images are not consciously visible (Öhman, 2002). It could therefore be suggested that positive infant faces trigger a direct unconscious and facilitated attentional allocation towards them. This may be particularly heightened in mothers with affective symptoms such as anxiety because people with affective symptoms are unconsciously primed to orient towards certain emotional cues (Posner, 1990).

The subsequent disengagement shown by mothers with affective symptoms could be reflective of a disrupted reward system which has been found in people with depression. For example, eye tracking research suggests people with depression tend to spend more time than controls focused on negative scenes (Caseras, Garner, Bradley, & Mogg, 2007). Further behavioural evidence for a disrupted reward system in people with depression is an increased disruption to performance on a cognitive task after negative feedback (Martin-Soelch, 2009) and increased recognition of and attentional bias towards negative facial expressions and words (Joormann & Gotlib, 2010; Kellough, Beevers, Ellis, & Wells, 2008). Research investigating neural responses in depression also suggest a disrupted reward system. For example, people with depression show reduced activation of the nucleus accumbens (a region that plays a central role in the reward circuit) towards their favourite music compared to non-depressed individuals (Osuch et al., 2009). Furthermore, in an EEG study, individuals were asked to anticipate winning money in a slot machine game. Depressed individuals did not show an increase in left pre-frontal cortex activity that was seen in non-depressed controls (Shankman, Klein, Tenke, & Bruder, 2007). This suggests a deficit in reward anticipation (Shankman et al., 2013). As previous research has found that smiling infant faces trigger reward systems in the brain (Strathearn et al., 2008) it could be suggested that mothers with affective symptoms disengage faster from infant faces because of a disrupted reward system.

This theory and research suggest that it is possible to be both unconsciously drawn to certain stimuli, but also unconsciously disengage from it showing how both attention and perception are linked. The link between unconscious biases such as attention and perception are also likely to influence a mother's feelings about her infant and her behaviour towards her infant. This interplay can be demonstrated using the results from Article 5. For example, the results suggest that first fixation to but faster disengagement from positive faces, and a lower score on the IIQ were associated with more maternal flatness of affect.

A mother that notices her infant's emotions, does not disengage and then accurately interprets them is likely to see her baby as showing a range of different emotional expressions. This may lead her to see her infant as an intentional being because she processes the range of emotions her infant displays and then responds appropriately meaning the

infant's emotion is either changed (i.e. sad to happy through maternal comfort) or reinforced (happy remains happy through maternal positive attention). On the other hand, a mother who attends to positivity but then looks away from it is able to identify her infant as showing an emotional expression but is not then able to categorise it effectively. Without being able to categorise it effectively, a mother cannot respond appropriately meaning a mother may eventually see her baby as showing many different emotions but with no real intention. This may lead mothers to feeling despondent in their responding to their infant hence showing flatness of affect.

Infant behaviour

Article 5 found that infant behaviour was associated with maternal sensitivity, and maternal symptoms of anxiety, depression and PTS. Previous studies have also found that maternal sensitivity and infant behaviour are related to one another (Bornstein et al., 2015; Van Egeren et al., 2001).

Maternal symptoms of anxiety, depression and PTS were associated with infant negative affect, which is in line with previous research. Infant negative affect was rated by the researcher and is therefore arguably more objective than self-report data used in previous studies. For example, research has found that mothers with mental health difficulties will often rate their infants as having a more difficult temperament (Davies et al., 2008; Martini et al., 2017; McGrath et al., 2008; Radesky et al., 2013). The use of maternal reports of infant temperament has been criticized by some authors, and studies have found that individual differences can influence mothers' perception of their infant's temperament. For example, Bates, Freeland, and Lounsbury (1979) found that more extroverted mothers would rate their babies more positively than less extraverted mothers. Furthermore, Vaughn, Bradley, Joffe, and Seiffer (1987) found that 4-6 month old infants who were rated as more difficult were more likely to have mothers who were anxious, had lower self-esteem, were more defensive and impulsive.

It could be argued that mothers with postnatal mental health difficulties perceive their infant as being more difficult in temperament because of their mental-health-related cognitions. For example, depression is associated with feelings of being unable to cope (American Psychiatric Association, 2013), which could arguably lead to a mother finding her infant more difficult to soothe or comfort, because everything feels difficult. However, the results from Article 5 suggest that other factors may be at play. The foetal programming hypothesis posits that the *in-utero* environment can have long term effects on a person's physiological systems that could affect both their health and behaviour (Pesonen et al., 2006),

and could potentially explain the maternal mental health and infant temperament relationship. For example, Davis et al. (2007) found that maternal cortisol at 30-32 weeks gestation, and prenatal anxiety and depression was associated with maternal reported infant negative temperament. Furthermore, Werner et al. (2007) found that an antenatal psychiatric diagnosis was associated with infants who cried more and who were more difficult to settle.

An alternative explanation for the relationship between maternal mental health and infant temperament is the dyadic systems approach, which argues that both maternal and infant behaviour influence one another. For example, many studies have found a relationship between maternal sensitivity, and infant temperament (Kivijarvi, Raiha, Kaljonen, Tamminen, & Piha, 2005; Mills-Koonce et al., 2007; Seifer, Schiller, Sameroff, Resnick, & Riordan, 1996). Sensitive caregiving may lead to a relaxed happy infant, which means the mother finds it easier to be relaxed and happy and displays more sensitivity and the cycle continues. Alternatively, an infant with a difficult temperament, may lead to a mother feeling stressed or anxious when caring for her infant, leading to less sensitive responses which could lead to the infant showing more distress.

However, Kaplan, Evans, and Monk (2008) provided evidence to suggest that infant behaviour may be a result of both in utero exposure and interactions with the social world. For example, they found that if a mother had an antenatal psychiatric diagnosis and displayed poor maternal sensitivity their infant would have higher levels of cortisol. On the other hand, if mothers had an antenatal psychiatric diagnosis and displayed high maternal sensitivity their infant would have lower levels of cortisol.

These results from these studies combined suggests that infant temperament is likely to be caused by a range of factors, including the *in-utero* environment, maternal mental health status and maternal sensitivity.

7.3 Strengths and limitations

The strengths and limitations of the individual articles in the thesis have been considered in each article (1-5). This section gives an overview of some important methodological considerations. The section starts with a summary of the methodological strengths of the studies before considering the most important limitations.

7.3.1 Strengths

Strengths of each article have been discussed in each chapter. This section presents a selection of merits, including formulating and testing an evidence-based cognitive model, and the use of eye-tracking methodology.

Formulating and testing an evidence-based model

The cognitive model was informed by a systematic review of the literature and by previous research carried out on maternal affective symptoms, maternal sensitivity, infant behaviour, and maternal processing of infant-related information. The model was therefore grounded in research. Only outcomes relevant to the model were measured, and therefore the justification for using each of these measures was clear. This is a methodological strength because it means that data mining was avoided.

The development of a model is useful for researchers because it means that each individual aspect can be explored and tested by researchers. It gives researchers a basis for exploring relationships and patterns between variables, to give an explanation for a certain phenomenon or behaviour.

The development of this specific model means that aspects of the model that have preliminary support can be further explored, and aspects that have no support can be redeveloped based on other theory and research. This means that more can be found out about the relationship between postnatal mental health difficulties and maternal sensitivity.

Eye-tracking

This is the first study that has used eye-tracking to assess attentional biases in the perinatal period in women with mental health difficulties. This study therefore provides a novel contribution to the literature. The successful use of eye-tracking in this study suggests this is a method that can be applied to more research conducted in the perinatal period. Eye-tracking is arguably a more naturalistic reflection of attentional biases, and processing of information (Armstrong & Olatunji, 2012). Therefore, the more studies that are carried out in this area, the more we can learn about how mothers process information related to their infant and how this processing potentially influences their behaviour towards their infant.

7.3.2 Limitations

There are a number of practical and methodological limitations which have been addressed in each chapter. In this section, the following limitations regarding sampling and confounding variables will be addressed.

Sampling

There are several issues regarding sampling that need to be considered when evaluating the findings of the investigation.

7.3.2.1.1 Sample Characteristics

The sample may not be representative of the general population in a number of ways. The majority of the participants (over 80%) who took part in this research were white. For the

Infant Faces Database (Article 2), only five of the infants in the database are not Caucasian. This could have implications if researchers want to use the images when recruiting individuals from different ethnicities. For example, there is some research about the “other-race effect” which describes how people find it easier to recognise faces from their own race (Herzmann, Minor, & Adkins, 2017; Meissner, Brigham, & Butz, 2005). This research tends to focus on recognition of the face as a whole, rather than recognition and categorisation of emotional expressions and certain emotions have been argued to be innate and universal across cultures (Ekman, 1970). However, a more recent meta-analysis found that accuracy of emotional interpretation was higher in those of the same national, ethnic or regional group (Elfenbein & Ambady, 2002). Therefore, this suggests the lack of infant faces from other ethnicities could have important implications if being used with individuals who are not white.

This therefore limits the generalisability of the results of the study. There may be differences in the way people process infant-related information across ethnicities, which this study may have missed. Furthermore, there may be differences in maternal sensitivity across cultures. For example, Bornstein, Putnick, and Suwalsky (2012) found Italian mothers display more maternal sensitivity when interacting with their 20-month old infants, compared to Argentine and US mothers. Furthermore, Israeli mothers have been found to display more maternal sensitivity when interacting with their 5-month old infant than Palestinian mothers (Feldman & Masalha, 2010). Therefore, any cross-cultural differences that may have been present within the sample are likely to have been missed due to the small number of individuals from different ethnicities and cultures.

The sample was also highly educated. The majority of women who participated in Articles 3-5 had completed an undergraduate or postgraduate degree (85.4%) and the majority of women (47.9%) and their partners (43.8%) were employed in a professional occupation. This includes roles such as scientists, lawyers, engineers, therapists, all of which are specialised roles that require specialist training, and each of which provide a salary higher than the national average (Office for National Statistics, 2016). Ratings of maternal sensitivity have been associated with education (Pederson et al., 1990), socio-economic status (Crittenden & Bonvillian, 1984) and income (Bakermans-Kranenburg, van Ijzendoorn, & Kroonenberg, 2004). Therefore, it is possible that this highly educated sample may have contributed to certain results, and different results may have been found if a more diverse sample was recruited.

The pooling of affective symptoms into one group is also an issue. This was mainly done from a statistical power perspective as it was difficult to recruit enough mothers to have three separate groups, furthermore comorbidity of mental illness is high in the perinatal period (Ballard et al., 1995; Lyons, 1998; White et al., 2006). Within this study, 65.22% of mothers in the affective symptoms group had a mixture of anxiety, depression and/or PTS symptoms. It is possible that comorbidity may obscure biases i.e., a bias observed in depressed women may be countered if the woman also has anxiety. For example, individuals tend to have their attention captured by disorder specific information (such as fear related stimuli for anxiety) (Yiend, 2010) and perception of emotion has been found to differ across diagnoses (Demenescu et al., 2010; Torro-Alves et al., 2016). Therefore, the presence of comorbidity may alter these biases. There is some support for this. For example, a study by Mogg, Millar, and Bradley (2000) did not find evidence for an attentional bias to sad faces in individuals with depression and suggested this was due to the comorbid diagnosis of generalised anxiety disorder in 13 of the 15 participants. Furthermore, Grant and Beck (2006) found that individuals with comorbid depression and social anxiety disorder did not display an attentional bias to social threat words, whereas those with social anxiety did. This suggests comorbidity could have played a part in the results of this study.

7.3.2.1.2 Sample size

The sample size for this thesis was small, with a total of 47 participants in the control group, and only 23 in the experimental group. Small and uneven sample sizes can reduce statistical power. Initial sample size calculations, before the research was carried out suggested that a total of 55 individuals within each group would be needed to ensure enough statistical power. This was not possible due to recruitment difficulties and therefore, the small sample size in this study increases the chance of making a type 2 error (Faber & Fonseca, 2014). To address this effect sizes were considered throughout Articles 3-5. The flow diagram presented in Figure 1-2 showed the difficulty of recruitment in this population. For example, 228 women completed the questionnaire and 204 left contact details. Of the 194 women who were eligible to participate only 80 women agreed to take part.

Recruitment was likely difficult due to the sample that was being recruited and the tasks that were being asked of mothers. Many mothers who filled out the survey indicated they could not take part in the computer-based tasks because of the difficulty bringing an infant into central London. To try and increase numbers, recruitment was attempted in a variety of ways; this included 1) an internal email being sent to National Childbirth Trust groups to encourage group leaders to talk about the study to their group members; 2) visiting

baby-cafes and mother-baby groups at children's centres; 3) posting in parenting groups on Facebook, or posting on Twitter and using appropriate "hashtags" to try and encourage the correct demographic to view these tweets; 4) contacting a variety of "mummy bloggers" to ask them to spread the word about the research; 5) applying for and gaining NHS ethical approval so that recruitment posters for the could be put up in waiting rooms of the perinatal psychiatry services in East London NHS Foundation Trust, and so that perinatal psychiatrists could inform women about the research; 6) creating a YouTube video explaining the purpose of the study, showing the rooms the study would take place in and the exact procedures that would be followed; 7) making revisions to the study procedure and applying for ethical amendments so that a £25 gift voucher could be offered as an incentive. Despite this, recruitment was still low, and it was difficult to get mothers to come to City, University of London, before their baby was too old.

A small number of mothers indicated that getting out of the house with a young baby was difficult for them, and they would have been more likely to take part if the study could have been carried out at their house. Unfortunately, this was not possible for this particular study, due to the lack of availability of a portable eye-tracking unit. However, this could be a consideration for future research that aims to recruit women with affective symptoms and young babies.

Confounding variables

A confounding variable is an outside influence that changes the effect of the independent variable on the dependent variable (Heiman, 2002). The confounding variables most likely to have influenced the results of the study can be grouped into two categories: 1) cognitive tasks; 2) demand characteristics.

7.3.2.1.3 Cognitive tasks

There were two factors that may have influenced the results with regards to the cognitive tasks. The first is that the influence of neither infant cuteness nor baby schema was assessed. The second is that the majority of mothers had their infant in the room during the computer-based tasks.

7.3.2.1.3.1 Baby schema

The computer-based tasks within this thesis did not control for the influence of baby schema on maternal processing of infant emotion. Baby schema refers to how all infants across different species have similar facial structures, including a high, slightly bulging forehead, large eyes, and rounded cheeks (Lorenz, 1943). The degree of baby schema in faces is correlated with positive attributions, such as cuteness, warmth, fondness, and honesty

(Berry & McArthur, 1985), and babies with higher levels of baby schema are more likely to capture attention (Brosch et al., 2007). It could therefore be suggested that maternal first fixation, dwell time and disengagement from infant faces may have been associated with the degree of baby schema possessed by the infant. This was not investigated due to time constraints, and future research should explore the impact of baby schema on the computer-based tasks carried out in this thesis.

7.3.2.1.3.2 Maternal distraction

Mothers were advised to bring someone with them to look after their infant during the computer-based tasks. However, this was not always possible; 74% of mothers (n = 52 out of 70) came alone. This meant that during the computer-based tasks their infant was in the room being looked after by the researcher. Mothers may therefore have been distracted by their infant during these tasks. With regards to the task assessing mothers' ability to disengage from emotional faces (Article 3), mothers' distraction could have led to either faster reaction times (if they were speeding up in order to end the trial so that they could tend to their baby) or slower reaction times (if distraction led to them taking longer to process the face). Regarding the task assessing mothers' ability to accurately categorise infant emotional expressions, the sound of their baby cooing or laughing may have led to them categorise an increased number of faces as positive. Conversely, the sound of their infant being unsettled or crying may have led to them categorise more faces as negative. The same pattern is also likely to be true for Article 4, where mothers' first fixation, and subsequent dwell time, to more positive faces was measured.

7.3.2.1.4 Demand characteristics

Demand characteristics occur when participants guess the aim of the study, leading to an unconscious change in their behaviour to fit in with this guess (Heiman, 2002). Two of the tasks carried out in this thesis are likely to have been influenced by demand characteristics; the eye-tracking selective attention study and the maternal sensitivity task.

7.3.2.1.4.1 Eye-tracking

One of the studies in this thesis investigated mothers' first fixation when presented with two infant emotional faces side-by-side, and their subsequent dwell time (Article 4). Although mothers were told that their pupil dilation was being measured, once they were told the true nature of the task after it had ended, the majority stated that they had already guessed the true outcome measure. This suggests that mothers may have unconsciously altered their gaze patterns. Mothers with affective symptoms were found to fixate first on the more positive image, and it could be argued that this result was found as a result of demand

characteristics. Mothers were aware that they were taking part in research assessing the processing of infant emotion and its relationship with maternal sensitivity. Therefore, mothers with affective symptoms may have consciously fixated first on the neutral images in the negative neutral trials, in order to present themselves in a way that looks “positive”. Mothers with mental health difficulties often report feeling like a “bad mother” (Zauderer, 2009), and this could have therefore been a conscious mechanism to protect them from being judged in this way.

7.3.2.1.4.2 Mother-infant interaction

In this thesis, maternal sensitivity was measured using a video-recorded free-play paradigm. One of the limitations of using video-recorded free-play paradigms is that they may not be a good representation of mothers and infant’s interactions. Social psychology research has demonstrated that when people think they are being watched they act in a more pro-social way (Bateson et al., 2006; Ekström, 2012; Ernest-Jones et al., 2011). Therefore, the recordings of mother-infant interaction are likely to have been affected by this. Furthermore, many mothers commented on how strange it felt to be recorded playing with their infant as well as being worried that they had not provided enough data due to their infant being more interested in the toys than them. This shows that mothers were clearly aware of the camera, and that their interactions were going to be rated, suggesting that these recorded interactions are unlikely to be a close reflection of true mother-infant interaction.

Research has been carried out to try and identify the validity and reliability of observational measures of maternal sensitivity. De Wolff and van Ijzendoorn (1997) conducted a two-part meta-analysis of maternal sensitivity and attachment. The first part aimed to describe the construct of maternal sensitivity using sets of concepts. Based on the papers they selected for the meta-analysis, the authors identified 40 concepts that described maternal sensitivity. These were grouped into five clusters; synchrony, mutuality, positive attitude, emotional support and stimulation. The results from this meta-analysis suggest that maternal sensitivity is often used as a blanket term to identify many different types of maternal behaviour. Therefore, this suggests that different measures of maternal sensitivity may capture different aspects of maternal behaviour. Furthermore, a study aiming to identify the validity and reliability of four popular maternal sensitivity measures found that, while these measures were related to one another, the relationship was weak, suggesting that these measures cannot be used interchangeably, and do not all measure the same concept (Lee, 2016). These studies suggest that caution should be taken when choosing maternal sensitivity measures, and that they do not all measure the same construct.

Another limitation with the specific tool used to measure maternal and infant behaviour in this thesis was the poor inter-rater reliability for some of the subscales of the measure (see Table 6-2). Subscales that measured behaviour that are colloquially particularly easy to identify such as intrusiveness and flatness of affect had higher ICC's than subscales that measured more difficult behaviours to identify such as infant activity. Differences in maternal and infant behaviour were often very nuanced across videos making coding difficult. Therefore, future research could focus on re-coding these videos using a different tool which aims to measure more subtle differences in behaviour, such as a micro-coding scale (Censullo et al., 1987; Clark, 1999).

A further limitation with the maternal sensitivity measure chosen is the fact that such a short period of time was used to measure maternal behaviour. Prior to the play session many mothers fed their infant to make sure they were in a good mood, despite being told that this was okay to do whilst the video camera was recording. This meant that for most mothers the babies were in a good mood and very little crying was observed. This may explain the poor inter-rater reliability found for sensitivity to distress (Table 6-2) as there were very few mothers that this scale was applicable for ($n = 25$; 35.71%). Future research could therefore replicate the testing of the model but use a different method to measure maternal sensitivity. One way of assessing maternal sensitivity that overcomes some of the drawbacks of traditional maternal sensitivity recording measures is through the use of first-person cameras. These are small portable cameras worn by the participant which face outward to capture the viewpoint of the individual. The use of these camera mean that the researcher does not have to be present, different viewpoints can be observed and they reduce participant burden by not requiring participants to attend a testing session. Lee et al. (2017) found that these cameras were a reliable way to record maternal and infant behaviours and the frequency of less desirable behaviours observed increased. This suggests that many of the drawbacks identified from the measure of maternal and infant behaviour chosen for this thesis may be overcome through the use of first-person cameras.

7.4 Implications

The current thesis has several practical and theoretical implications. Specific implications are discussed in each article. This section highlights some key implications from the work in the thesis as a whole, including implications for healthcare practice and future research.

7.4.1 Implications for research

There are three implications for research related to the findings of this thesis. The first relates to the areas future research should focus on, based on the findings from Article 5. The second relates to research implications based on the limitations of this work. The third relates to research that could be carried out with fathers.

Research implications based on the findings from the cognitive model

As stated above, this thesis aimed to identify whether the way in which mothers' process infant-related information could partially explain the relationship between maternal affective symptoms and maternal sensitivity. The results from Article 5 suggest that in some cases maternal affective symptoms and infant-related processing factors predicted maternal behaviour, however the mechanisms underlying other aspects of maternal behaviour, such as positive regard for the infant and maternal sensitivity to distress, were not identified (see Figure 7-1). Therefore, future work needs to focus on systematically mapping potential mechanisms underlying maternal sensitivity, and then strategically investigating these factors.

One potential infant-related factor that may explain maternal positive regard for her infant is a mother's habituation to certain stimuli. Habituation is a diminished response to a repeatedly occurring stimuli (Rankin et al., 2009). This thesis found that mothers with affective symptoms fixated first to more positive infant faces but disengaged faster from these faces. Continual fixation onto positive infant faces may lead to habituation. A mother who habituates quickly to positivity may see her infant as being less positive because her infant needs to show a particularly exaggerated positive expression for a mother to categorise this as such. This may mean that mothers who habituate to positive faces at a quicker rate show less positivity when interacting with their infant because they are seeing less positivity from their infant. Future research could investigate this by measuring how quickly mother's habituate to infant emotional expressions and correlate this with maternal positive regard for her infant.

The disrupted reward system associated with depression may explain maternal sensitivity to distress. Smiling infant faces, and the degree of cuteness within an infant face have been found to activate the brain's reward system (Glocker, Langleben, Ruparel, Loughhead, Valdez, et al., 2009; Strathearn et al., 2008) and induce caregiving motivation in adults (Glocker, Langleben, Ruparel, Loughhead, Gur, et al., 2009). On the other hand, infant cries lead to less activation in neural structures across the brain in depressed compared to non-depressed mothers (Laurent & Ablow, 2012). Therefore, this reduced brain activation to

infant mood may mean mothers are unconsciously less motivated to change their infant's state leading to less sensitivity to distress. Neuroimaging research should investigate this by identifying whether these patterns of brain activation found in mothers with depression are associated with their behaviour towards their infant.

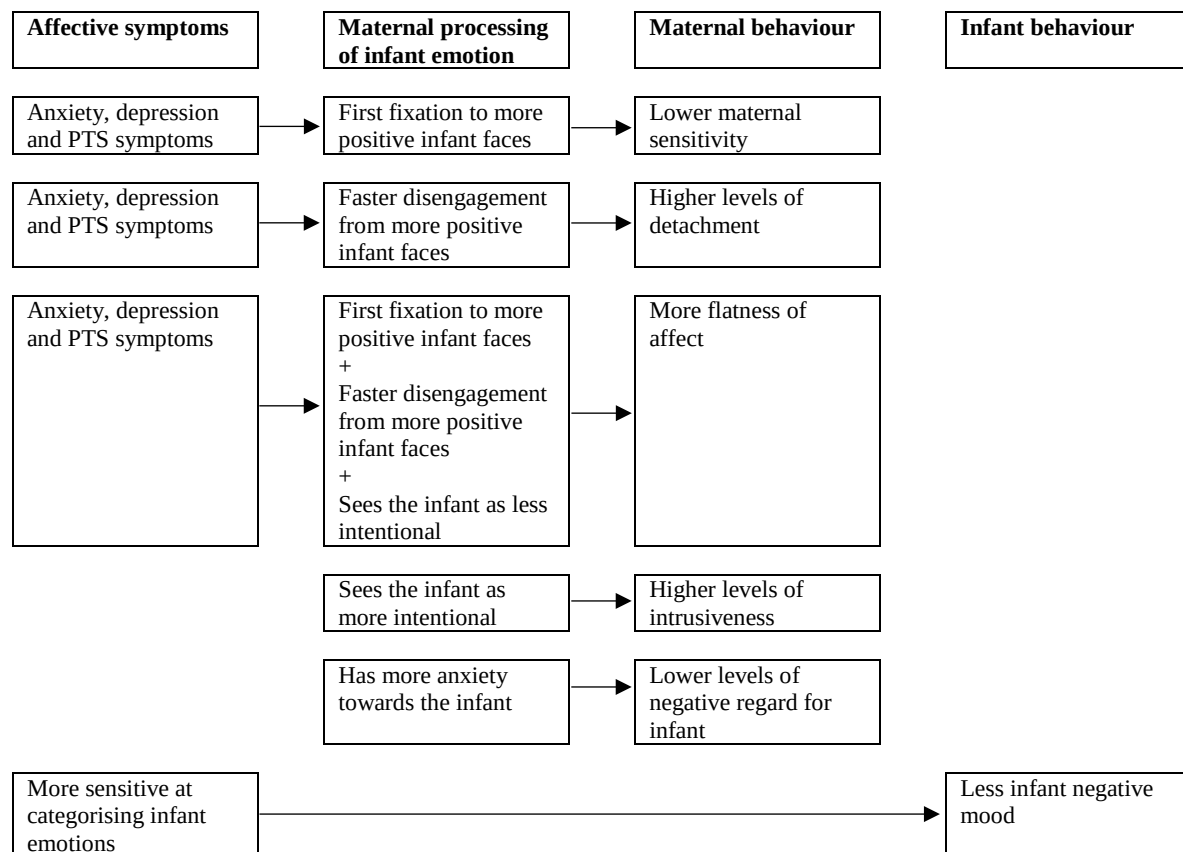


Figure 7-1. Summary of results from the cognitive model of maternal sensitivity (Article 5)

Research implications based on limitations of this work

One of the limitations from this research was the characteristics of the sample – only women with symptoms rather than diagnoses were recruited. Research should therefore investigate whether biases in processing infant emotion are found only in women with diagnosed postnatal mental health difficulties, and whether there are particular biases associated with specific postnatal mental health difficulties. This would enable interventions to be developed with the aim of changing biases associated with certain mental health difficulties, potentially reducing postnatal mental health symptoms (see Attentional Bias Modification literature below), and therefore improving mothers' quality of life. Another limitation of the recruited sample was the fact that the majority were white, well-educated

and of a high socio-economic status. This means that any infant-related processing biases, maternal behaviour or infant behaviour patterns associated with different socio-economic statuses, ethnicities or cultures may have been missed. Therefore, it is important that this study is replicated on a much wider scale to ensure that any results found are applicable to a wider population. Any patterns found on a larger scale would have implications for interventions.

Limitations with the way the study was carried out with regards to not controlling for maternal distraction and baby schema as discussed in Section 7.3.2.1.3 should also be addressed. Future research should focus on rating the amount of baby schema each infant has in the City Infant Faces Database, and the computer-based tasks carried out in this thesis should be replicated to identify whether baby schema influences accuracy at emotional categorisation, disengagement, first fixation and dwell time towards infant emotional expressions. Similarly, these tasks should be replicated without the distraction of infants in the room, as this may have been a confounding variable in the results.

The limitations with regards to the maternal sensitivity measure used should be addressed. Future research could firstly focus on recording maternal and infant behaviour using first person cameras which overcome the issues with demand characteristics, time of recording and participant burden (Lee et al., 2017). It would be interesting to see if similar results are found when demand characteristics play less of a role. Secondly, future research could focus on using a different maternal sensitivity rating scale. Maternal sensitivity rating scales can generally be grouped into macro and micro-level. Macro-level scales look at a global rating of maternal behaviour, and micro-level scales look at behaviour states that are coded in very small-time segments (Mesman, 2010). This thesis used macro-coding to assess maternal sensitivity which is an efficient way to assess global behaviour. However, as discussed above (see Section 7.3.2.1.4.2) this measure is not particularly sensitive to nuanced behavioural changes across participants. Future research could therefore use a micro-coding approach to assess contingency and time course between mother and infant responses. This micro-level coding would mean that the infant-related factors found in this thesis can be linked to maternal behaviour. For example, using micro-coding means it would be possible to observe whether mothers who look longer at pictures of positive infant faces actually look at their infant's positive face for a longer period of time during live interactions. Such work could help bridge the gap in mechanisms from cognition to behaviour

Fathers

More recently, research has focused on paternal mental health difficulties and the impact these can have on child developmental difficulties. For example, a population based study found that paternal postnatal depression was associated with adverse emotional and behavioural outcomes in children aged 3.5 years (Ramchandani, Stein, Evans, & O'Connor, 2005). A recent study found that mothers and fathers process infant emotional expressions differently, with mothers providing more extreme ratings of infant emotional expressions. However, both mothers and fathers rated the images as more negative if suffering from depressive symptoms (Parsons, Young, Jegindoe Elmholt, Stein, & Kringelbach, 2017). Research is sparse in the area of paternal sensitivity and paternal processing of infant emotion, but the patterns found in this thesis suggest that the cognitive model developed in this thesis could be applied to fathers, in order to identify whether infant-related processing explains some of the variance in paternal sensitivity.

7.4.2 Implications for healthcare practice

There are two main implications for healthcare practice: reducing infant-related processing biases and improving maternal sensitivity.

Changing infant-related information processing

The results from this thesis found that the processing of certain infant-related information is related to maternal sensitivity. For example, mothers who are better at categorising infant faces were less intrusive when interacting with their infant. This suggests that there could be some benefit in attempting to change these processing patterns. However, this is preliminary evidence and future studies may not find the same patterns.

Attentional bias modification (ABM) is a potential route that could be taken if future studies report similar findings. ABM aims to change attentional biases through redirecting attention. This is done by asking participants to identify a target that is consistently behind a specific emotional stimulus. Therefore, to change someone's cognitive bias towards more positive images, the target would always be behind a positive image. This would lead to participants developing a habit of orienting towards the positive image when identifying the target (Browning, Holmes, Charles, Cowen, & Harmer, 2012).

ABM has been found to be effective in the non-perinatal population. For example, Browning et al. (2012) found that using positive ABM with faces reduced residual symptoms of depression. Yang, Ding, Dai, Peng, and Zhan (2015) carried out an ABM RCT using words as the stimuli, and found that ABM led to a significant reduction in depressive symptoms. Furthermore, a greater number of participants remained asymptomatic in the

ABM condition compared to controls at the 7-month follow up. Additionally, a meta-analysis of 12 studies found that ABM reduced anxiety with a medium effect size (Hakamata et al., 2010). Only one study has looked at ABM in the perinatal period. Carnegie et al. (2016) used attentional bias modification to change the threshold at which mothers' perceived infant distress. Results showed that ABM worked, and that mothers reduced the threshold at which they perceived infant distress. However, more research is needed to see whether the effect is long-lasting, and further research would need to examine whether ABM reduces postnatal symptoms of depression and anxiety before this could be rolled out as a treatment option for postnatal mental illness.

Improving maternal sensitivity

The finding from this thesis, and other studies discussed above regarding the relationship between maternal mental health, maternal sensitivity, and infant behaviour, provide support for the use of interventions to improve the parent-child relationship. It should be noted that the findings from this study can be used only in conjunction with other studies that suggest maternal behaviour and infant behaviour are inter-related. This study is too small, and has too many methodological issues, to make this claim itself.

To improve the parent-child relationship, two types of intervention may be beneficial: parent-infant psychotherapy and video-feedback techniques.

Parent-infant psychotherapy (PIP) is intended to address problems in the parent-infant relationship by working directly with the parent and infant in the home or clinic, to identify unconscious patterns of relating and behaving, and influences from the past that are effecting the parent-infant relationship (Barlow, Bennett, Midgley, Larkin & Wei, 2015, p.3). Parent-infant psychotherapy has been found to be effective in reducing functional and behavioural problems in toddlers, and in increasing sensitivity of mothers (Cramer et al., 1990; Likierman, 2003). A Cochrane review of the parent-infant psychotherapy trials found that those who had parent-infant psychotherapy were more likely to have an infant with a secure attachment. However, the authors concluded that the majority of the papers in the review had a high risk of bias in terms of the methodology. Furthermore, the authors found there to be no evidence that parent-infant psychotherapy was more effective than other parent-infant interventions at improving maternal mental health symptoms, maternal sensitivity and child outcomes (Barlow, Bennett, Midgley, Larkin, & Wei, 2015). Therefore, although parent-infant psychotherapy could be a useful intervention for mothers, it is not the only effective option available.

An alternative is video-feedback, which is a more behavioural approach. There are many different types of video-feedback techniques (Video Interaction Guidance, Video Intervention Positive Parenting, Video Home Training), but the main premise is that mother-infant interactions are videotaped, and are then watched back with the therapist. The therapist will help the mother recognise her own positive responses and interactions with her infant, and facilitate more appropriate responsiveness (Kennedy, Landor, & Todd, 2010).

There is some evidence supporting the use of video-feedback to improve parent-infant relationships. In a meta-analysis, Fukkink (2008) found that video-feedback increased parental sensitivity and resulted in behavioural and attitudinal changes from the parents towards their children. Another meta-analysis found that video-feedback increased child secure attachment to their mother (Bakermans-Kranenburg, van Ijzendoorn, & Juffer, 2003). Furthermore, video-feedback has been found to improve maternal sensitivity, and increase child cooperativeness (Cohen et al., 1999; Tucker, 2006). A recent randomised controlled trial (RCT) assessing the effect of video-feedback versus standard hospital care in mothers of pre-term infants found that video-feedback reduced maternal withdrawal and increased maternal sensitivity (Tooten et al., 2012). However, it did not improve maternal intrusiveness, suggesting that video-feedback may not be an effective intervention for everyone.

The results from these studies suggest that there are interventions available for mothers and infants to help them improve their relationship. However, as these interventions may not be successful for everyone, more should be developed and tested to ensure that an effective intervention is available for all parent-child dyads.

7.5 Conclusions

In conclusion, the studies presented in this thesis have developed and tested a cognitive model of maternal sensitivity. This thesis has provided important contributions to the literature on postnatal affective symptoms, processing of infant-related information and maternal sensitivity. The findings support previous research, which has found maternal mental health difficulties to be associated with lower levels of maternal sensitivity. This thesis also provides support for the dyadic systems approach to mother-infant interaction, finding that maternal and infant behaviour are associated with one another. This thesis also provides further observational evidence that mothers with postnatal mental health difficulties are more likely to have babies with a difficult temperament.

In addition, this thesis has provided novel and interesting findings, such as mothers' processing of certain infant-related information being associated with their maternal

sensitivity. For example, mothers with affective symptoms who fixate first on more positive images, disengage more quickly from positive images and see their infant as being more intentional show less overall maternal sensitivity, more detachment and more flatness of affect.

Overall this thesis provided a novel contribution to the literature by developing and testing a model based on previous research and using robust measures such as eye-tracking technology and observational measures of mother-infant interaction. However, interpretation of the data is hindered due to methodological issues, such as small sample sizes, homogeneous sample and demand characteristics. Therefore, more research is needed to test this model on a larger, more heterogeneous sample.

8 References

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9 Appendices

Appendix 1. Full ethical approval from SHS



School of Health Sciences

Ref: PhD/14-15/05

16 September 2014

Dear Rebecca / Susan

Re: Maternal Perception of Infant Emotion

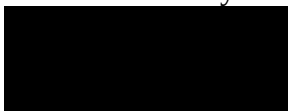
Thank you for forwarding amendments and clarifications regarding your project. These have now been reviewed **and approved** by the Chair of the School Research Ethics Committee.

Please find attached, details of the full indemnity cover for your study.

Under the School Research Governance guidelines you are requested to contact myself once the project has been completed, and may be asked to complete a brief progress report six months after registering the project with the School.

If you have any queries please do not hesitate to contact me as below.

Yours sincerely



Alison Welton

Research Governance Officer



Appendix 2. Full ethical approval from NHS ethics NRES approval


Health Research Authority
London - Central Research Ethics Committee
3rd Floor, Barlow House
4 Minshull Street
Manchester
M1 3DZ
Telephone: 0207 1048 007

08 June 2016

Ms Rebecca Webb, PhD Student
City University London
School of Health Sciences
City University London
London
EC1R 1UW

Dear Ms Webb

Study title:	Mothers' and Infant's Perception of Emotional Expressions and Play
REC reference:	16/LO/0605
Protocol number:	2
IRAS project ID:	192426

Thank you for your letter of 4 June 2016 and subsequent documentation, responding to the Committee's request for further information on the above research and submitting revised documentation. The further information has been considered on behalf of the Committee by the Chair.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details. Publication will be no earlier than three months from the date of this opinion letter. Should you wish to provide a substitute contact point, require further information, or wish to make a request to postpone publication, please contact the REC Manager, Elaine Hutchings, NRESCommittee.London-Central@nhs.net.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a favourable ethical opinion for the above research on the basis described in the application form, protocol and supporting documentation as revised, subject to the conditions specified below.

Conditions of the favourable opinion

The REC favourable opinion is subject to the following conditions being met prior to the start of the study.

Management permission must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements. Each NHS organisation must confirm through the signing of agreements and/or other documents that it has given permission for the research to proceed (except where explicitly specified otherwise).

Guidance on applying for NHS permission for research is available in the Integrated Research Application System, www.hra.nhs.uk or at <http://www.rdforum.nhs.uk>.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of management permissions from host organisations

Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database within 6 weeks of recruitment of the first participant (for medical device studies, within the timeline determined by the current registration and publication trees).

There is no requirement to separately notify the REC but you should do so at the earliest opportunity e.g. when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non-clinical trials this is not currently mandatory.

If a sponsor wishes to contest the need for registration they should contact Catherine Blewett [REDACTED] the HRA does not, however, expect exceptions to be made. Guidance on where to register is provided within IRAS.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Ethical review of research sites

NHS sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	Version	Date
Copies of advertisement materials for research participants [Recruitment flyer for mothers without birth trauma]	2	02 March 2016
Copies of advertisement materials for research participants [Recruitment flyer for mothers with birth trauma]	2	02 March 2016
Covering letter on headed paper [Response to Reviewers Comments]	1	15 March 2016
Covering letter on headed paper [Response to Reviewers Comments]	2	04 June 2016
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only) [Indemnity Cover Full]	2	02 March 2016
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only)		01 August 2015
GP/consultant information sheets or letters [GP Letter]	1	02 March 2016
IRAS Checklist XML [Checklist_22032016]		22 March 2016
IRAS Checklist XML [Checklist_25042016]		25 April 2016
IRAS Checklist XML [Checklist_04062016]		04 June 2016
IRAS Checklist XML [Checklist_07062016]		07 June 2016
Non-validated questionnaire [Non-validated questionnaire]	1	26 October 2015
Other [Ansgar Endress CV]	1	02 March 2016
Other [Valerie Thurtle CV]	1	03 March 2016
Other [Barbara Aninakwa CV]	1	03 March 2016
Other [Coding manual parent infant interaction]		
Other [Unfavourable opinion letter 16/LQ/0140]		01 February 2016
Other [Resource Sheet to be sent with Participant Letter]	2	04 June 2016
Other [Provisional opinion from committee]	1	04 June 2016
Participant consent form [Consent form for infant]	1	04 January 2016
Participant consent form [Consent form for Mother]	2	04 June 2016
Participant information sheet (PIS) [Letter to be sent to participants if they reach clinical cut off levels: Updated]	2	02 March 2016
Participant information sheet (PIS) [Postnatal Information Sheet for Mothers who had a Traumatic Birth: Updated]	3	07 June 2016
Participant information sheet (PIS) [Information Sheet on Online Survey Software Qualtrics: Updated]	3	06 June 2016
Participant information sheet (PIS) [Information sheet for mothers who did not have a traumatic birth: Updated]	3	07 June 2016
REC Application Form		22 April 2016
Research protocol or project proposal [Updated protocol]	V2	16 March 2016
Summary CV for Chief Investigator (CI) [Rebecca Webb Academic CV]	1	26 October 2015
Summary CV for supervisor (student research) [Susan Ayers Supervisor CV]	1	02 March 2016
Summary, synopsis or diagram (flowchart) of protocol in non-technical language [Flow chart of protocol: Updated]	2	

Validated questionnaire [Infant Intentionality Questionnaire]		
Validated questionnaire [PTSD Scale]		
Validated questionnaire [Postpartum Bonding Scale]		
Validated questionnaire [HADS]		

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

Reporting requirements

The attached document "*After ethical review – guidance for researchers*" gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The HRA website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website: <http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/>

HRA Training

We are pleased to welcome researchers and R&D staff at our training days – see details at <http://www.hra.nhs.uk/hra-training/>

With the Committee's best wishes for the success of this project.

Yours sincerely



pp
Dr Andrew Hilson
Chair

Email: NRESCCommittee.London-Central@nhs.net

Enclosures: "After ethical review – guidance for researchers"

Copy to: Ms Alison Welton, City University London

2.2. HRA Approval



Ms Rebecca Webb
PhD Student
City University London
School of Health Sciences
City University London
London
EC1R 1UW

Email: hra.approval@nhs.net

20 July 2016

Dear Ms Webb

**Letter of HRA Approval for a study processed
through pre-HRA Approval systems**

Study title: Mothers' and Infant's Perception of Emotional Expressions
and Play
IRAS project ID: 192426
Sponsor City University London

Thank you for your request for HRA Approval to be issued for the above referenced study.

I am pleased to confirm that the study has been given HRA Approval. This has been issued on the basis that the study is compliant with the UK wide standards for research in the NHS.

The extension of HRA Approval to this study on this basis allows the sponsor and participating NHS organisations in England to set-up the study in accordance with HRA Approval processes, with decisions on study set-up being taken on the basis of capacity and capability alone.

If you have submitted an amendment to the HRA between 23 March 2016 and the date of this letter, this letter incorporates the HRA Approval for that amendment, which may be implemented in accordance with the amendment categorisation email (e.g. not prior to REC Favourable Opinion, MHRA Clinical Trial Authorisation etc., as applicable). If the submitted amendment included the addition of a new NHS organisation in England, the addition of the new NHS organisation is also approved and should be set up in accordance with HRA Approval processes (e.g. the organisation should be invited to assess and arrange its capacity and capability to deliver the study and confirm once it is ready to do so).

Participation of NHS Organisations in England

Please note that full information to enable set up of participating NHS organisations in England is not provided in this letter, on the basis that activities to set up these NHS organisations is likely to be underway already.

The sponsor should provide a copy of this letter, together with the local document package and a list of the documents provided, to participating NHS organisations in England that are being set up in accordance with [HRA Approval Processes](#). It is for the sponsor to ensure that any documents provided to participating organisations are the current, approved documents.

For non-commercial studies the local document package should include an appropriate [Statement of Activities and HRA Schedule of Events](#). The sponsor should also provide the template agreement to be used in the study, where the sponsor is using an agreement in addition to the Statement of Activities. Participating NHS organisations in England should be aware that the Statement of Activities and HRA Schedule of Events for this study have not been assessed and validated by the HRA. Any changes that are appropriate to the content of the Statement of Activities and HRA Schedule of Events should be agreed in a pragmatic fashion as part of the process of assessing, arranging and confirming capacity and capability to deliver the study. If subsequent NHS organisations in England are added, an amendment should be submitted to the HRA..

For commercial studies the local document package should include a validated industry costing template and the template agreement to be used with participating NHS organisations in England.

It is critical that you involve both the research management function (e.g. R&D office and, if the study is on the NIHR portfolio, the LCRN) supporting each organisation and the local research team (where there is one) in setting up your study. Contact details and further information about working with the research management function for each organisation can be accessed from www.hra.nhs.uk/hra-approval.

After HRA Approval

In addition to the document, *‘After Ethical Review – guidance for sponsors and investigators’*, issued with your REC Favourable Opinion, please note the following:

- HRA Approval applies for the duration of your REC favourable opinion, unless otherwise notified in writing by the HRA.
- Substantial amendments should be submitted directly to the Research Ethics Committee, as detailed in the *After Ethical Review* document. Non-substantial amendments should be submitted for review by the HRA using the form provided on the [HRA website](#), and emailed to hra.amendments@nhs.net.
- The HRA will categorise amendments (substantial and non-substantial) and issue confirmation of continued HRA Approval. Further details can be found on the [HRA website](#).

Scope

HRA Approval provides an approval for research involving patients or staff in NHS organisations in England.

If your study involves NHS organisations in other countries in the UK, please contact the relevant national coordinating functions for support and advice. Further information can be found at <http://www.hra.nhs.uk/resources/applying-for-reviews/nhs-hsc-rc-review/>.

If there are participating non-NHS organisations, local agreement should be obtained in accordance with the procedures of the local participating non-NHS organisation.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please email the HRA at hra.approval@nhs.net. Additionally, one of our staff would be happy to call and discuss your experience of HRA Approval.

HRA Training

We are pleased to welcome researchers and research management staff at our training days – see details at <http://www.hra.nhs.uk/hra-training/>.

If you have any queries about the issue of this letter please, in the first instance, see the further information provided in the question and answer document on the [HRA website](#).

Your IRAS project ID is 192426. Please quote this on all correspondence.

Yours sincerely

Catherine Adams

Senior Assessor

Email: hra.approval@nhs.net

Copy to: Ms Alison Welton, City University London

Appendix 3. Full list of search terms for systematic search (Article 1)

Search One – Depression

Attention*	Depress*	Pregnan*
Bias	Dysphori*	Antenatal
“Selective attention”	“Low mood”	Perinatal
Cognitive	“Negative affect”	Birth
Percept*	Dysthymia	Birth-related
“Negative stimuli”	Mood	Child-bearing
Emotion*	“Affective disorder”	Postnatal
Infant		Postpartum
Baby		Mother
Babies		Maternal
Adult		
Face*		
Facial		
Processing		
Interpretation		
Expression		

Search 2: anxiety

Attention*	Anxiety	Pregnan*
Bias	Anxious	Antenatal
“Selective attention”	GAD	Perinatal
Cognitive	Generalized anxiety	Birth
Percept*	disorder	Birth-related
“Negative stimuli”	Worry	Child-bearing
Emotion*	Fear	Postnatal
Infant	Stress	Postpartum
Baby	“Affective disorder”	Mother
Babies		Maternal
Adult		
Face*		

Facial Processing Interpretation Expression		
--	--	--

Search 3: PTSD

Attention*	Anxiety	Pregnan*
Bias	Anxious	Antenatal
“Selective attention”	GAD	Perinatal
Cognitive	Generalized anxiety	Birth
Percept*	disorder	Birth-related
“Negative stimuli”	Worry	Child-bearing
Emotion*	Fear	Postnatal
Infant	Stress	Postpartum
Baby	“Affective disorder”	Mother
Babies		Maternal
Adult		
Face*		
Facial		
Processing		
Interpretation		
Expression		

Appendix 4. Supplementary Results (Article 2)

To save space and paper, supplementary results are available electronically via this link:

<https://link.springer.com/article/10.3758%2Fs13428-017-0859-9#SupplementaryMaterial>

Appendix 5. Qualtrics Questionnaire (Article 3, 4 and 5)

Emotional well-being questionnaire

Please note, participants could not see text written in grey, or skip logic.

Start of Block: Information about the study

What is the purpose of the study? In brief, we are interested in how you and your baby notice and respond to different emotional expressions. This study would involve various activities where you and your baby look at photos of faces with happy or sad expressions and play together.

What do I have to do? First you will be asked to fill in the questions which follow on the next page. These ask about you, your baby, and your emotional well-being and will take about 10-20 minutes. Once you have answered these questions and pressed “submit” your responses will be automatically sent to a secure electronic database. If your answers to these questions indicate that you might be suffering from anxiety or depression we will contact you to let you know and give you advice on how to get help. At the end of the survey we will provide you with information on appropriate sources of support.

Once you have completed the survey we will arrange a time for you and your baby to come to City University London to do the following activities.

Activities for you and your baby (with estimated times):

1. You and your baby playing (5-10 minutes).
2. Your baby looking at photos of faces showing different emotions (5-10 minutes).

Activities for you (all done on a computer):

1. Looking at photos of babies' faces showing different emotions (40 minutes).
2. A game where you will need to locate certain objects (i.e. a line) on the screen (10 minutes). (This is a bit hard to explain, but it is actually fun)

We will video some of these activities in order to analyse them later e.g. tracking where your baby looks when shown different faces. We need to video-tape them because where your baby is looking changes rapidly, so we need to play the recording in slow-motion to be able to see where they are looking during the activity.

We suggest you bring someone with you who knows your baby to look after them during this time. However, if this is not possible we can keep your baby in their buggy, on your lap or

with the researcher (whichever you are happiest with) while you do the activities. There are also plenty of breaks and you are of course free to stop at any time if your baby needs you.

All the information collected during this period will be anonymised and kept in an electronic password protected database. You can withdraw you and/or your baby's information from this study at any point if you wish to. We are also happy to send you a summary of the results if you would like.

For more detailed information about the purpose of the study please [click here](#) to read the full information sheet.

End of Block: Information about the study

Start of Block: Obstetric Questions

In this section we will ask you some basic obstetric questions.

Please click on the arrow to continue.

Page Break

How many times have you been pregnant?

How many other children do you have (not including your baby)?

Have you ever suffered from a late miscarriage, still birth or an infant dying?

- ☐ Yes
- ☐ No

Before you knew you were pregnant, how much did you want a baby?

- ☐ 0 Not at all
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ 6 Very much

When you found out you were pregnant, what phrase best describes your feelings?

- ☐ Very happy and had strongly positive feelings
- ☐ Generally positive but had some negative feelings
- ☐ Indifferent, or uncertain with mixed feelings
- ☐ Generally negative, but had some positive feelings
- ☐ Upset and had strongly negative feelings

How planned was this pregnancy?

- ☐ Definitely planned
- ☐ Not sure
- ☐ Definitely not planned

Page Break

Are you currently taking any anti-psychotic medication (i.e. antidepressants, anti-anxiety etc.). If yes please specify the name of drug (if unsure just say what you are taking it for).

- ☐ Yes _____
- ☐ No

End of Block: Obstetric Questions

Start of Block: Questionnaire about your baby

In this section we will ask you questions about your baby.

Please click on the arrow to continue

Page Break

Please think about your baby and answer the following questions:

How do you feed your baby?

- ☐ Bottle feed
- ☐ Breast feed
- ☐ Mix feed

Infant Intentionality Questionnaire (Feldman and Reznick, 1996)

Do you think your baby can feel?

	1: Rarely	2	3	4	5: Always
Happiness?	☐	☐	☐	☐	☐
Joy?	☐	☐	☐	☐	☐
Love?	☐	☐	☐	☐	☐
Fear?	☐	☐	☐	☐	☐
Sadness?	☐	☐	☐	☐	☐
Guilt?	☐	☐	☐	☐	☐
Surprise?	☐	☐	☐	☐	☐

Please answer the following questions:

	1: Rarely	2	3	4	5: Always
Do you think your baby is aware of being dirty, hungry or tired?	☐	☐	☐	☐	☐
When your infant cries do you think s/he is aware of the fact s/he needs something?	☐	☐	☐	☐	☐
When your baby cries do you feel s/he means to tell you s/he's	☐	☐	☐	☐	☐

distressed or
sad?

When your
baby is dirty,
hungry or
tired, do you
think s/he
feels she can
do something
about it?

☐ ☐ ☐ ☐ ☐

Do you think
babies can
shut out their
surroundings
when things
become too
much for
them?

☐ ☐ ☐ ☐ ☐

Do you think
babies are
born with the
ability to
communicate
their needs,
and make
sure these are
met?

☐ ☐ ☐ ☐ ☐

When you
baby is
reaching for a
toy, does it

☐ ☐ ☐ ☐ ☐

seem to you
that s/he
intends to get
the toy?

When your
baby is
looking
around, do
you think this
is because
they want to
learn about
the world?

Do you
believe
babies seek
emotional
experiences
and have
ways of
achieving
this?

Do you think
babies know
more than
they can
express?

☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐

☐ ☐ ☐ ☐ ☐

Page Break

How well do you think your baby can ensure their needs are met in the following areas?

	1: Not capable	2	3	4	5: Very capable
Learning needs (i.e. getting objects s/he finds interesting)?	☐	☐	☐	☐	☐
Social/emotional needs (i.e. making sure you are near and listening)?	☐	☐	☐	☐	☐

Please answer the following questions:

	1: Rarely	2	3	4	5: Always
Do you think some babies are better at being sociable than others?	☐	☐	☐	☐	☐
Do you think your baby knows if you have had a bad day?	☐	☐	☐	☐	☐
Do you think babies can react to their mother's insecurity?	☐	☐	☐	☐	☐

Do you feel like your baby is more aware of your moods than the moods of others?	☐	☐	☐	☐	☐
--	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------

Do you think babies are aware of problems in their environment such as a domestic emergency (i.e. broken down washing machine)?	☐	☐	☐	☐	☐
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Do you think your baby is aware of other children's distress?	☐	☐	☐	☐	☐
---	-----------------------	-----------------------	-----------------------	-----------------------	-----------------------

Do you think your baby can feel when you are:

	1: Rarely	2	3	4	5: Always
Worried?	☐	☐	☐	☐	☐
Happy?	☐	☐	☐	☐	☐

Sad?	☐	☐	☐	☐	☐
Surprised?	☐	☐	☐	☐	☐

Page Break

Please answer the following questions:

	1: Rarely	2	3	4	5: Always
Do you ever feel that your baby is trying to tell you something?	☐	☐	☐	☐	☐
When your baby smiles, do you think it is because s/he wants you to do something for her/him?	☐	☐	☐	☐	☐
When your baby cries, do you think s/he is aware that you are near, and can take care of her/his needs?	☐	☐	☐	☐	☐
When your baby cries, do you think	☐	☐	☐	☐	☐

s/he is aware
of the fact
s/he can get
help by
crying?

Does your
baby ever cry
because s/he
is angry with
you?

☐ ☐ ☐ ☐ ☐

When your
baby smiles,
is it because
s/he feels
something is
bothering
you, and can
make you
feel better?

☐ ☐ ☐ ☐ ☐

When your
baby smiles
do you think
s/he is trying
to tell you
something?

☐ ☐ ☐ ☐ ☐

Do you think
your baby
tries to help
you when
you are hurt?

☐ ☐ ☐ ☐ ☐

Please answer the following questions:

	1: No	2	3	4	5: Yes
When your infant hurts you (i.e. kicking legs during a nappy change) do you think s/he does it on purpose?	☐	☐	☐	☐	☐
Do you think some babies are spiteful?	☐	☐	☐	☐	☐

Page Break

Postpartum Bonding Questionnaire (PBQ) (Brockington, Fraser & Wilson, 2006)

Please state your response to the following statements:

	Always	Very Often	Quite Often	Sometimes	Rarely)	Never)
I feel distant from my baby	☐	☐	☐	☐	☐	☐
I love to cuddle my baby	☐	☐	☐	☐	☐	☐
I regret having my baby	☐	☐	☐	☐	☐	☐

I enjoy playing with my baby	☐	☐	☐	☐	☐	☐
I feel angry with my baby	☐	☐	☐	☐	☐	☐
My baby annoys me	☐	☐	☐	☐	☐	☐
I feel the only solution is for someone else to look after my baby	☐	☐	☐	☐	☐	☐
My baby makes me feel anxious	☐	☐	☐	☐	☐	☐
I am afraid of my baby	☐	☐	☐	☐	☐	☐
I feel confident when caring for my baby	☐	☐	☐	☐	☐	☐

My baby is						
easily	☐	☐	☐	☐	☐	☐
comforted						

End of Block: Questionnaire about your baby

Start of Block: Emotional Well-being Questionnaires

In this section we will ask you about your most recent birth experience.

Please click on the arrow to continue.

Page Break

Please think about your most recent birth and answer the following questions:

What is your baby's date of birth?

Post-traumatic stress disorder diagnostic scale (PDS) (Foa, 1995)

During the birth:

	Yes	No
Were you physically injured?	☐	☐
Was your baby physically injured?	☐	☐
Did you think that your life was in danger?	☐	☐
Did you think that your baby's life was in danger?	☐	☐
Did you feel helpless?	☐	☐

Did you feel terrified?

☐

☐

In the last month, how often have you been:

	Not at all or only one time	Once a week or less/ Once in a while	2 to 4 times a week/Half the time	5 or more times a week/ Almost always
Having upsetting thoughts or images about birth that came into your head when you didn't want them to	☐	☐	☐	☐
Having bad dreams or nightmares about the birth	☐	☐	☐	☐
Reliving the birth, acting or feeling as if it was happening again	☐	☐	☐	☐
Feeling emotionally upset when you were reminded of the birth (for example, feeling scared, angry, sad, guilty etc)	☐	☐	☐	☐

Experiencing physical reactions when you were reminded of the birth (for example, breaking out in a sweat, heart beating fast)	☐	☐	☐	☐
Trying not to think about, talk about, or have feelings about the birth	☐	☐	☐	☐
Trying to avoid activities, people, or places that remind you of the birth	☐	☐	☐	☐
Not being able to remember an important part of the birth	☐	☐	☐	☐
Having much less interest or participating much less often in important activities	☐	☐	☐	☐

Feeling distant or cut off from people around you	☐	☐	☐	☐
Feeling emotionally numb (for example, being unable to cry or unable to have loving feelings)	☐	☐	☐	☐
Feeling as if your future plans or hopes will not come true (for example, you will not have a career, marriage, or a long life)	☐	☐	☐	☐
Having trouble falling or staying asleep	☐	☐	☐	☐
Feeling irritable or having fits of anger	☐	☐	☐	☐
Having trouble concentrating (for example drifting in and out of conversations,	☐	☐	☐	☐

losing track of a
story on
television,
forgetting what
you read)

Being overly
alert (for
example,
checking to see
who is around
you, being
uncomfortable
with your back
to a door, etc)

Being jumpy or
easily startled
(for example,
when someone
walks up behind
you)

☐

☐

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☐

Skip To: Q11 If In the last month, how often have you been: = Having upsetting thoughts or images about birth that came into your head when you didn't want them to

Page Break

How long have you experienced the problems described on the previous page?

- ☐ Less than 1 month
- ☐ 1 to 3 months
- ☐ More than 3 months

How disabling were these reactions?

- ☐ Not at all disabling

- ☐ Slightly disabling
- ☐ Definitely disabling
- ☐ Markedly disabling
- ☐ Severely disabling

Please indicate if the problems you rated above interfered with any of the following areas of your life:

	Yes	No	N/A
Work	☐	☐	☐
Household chores and duties	☐	☐	☐
Relationships with friends	☐	☐	☐
Fun and leisure activities	☐	☐	☐
Schoolwork	☐	☐	☐
Relationships with your family	☐	☐	☐
Sex life	☐	☐	☐
General satisfaction with life	☐	☐	☐
Overall level of functioning in all areas of your life	☐	☐	☐

Page Break

Next we will ask you about other traumatic events you may have experienced.

Page Break

Have you experienced any of the following traumatic events:

	Yes	No
Serious accident, fire, or explosion (for example an industrial, farm, car, plane or boating accident)	☐	☐
Natural disaster (for example, tornado, hurricane, flood, or major earthquake)	☐	☐
Non-sexual assault by someone you know (for example being mugged, physically attacked, shot, stabbed or held at gunpoint)	☐	☐
Non-sexual assault by a stranger (for example being mugged, physically attacked, shot, stabbed or held at gunpoint)	☐	☐
Sexual assault by someone you know (for example, rape or attempted rape)	☐	☐
Sexual assault by a stranger	☐	☐
Military combat or experience of a war zone	☐	☐
Sexual contact when you were younger than 16 with someone who was 5 or more years older than you (for	☐	☐

example, contact with genitals, breasts)		
Imprisonment (for example prison inmate, prisoner of war, hostage)	☐	☐
Torture	☐	☐
Life-threatening illness	☐	☐
Other traumatic event (please specify)	☐	☐

*Skip To: End of Block If Have you experienced any of the following traumatic events: =
Natural disaster (for example, tornado, hurricane, flood, or major earthquake)*

Page Break

During this traumatic event:

	Yes	No
Were you physically injured?	☐	☐
Was someone else physically injured?	☐	☐
Did you think that your life was in danger?	☐	☐
Did you think someone elses life was in danger?	☐	☐
Did you feel helpless?	☐	☐
Did you feel terrified?	☐	☐

In the last month, how often have you been:

	Not at all or only one time	Once a week or less/ Once in a while	2 to 4 times a week/Half the time	5 or more times a week/ Almost always
Having upsetting thoughts or images about the event that came into your head when you didn't want them to	☐	☐	☐	☐
Having bad dreams or nightmares about the event	☐	☐	☐	☐
Reliving the event acting or feeling as if it was happening again	☐	☐	☐	☐
Feeling emotionally upset when you were reminded of the event (for example, feeling scared, angry, sad, guilty etc)	☐	☐	☐	☐
Experiencing physical reactions when you were	☐	☐	☐	☐

reminded of the
event (for
example,
breaking out in a
sweat, heart
beating fast)

Trying not to
think about, talk
about, or have
feelings about
the event

Trying to avoid
activities,
people, or places
that remind you
of the event

Not being able
to remember an
important part of
the event

Having much
less interest or
participating
much less often
in important
activities

Feeling distant
or cut off from
people around
you

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Feeling emotionally numb (for example, being unable to cry or unable to have loving feelings)	☐	☐	☐	☐
Feeling as if your future plans or hopes will not come true (for example, you will not have a career, marriage, or a long life)	☐	☐	☐	☐
Having trouble falling or staying asleep	☐	☐	☐	☐
Feeling irritable or having fits of anger	☐	☐	☐	☐
Having trouble concentrating (for example drifting in and out of conversations, losing track of a story on television,	☐	☐	☐	☐

forgetting what
you read)

Being overly
alert (for
example,
checking to see
who is around
you, being
uncomfortable
with your back
to a door, etc)

Being jumpy or
easily startled
(for example,
when someone
walks up behind
you)

☐

☐

☐

☐

☐

☐

☐

☐

Skip To: Q11 If In the last month, how often have you been: = Having upsetting thoughts or images about birth that came into your head when you didn't want them to

Page Break

How long have you experienced the problems described on the previous page?

- ☐ Less than 1 month
- ☐ 1 to 3 months
- ☐ More than 3 months

How disabling were these reactions?

- ☐ Not at all disabling
- ☐ Slightly disabling
- ☐ Definitely disabling
- ☐ Markedly disabling

☐ Severely disabling

Please indicate if the problems you rated above interfered with any of the following areas of your life:

	Yes	No	N/A
Work	☐	☐	☐
Household chores and duties	☐	☐	☐
Relationships with friends	☐	☐	☐
Fun and leisure activities	☐	☐	☐
Schoolwork	☐	☐	☐
Relationships with your family	☐	☐	☐
Sex life	☐	☐	☐
General satisfaction with life	☐	☐	☐
Overall level of functioning in all areas of your life	☐	☐	☐

End of Block: Emotional Well-being Questionnaires

Start of Block: Emotional Well-being Questions Pt. 2

In this section we will ask about your emotional well-being and symptoms you might be experiencing.

Please press the arrow to continue.

Page Break

Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983)

Read each item carefully and tick the box next to the reply which comes closest to how you have been feeling in the past week. Don't take too long over your replies; your immediate reaction to each item will probably be more accurate than a long thought-out response.

I feel tense or wound up

- ☐ Most of the time
- ☐ A lot of the time
- ☐ From time to time, occasionally
- ☐ Not at all

I still enjoy the things I used to

- ☐ Definitely as much
- ☐ Not quite so much
- ☐ Only a little
- ☐ Hardly at all

I get a sort of frightened feeling as if something awful is about to happen

- ☐ Very definitely and quite badly
- ☐ Yes, but not too badly
- ☐ A little, but it doesn't worry me
- ☐ Not at all

I can laugh and see the funny side of things

- ☐ As much as I always could
- ☐ Not quite so much now
- ☐ Definitely not so much now
- ☐ Not at all

Worrying thoughts go through my mind

- ☐ A great deal of the time
- ☐ A lot of the time
- ☐ From time to time but not too often
- ☐ Only occasionally

I feel cheerful

- ☐ Most of the time
- ☐ Sometimes
- ☐ Not often
- ☐ Not at all

I can sit at ease and feel relaxed

- ☐ Definitely
- ☐ Usually
- ☐ Not often
- ☐ Not at all

I feel as if I am slowed down

- ☐ Nearly all the time
- ☐ Very often
- ☐ Sometimes
- ☐ Not at all

I get a sort of frightened feeling like 'butterflies' in the stomach

- ☐ Nearly all the time
- ☐ Quite often
- ☐ Occasionally
- ☐ Not at all

I feel as if I have lost interest in my appearance

- ☐ Definitely
- ☐ I don't take as much care as I should
- ☐ I may not take quite as much care
- ☐ I take just as much care as ever

I feel restless as if I have to be on the move

- ☐ Very much indeed
- ☐ Quite a lot
- ☐ Not very much
- ☐ Not at all

I look forward with enjoyment to things

- ☐ As much as I ever did
- ☐ Rather less than I used to
- ☐ Definitely less than I used to
- ☐ Hardly at all

I get sudden feelings of panic

- ☐ Very often indeed
- ☐ Quite often
- ☐ Not very often
- ☐ Not at all

I can enjoy a good book or radio or TV programme

- ☐ Often
- ☐ Sometimes
- ☐ Not often
- ☐ Very seldom

End of Block: Emotional Well-being Questions Pt. 2

Start of Block: Demographic Questions

In the final section, we will ask you some basic demographic questions.

Please click the arrow to continue.

Page Break

What is your gender?

- ☐ Male
- ☐ Female

What is your age?

Please state your highest level of education:

- ☐ Primary and/or middle school
- ☐ Secondary school
- ☐ Further education i.e. Sixth Form, College
- ☐ Trade/technical/vocational training
- ☐ Undergraduate degree
- ☐ Postgraduate degree

What is your marital status?

- ☐ Single
- ☐ In a relationship
- ☐ Living with partner
- ☐ Married
- ☐ Separated/divorced
- ☐ Widowed

Who do you live with?

- ☐ Husband/partner
- ☐ Husband/partner and children
- ☐ Parents
- ☐ Friends
- ☐ Just your children
- ☐ Alone

What job do you do, or did you do before getting pregnant? Please state job title and type of business

Display This Question:

If What is your marital status? = In a relationship/Living with partner/Married

If your partner is employed, please specify their job title and type of business below:

What is your ethnic group?

- ☐ White
 - ☐ Mixed/Multiple ethnic groups
 - ☐ Asian
 - ☐ Black/African/Caribbean/Black British
 - ☐ Other ethnic group (please specify)
-

Page Break

Do you consider yourself to have a disability?

- ☐ Yes
- ☐ No

Skip To: Q77 If Do you consider yourself to have a disability? = No

Please indicate the nature of your disability:

- ☐ Dyslexia
 - ☐ Blind/partially sighted
 - ☐ Deaf/hearing loss
 - ☐ Mobility (physical disability)
 - ☐ Learning disability
 - ☐ Mental health difficulty (i.e. depression, anxiety, schizophrenia)
 - ☐ Progressive disability/chronic illness (i.e. MS)
 - ☐ Other, please specify
-

Page Break

Q77 We will be asking some women from this study if they are interested in coming to City University London to do the tasks outlined at the beginning. If you would be interested in taking part in these tasks, please leave your contact details below.

If you are not interested in taking part please put n/a in the boxes.

E-mail address

Telephone Number

Mobile Number

End of Block: Demographic Questions

Start of Block: Thank you

Thank you for filling in this survey – we really appreciate your help!

We will be asking some women from this study if they are interested in coming to City University London to do the tasks outlined at the beginning. We will be in touch with you about this in the next 10 days. If you are not part of this group but would like to hear more about the results of this study please the box below and we will email you a summary of the results when they are available in 2016.

Please tick here if you would like to be e-mailed a summary of the results when they are available.

☐

If completing this survey has raised any issues or questions please feel free to get in touch with the lead researcher, Rebecca Webb at [REDACTED] Alternatively, please follow the links for information and support pages:

Postnatal Anxiety: Information on symptoms, causes, treatments

Postnatal Depression: Information on symptoms, causes, treatments

Birth Trauma Association: UK charity offering support to women who have had a traumatic birth experience

PANDAS: UK charity in offering support to families suffering from pre (antenatal) and postnatal illnesses

APNI: Providing support to mothers with postnatal mental illness

End of Block: Thank you

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