Rita Tatiana Amiel Castro

Maternal mental health during pregnancy:

Associations with breastfeeding and infant temperament

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Dedication

To my parents, whose unconditional love and support crossed borders to help me achieve all I have in life; to my sister Paula, for always making her happiness mine.

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There is an excerpt of a Brazilian book, which inspired me throughout the time it took me to complete my PhD. It refers to the people from northeastern Brazil, where I am from, and it says: “O sertanejo é, antes de tudo, um forte” (literal translation: “People of the backlands are above all a fortress”). These words reminded me that every challenge and every difficult moment during this PhD would bring me new knowledge and showed me I had the necessary strength to overcome it. The last years were filled with numerous experiences and possibilities in the research area, which I am very grateful to have experienced. However, these experiences and this work would not have been possible without the encouragement and support I received from a great number of individuals.

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Abstract

In view of the substantial challenge posed by the global burden of depression, it is relevant to investigate how a disease, which is a leading cause of disability worldwide, may affect mothers, mothers-to-be, and their infants. Maternal depression can have a far-reaching impact on an individual's life. It can compromise her work, maternal practices, family, and the infant's health and development. However, whereas associations have been done between perinatal depression and aspects such as birth outcomes or maternal level of interaction with the baby, other lines of research present limited studies or conflicting findings. In this dissertation, a new perspective on prenatal depression is provided. The link prenatal depression has with breastfeeding behaviour and infant temperament is investigated. In order to offer a better understanding of these topics, the role maternal coping styles and attitudes towards feeding might exert is also considered. For this, two empirical studies were conducted. The first, aimed to examine the associations between prenatal depression and breastfeeding behaviour, accounting for a wide range of covariates. The second investigated the way in which maternal mood and coping variation affect breastfeeding and infant temperament.

In the first study, the impact of self-reported prenatal depressive symptoms, attitudes towards breastfeeding and socio-demographic factors in predicting breastfeeding through the first six months was investigated. Previous research has suggested that prenatal depression might affect breastfeeding, but the association was not clear. While some studies reported that prenatal depression predicts reduced breastfeeding initiation, others found it to predict shorter breastfeeding duration, and some did not find any relationship. This study aimed to clarify these findings including potential confounders into the analysis, in order to find the real effect prenatal depressive symptoms have on breastfeeding practices. Nine thousand four hundred and seventy-nine participants provided data on prenatal depressive symptoms, attitudes towards breastfeeding, breastfeeding practices and socio-demographic information from 18 weeks gestation until six months postpartum. Prenatal depressive symptoms were associated with decreased breastfeeding initiation and duration. However, the prediction of breastfeeding by these symptoms was confounded with the covariates. When accounting for them, prenatal depressive symptoms were only significantly associated with breastfeeding at the first postpartum day. On the other hand, a positive prenatal attitude towards breastfeeding was associated with a 20-30% increase in breastfeeding initiation and maintenance at one and six months. These findings provide innovative evidence of the real effect prenatal depressive symptoms have on breastfeeding behaviour, and how

a positive attitude towards breastfeeding may contribute to feeding practices. This further helped to elucidate the currently inconsistent literature on the subject.

In the second study, changes in maternal mood and maternal coping styles from pregnancy throughout the first six months postpartum were examined, and the effects of mood and coping on both breastfeeding and child temperament were investigated. Maternal coping in pregnancy and postpartum plays an important role in maternal mood, and in combination they may impact infant outcomes. Previous research largely investigated the effects perinatal mental disorders have on breastfeeding and on child's temperament, but uncertainty remains regarding the influences of normal mood changes. One hundred and sixty-two pregnant women participated in this study providing self-reported data on mood, coping styles, infant feeding and infant temperament from 20 weeks gestation until six months postpartum. Significant changes were seen in maternal mood across pregnancy and postpartum, and at 20 weeks gestation lower mood predicted higher infant's extraversion. Increased use of problem-focused coping at 20 and 28 gestational weeks was associated with lower infant's negative affect, and at 28 gestational weeks with higher infant's effortful control. Importantly, maternal mood and coping independently predicted infant outcomes and were not associated with breastfeeding at any time point. Most women provided exclusive or mixed breastfeeding at one and six months, independent of maternal mood. Possibly, the stable coping styles from pregnancy throughout postpartum, and the use of healthy coping strategies by most women were associated with a mentally healthy sample.

In conclusion, this dissertation provides novel evidence about the effects prenatal depressive symptoms and maternal mood have on breastfeeding practices and on infant's temperament. These findings contribute to a new perspective on this research area. They underscore the importance to consider not only prenatal depressive symptoms, but also maternal coping and attitudes towards breastfeeding when developing effective interventions to reduce depression in pregnancy and to promote breastfeeding.

Figures

Tables

Abbreviations

ADHD	Attention deficit hyperactivity disorder
AA	Arachidonic acid
ACTH	Adrenocorticotropic hormone
AIDS	Acquired immune deficiency syndrome
ALSPAC	Avon longitudinal study of parents and children
APA	American psychiatric association
BMI	Body mass index
CBT	Cognitive-behavioural therapy
CRH	Corticotropin-releasing hormone
DHA	Docosahexaenoic acid
DSM-IV	Diagnostic and statistical manual of mental disorders – fourth edition
EEG	Electroencephalography
EPDS	Edinburgh prenatal depression scale
GCs	Glucocorticoids
HFD	High in fat diet
HIV	Human immunodeficiency virus
HPA	Hypothalamic-pituitary-adrenal
IPT	Interpersonal psychotherapy
LBW	Low birth weight
LG	Licking and grooming
MDD	Major depressive disorder
pCRH	Placental corticotropin-releasing hormone
PPD	Postpartum depression
PTB	Preterm birth
PTSD	Posttraumatic stress disorders
SES	Socio-economic status

SSRI	Selective serotonin re-uptake inhibitors
TPB	Theory of planned behaviour
TRA	Theory of reasoned action
TSST	Trier social stress test
UK	United Kingdom
US	United States
WHO	World health organization
11β-HSD2	11β-Hydroxysteroid dehydrogenase

Introduction

Depression is the most predominant of all childbearing mental illnesses and a leading cause of disability in women in reproductive age (O'Hara & Swain, 1996; Nobel, 2005). Previous research has shown that high levels of depression or anxiety in women during pregnancy double their children's risk for attention deficit hyperactivity disorder (ADHD), conduct disorders, difficult temperament and behavioural problems later on (O'Connor, Heron, Golding, Beveridge & Glover, 2002). Prenatal depression and anxiety contribute an estimated 10-15% of the variance in these outcomes (Talge, Neal & Glover, 2007). High levels of prenatal anxiety and depression are frequently comorbid. In combination with stress they increase the risk for preterm delivery, low birth weight, impaired memory, and cognitive malfunction among others. These consequences are in part due to foetal programming effects, in which negative events occurring during critical periods of foetal development may have a lasting impact on the child. In addition, prenatal depression is a major risk factor for postpartum depression (Talge, Neal & Glover, 2007).

Mental illnesses around childbirth cause detrimental consequences for mothers and infants (Holbrook, Haselton, Schetter & Glynn, 2013). For instance, a number of aspects of maternal care can be compromised when a woman is affected by a perinatal mental disorder (Groer & Morgan, 2007). Negative effects include breastfeeding difficulties, potential negative perceptions of infant temperament and reduced sensitivity to the infant's needs (Rahman, Iqbal, Dunn, Lovel & Harrington, 2004). In their systematic review, Dennis and McQueen (2009) concluded that women with depression around childbirth are more likely to be worried about breastfeeding (Dennis, Janssen & Singer, 2004) and to discontinue breastfeeding much earlier than non-depressed women. Breastfeeding is widely acknowledged as beneficial for the physical health and emotional wellbeing of infants (World Health Organization [WHO], 2002a; American Academy of Paediatrics, 1997; Canadian Paediatric Society, 2005; Health Canada, 2004). It has been associated with higher infant cognitive development (Anderson et al., 1999), lower blood pressure, and lower body mass index (BMI) in children (Brion et al., 2011). It may also be a protective factor against obesity later in life (Toschke et al., 2007). Exclusive breastfeeding is recommended for the first six months of life (WHO, 2002a) and it is of concern that depressed mothers are less likely to achieve this (Dennis & McQueen, 2009). Moreover, maternal mental disorders can impact the development of the infant's temperament, since they may contribute to impaired mother-baby interactions and to inaccurate perceptions of the infant's temperament (Beck, 1996).

Early life temperamental traits can shape the child's adjustment, development, and behaviour from infancy to adulthood. It has been suggested that the type of feeding (formula or breast) might have an influence on children's temperamental characteristics (Kielbratowska, 2015). While some observational studies found breastfed infants to be less irritable, more active, and temperamentally easier (Field, Hernandez-Reif & Feijo, 2002; Worobey, 1998; Vandiver, 1997), others reported contrary findings (Lee, 2000; Lauzon-Guillain et al., 2012). Breast milk composition is a potential candidate to disentangle this controversy. However, so far, little is known about its potential effects (Hinde, 2013). Findings from animal as well as from humans' studies showed that lactation transmits hormones in milk - the stress hormone cortisol in particular - from mother to infant. This may negatively affect infant temperament (Glynn et al., 2007; Grey et al., 2013; Hinde & Capitanio, 2010; Sullivan et al., 2011). However, further research with human subjects that examines the lasting effects of breast milk's cortisol on temperament is warranted (Hinde, 2013).

Although the issues mentioned above were subject of intense investigation over the years, many important questions remain unanswered. This dissertation aims to provide a new perspective on maternal mental health disorders, prenatal depression in particular, breastfeeding and infant temperament by focussing not only on the link they have with each other, but considering their association with the role maternal coping styles and attitudes towards breastfeeding might exert.

This dissertation consists of three main parts. The first section develops the theoretical foundation to the research topics investigated. Chapter 1 provides a general overview on maternal mental disorders in the childbearing period, describing the most common disorders for these phases and how they can affect birth outcomes. Chapter 2 defines infant feeding and its methods and reviews the impact of pre- and postpartum mental disorders on breastfeeding, explores their association with infant temperament and development, and highlights the importance of intention and attitudes to breastfeeding behaviour. The focus of chapter 3 lies on maternal stress and breastfeeding. The theoretical concept and occurrence of prenatal stress are presented, followed by a description of the neurobiology of stress in pregnancy and its consequences for birth and offspring. The chapter is closed by discussing the effects of maternal stress on lactation. Chapter 4 discusses maternal coping styles in light of perinatal disorders and outcomes for infant temperament. The final chapter discusses the links between infant temperament and maternal mood during and after pregnancy as well as the effects of the type of feeding. The second section of this dissertation consists of two empirical studies that evolve on the concepts previously described. Lastly, the thesis concludes with a general discussion of the main findings, integration with the theoretical foundation, limitations, and suggestions for future research work.

PART I: THEORETICAL BACKGROUND

Chapter 1

Mental health disorders and the childbearing period

"Depression is living in a body that fights
to survive, with a mind that tries to die."
- Neil Lennon

Mental health is conceptualized as a state of psychological wellbeing in which individuals can realize their own capacities, live a productive life, cope with normal life stress, and contribute to their communities (WHO, 2010). The WHO further states that mental health is an essential part of general health and wellbeing and can be affected by a number of factors.

Over the last years, several studies have shown how women in their reproductive years in general and during pregnancy and postpartum in particular, were more vulnerable to mental health problems (Yonkers et al, 2011; Tolin & Foa, 2002). These disorders not only affect women, but also their families, partners, the developing foetus, and later the newborn (Kulkarni, 2006). The important biopsychological changes brought by the perinatal period require constant attention from health workers since they carry relevant risk factors for the mother's health and for the infant's neurodevelopment (Schetter & Tanner, 2012).

This chapter aims to discuss biological and psychological aspects of pregnancy, the most common mental diseases in the perinatal period and the negative outcomes they may have for birth and the newborn.

1.1 Definition of mental health disorders in the perinatal period

Mental health disorders denote a range of mental and behavioural dysfunctions that cause disease, suffering and poor ability to function in normal life (WHO, 1992). Commonly recognized mental disorders include depression, bipolar affective disorder, schizophrenia, anxiety disorders, intellectual disabilities, substance use disorders, and dementia (WHO, 2010). People with mental illnesses have higher rates of disability and mortality and are more likely to be affected by diseases such as cancer, diabetes, cardiovascular problems and human immunodeficiency virus (HIV) or to acquire immune deficiency syndrome (AIDS). Suicide is also a more frequent cause of death among people with mental disorders than in the general population (WHO, 2010).

Evidence from epidemiology, genetics, and neuroscience studies (Angermeyer & Kuhn, 1998; Haefner et al., 1998; Fink, Sumner, Rosie, Wilson & McQueen, 1999) emphasizes differences between sexes in the onset of some mental disorders such as depression and anxiety. Women are more prone to develop them and have more intense symptoms than men (Kulkarni, 2006). These differences suggest gender-specific causal mechanisms for the aforementioned disorders with different development, duration, and progression (Kulkarni, 2006). The incidence of mood disorders is increased in the childbearing years and the recurrence of past disorders is common during reproductive events (Figure 1; Kendler, Walters & Kessler, 1997), such as menarche, pregnancy, postpartum and menopause. Mood disorders might occur in different intensities, requiring different treatment approaches. Several studies have supported this hypothesis, showing associations between premenstrual symptoms and postpartum depression (Bloch et al., 2005; Warner et al., 1991) as well as between premenstrual and early pregnancy (10-12 weeks gestation) somatic symptoms (Winkel et al., 2013). However, pregnancy and postpartum present very specific issues in terms of treatment types due to associated risks for the baby (Tolin & Foa, 2002).

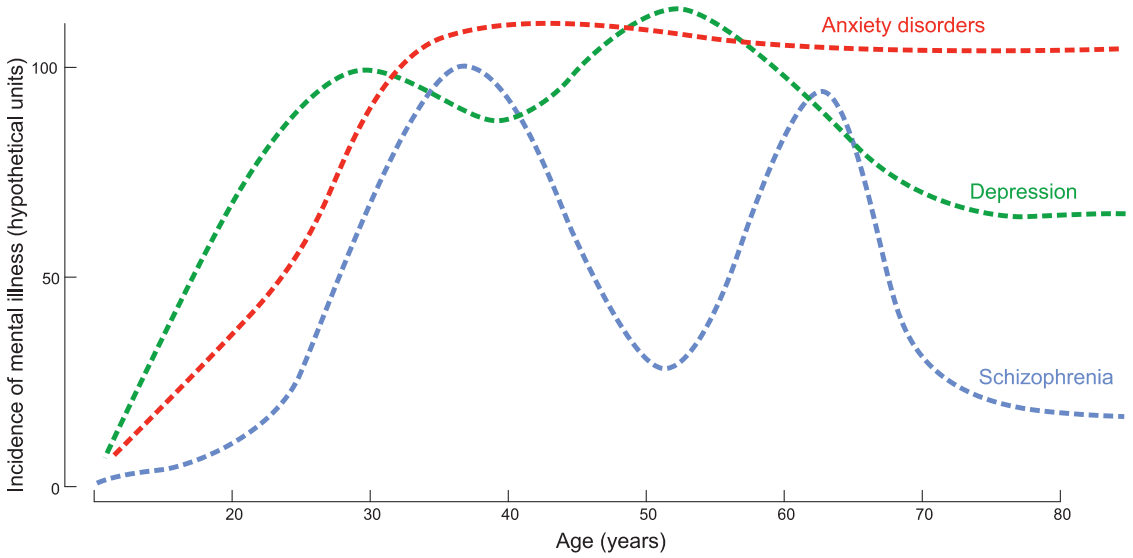

Figure1. Theoretical incidence of women's mental disorders over time (adapted from Kulkarrni, 2006).

Mental disorders in childbearing women have been studied since the 19th century (Brockington & Kumar, 1982), when Jeanne Etienne Esquirrol and Louis Victor Marcè established perinatal psychiatry as a sub-field of psychiatry. It investigates the complexity of the physiological, psychological and environmental processes involved in the perinatal period and the adverse consequences to the foetus and infant based on their distinct epidemiology, aetiology, treatment and

outcomes (Appleby, Kummar & Warner, 1996). Since its foundation, this sub-field has evolved greatly with hundreds of papers published in the area, dozens of research groups working with this topic around the world and an international society exclusively dedicated to the study of perinatal mental health.

1.2 Biological and psychological aspects of pregnancy, birth and postpartum

Pregnancy brings about many physiological, psychological and social changes in a woman's life (Nelson, 2003). Biologically, pregnancy requires a dramatic alteration in almost all maternal body systems to allow sustenance and growth of the foetus (Horan, 2007). It can be defined as "the development of an unborn within a woman's uterus and the accompanying physical, biochemical and developmental changes that occur on both mother and child from conception until birth" (Kalumuck, 2014; p.320). Limited in time, pregnancy has a mean duration – counting from the first day of the last menstrual period – of 284 days and is divided into three different phases called trimesters. Each trimester lasts about three months and is considered an important time point for pregnancy progression. All three are associated with specific physical and biochemical characteristics and foetal development stages (Kalumuck, 2014).

After fertilization, the genetic material of the sperm and egg combine to form the zygote. Within the zygote the embryogenesis - the process of cell division and cell differentiation of the embryo in the early stages of pregnancy - starts. The human embryo implants in the maternal endometrium. For approximately ten weeks the embryogenic process - which also creates the placenta and the umbilical cord - progresses. After the tenth gestational week, the embryo becomes known as a foetus. Organs and tissues undergo major growth and mature until birth. Hormonal alterations are also taking place in the mother, with higher production of oestrogen, estradiol and progesterone. The pituitary gland expands in order to produce prolactin, oxytocin, follicle stimulating, and luteinising hormone that will be released later in gestation. The thyroid gland activity is also increased to control the complex feedback systems of the hormonal organs that determine the course of pregnancy. The complete gestational period normally lasts from 38-40 weeks and after the release of several hormones from the ovaries, placenta and the pituitary gland, the maternal body is prepared for birth (Kalumuck, 2014).

For most women, the gestational period is a natural and joyful event. It is recognized as a time in which several psychological processes occur, new levels of personal maturity may be achieved and the transition to motherhood commences (Zager, 2009). A certain amount of anxiety is usual and expected (Chalmers, 1983) due to the far-reaching adjustments an expectant mother will face in the

following nine months. Fear of birth was reported in the literature as a worry for some pregnant women and increases when the delivery date gets nearer (Harder, 2013). Preparation for changes in social and partner relations are also recognized as tasks of pregnancy, which may lead to concerns and uncertainty (Raynor, 2006). According to Darvill et al. (2010), social support is a strong predictor of successful transition to the new maternal role. Other research (Beck, 2002; Chalmers, 1983; Waldenstrom et al., 2004) indicates that having support increases self-confidence in the motherhood role, facilitates a healthy obstetric outcome and reduces the prevalence of depressive symptoms in the postpartum phase.

Mood changes and psychological distress can also be part and associated with the psychological adjustments related to the gestational period (Raynor, 2006). A potential causal link between hormonal alterations occurring during pregnancy and changes in mood has been suggested by various authors, since they correlate in time (Steiner, 1998). The singularity of psychiatric disorders triggered by pregnancy and postpartum has been acknowledged by the American Psychiatric Association (APA; 1994) with their inclusion and specific designation in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV; Purnine & Frank, 1996). Since then, research in this area has increased considerably (APA, 2000). As part of the psychobiological changes experienced during pregnancy, a bond between mother and baby begins to develop already in utero (Raynor, 2006). Recent studies provide evidence with regard the functioning of the neurobiology of maternal behaviour during pregnancy (Brunton & Russel, 2008; Insel & Young, 2001). These studies focus on the essential role of oxytocin, vasopressin and the hypothalamic-midbrain-limbic-paralimbic-cortical circuits of the brain as the main sources for the early activation of maternal behaviour (Swain et al., 2007; Brunton & Russel, 2008). Animal studies have reported the importance of oestrogen and progesterone in the initial expression of maternal behaviours in pregnant rats (Rosenblatt, Mayer & Giordano, 1988; Kinsley, 1994). However, although it is possible to build a neurobiological model of early maternal behaviour, interaction with the newborn appears to be essential to maintain postnatal caregiving (Kelley, 1988; Klaus, Kennel & Ballard, 1982).

Regarding the postpartum period, Lyon (2008) states that the significant physical and emotional changes needed to return to the nonpregnant condition are often under-evaluated. The postpartum is a time of rapid change during which all body systems undergo major restructuration. This may lead to increased maternal fatigue (Katz, 2007). Additionally, the new mother needs to attend the demands of a new baby and become familiar with breastfeeding as well as with the specific care of the breasts that now are secreting milk (Neville, 2001). Metabolic and hormonal alterations are also

happening in a fast pace and the sharp decrease of oestrogen and progesterone after delivery may play a role in mood changes and disorders frequently presented during the postpartum period (Halbreich & Kahn, 2001; Stahl, 2001).

1.3 Mental health disorders in pregnancy and postpartum: an overview

The reproductive experience - gestation, birth, and lactation - is marked by an intense fluctuation and high exposure to psychoactive hormones (Lommatzsch et al., 2006). These hormonal fluctuations can cause somatic and affective symptoms, since, for example, estradiol levels during pregnancy are 30 times higher than during the menstrual cycle. Cortisol levels are also as high as in major depressive disorders (Glynn, 2012). Most women can cope with the hormonal changes without much disturbance, but others seem more predisposed to experience mental disorders in this period (Halbreich, 2010; Soares & Zitek, 2008).

This section provides an overview of the most common mental health disorders during pregnancy and postpartum since they are the foundation of the topics here discussed as well as the empirical papers.

1.3.1 Prenatal depression

Depression is generally regarded as the most common psychological complication during pregnancy (Cunningham et al., 1997) and is considered a serious mental health concern (Brock et al., 2014). Prenatal depression does not differ in its clinical symptomatology from depression outside the pregnancy period (Bitzer & Riecher-Rössler, 2005). Its symptoms include, but are not limited to low mood, decreased interest and enjoyment, changes in appetite, sleep, weight, energy and memory, lowered self-esteem, and feelings of guilt (Cantwell & Cox, 2006). During gestation, depression is often overlaid by somatic pregnancy-related discomforts making it challenging to diagnose (Bader et al., 2010).

Important changes in biological (e.g. thyroid functions, hormone levels, hypothalamic-pituitary-adrenal [HPA] axis function; Soldin et al., 2005), social, and psychological functions in every pregnancy trimester are likely to predispose the development of depressive symptomatology during pregnancy (Su et al., 2007). Maternal hormone concentrations play an important role regarding mood states (Da Costa, Brender & Larouche, 1998) and their variation can alter the prevalence of depression per trimester (Fan et al., 2009). Although up to 70% of pregnant women complain about negative mood symptoms (Cantwell & Cox, 2006), Bennet et al. (2004) reported a depression incidence of 7.4% ([95% CI] 2.2-12.6) in pregnant women in the first, 12.8% ([95% CI] 10.7-14.8)

in the second, and 12% ([95% CI], 10.7-14.8) in the third trimester. Evans et al. (2001) similarly reported a significant increase in depression scores between the 18th and 32nd gestational week when compared to early pregnancy.

While the first onset of depression may commonly occur during pregnancy, women are at increased risk if they have previously experienced depression, have a family history of depression or suffer from any other mood disorder (APA, 2000). Risk factors for depression during pregnancy include stressful life events, lack of social support, domestic violence (Lancaster et al. 2010), maternal anxiety, unwanted or unplanned pregnancy, low income, low education level and nicotine consumption (Frisch & Riecher-Rössler, 2011). Prenatal depression has also been associated with a history of previous abortions, ambivalent feelings towards pregnancy, high-risk pregnancy, and consideration of abortion (Kent et al., 1997).

Frequently, symptoms of depression remain undetected (Hatton et al., 2007) and only about 20% of pregnant women are properly diagnosed (Hatton et al., 2007). If left untreated, depression can cause a number of adverse consequences for the gestation, including alcohol and drug use, poor nutrition, and lack of compliance with prenatal care recommendations (Carter & Kostaras, 2005). Additional implications are potential negative effects on the foetus and on how a woman perceives her baby, potentially compromising the mother-baby relation and the postpartum care (Edwards et al., 2008).

Treatment for prenatal depression relies on the same methods used for depression at any other time (Carter & Kostaras, 2005). Psychoeducation, supportive therapies, and psychotherapies such as cognitive behavioural therapy (CBT) and interpersonal psychotherapy (IPT) have been shown to be effective treatments for prenatal depression (Dennis, Ross & Grigoriadis, 2007). Antidepressant drug therapy is also recognized as an effective treatment and recently has been shown to carry minor risks for the baby with benefits outweighing the risks (Wisner et al., 2009). Additionally, prenatal depression is a strong predictor of postpartum depression, as it will be further described in the section 1.3.4, almost doubling the overall risk of a new onset (Cantwell & Cox, 2006).

1.3.2 Maternal prenatal anxiety

The occurrence of anxiety states during pregnancy and following delivery is frequent (Oates, 2006) with 7- 21% of women showing clinically relevant anxiety levels in these phases (Grant, McMahon & Austin, 2008). During pregnancy, anxiety has an overall prevalence of 10% (Bennett et al., 2004; Gavin et al., 2005) and the concerns usually relate to the course of pregnancy, wellbeing of the foetus and complications at delivery (Evans et al., 2001). Furthermore, anxiety is commonly

comorbid with depressive symptoms pre and postpartum (Beck, 2002; Matthey et al., 2003; Ross et al., 2003).

Clinical symptoms can be very heterogeneous and are caused by a number of factors such as pre-existing disorders, symptoms developed during pregnancy, symptoms triggered by gestational physiological changes, pregnancy-related anxiety, and pregnancy complications (Alder & Urech, 2011). Women with a previous history of severe anxiety (e.g. phobias, obsessive-compulsive disorder, panic disorders) are at increased risk of relapse during pregnancy and postpartum (Oates, 2006; Carter & Kostaras, 2005; Kulkarni, 2006).

Although pregnancy is commonly associated with certain levels of anxiety disorders, a considerable amount of variation in anxiety during pregnancy cannot be explained by general anxiety (Orr et al., 2007). Pregnancy-related anxiety, characterized by pregnancy specific fears and worries (Brunton, Dryer, Saliba & Kohlhoff, 2015), may constitute an important source for this variation. In 2004, Huizink et al. reported “fear of giving birth”, “fear of bearing a physically or mentally handicapped child”, and “concern about one’s appearance” as specific anxiety factors in the pregnant population investigated. Moreover, they noted that general anxiety and depression accounted for only 8-27% of variance in concerns related to birth and foetal health. These findings suggest that it might be caused by a specific type of anxiety present during gestation (Huizink et al., 2004). It has been suggested that pregnancy-related anxiety may be more strongly associated with maternal and child negative outcomes than general anxiety and depression (Bayrampour et al., 2015). Cognitive-behavioural therapy, relaxation techniques, massage therapy, and social support are some of the methods that can help reduce levels of anxiety at the perinatal period (Alder & Urech, 2011).

1.3.3 Postpartum Blues

Postpartum blues, also commonly called the “baby blues”, occurs in 50-80% of women in the first week after delivery (Cantwell & Cox, 2006) with a peak incidence at the fifth day postpartum (Henshaw, 2003). It is a dysphoric and usually self-limiting condition that resolves fairly quickly (Zager, 2009) and it has been suggested to occur more often among primipara (Felber Piso, 2006; Riecher-Rössler, 2001).

Typical symptoms are lability of mood, sleep disturbance, irritability, tearfulness, fatigue, and hostile thoughts towards the newborn (Henshaw, 2003; Heron et al., 2005). Increased anxiety and depression in late pregnancy may predict postpartum blues (Cantwell & Cox, 2006) as well as marital conflicts, high levels of trait anxiety, menstrual dysregulation and difficulty to accept

motherhood (Ehlert et al., 1990). Furthermore, women experiencing postpartum blues were shown to present higher morning cortisol levels compared to women not presenting this disorder (Ehlert et al., 1990). This period is understood as a temporary and normal reaction to the significant changes occurring after birth. It is expected to resolve without major interventions (Schönberner, 2013). However, severe postpartum blues can be a risk factor for later postpartum depression (Reck et al., 2009).

1.3.4 Postpartum depression

Postpartum depression (PPD) is defined as a "major depressive disorder (MDD) with a specifier of postpartum onset within one month after childbirth" (APA, 2000). Some studies, however, have found it has a peak at six weeks postpartum and can last several months (Cantwell & Cox, 2006). It is the most well-known perinatal mental disorder and has an overall prevalence of 10-15% (Nonacs, Viguera & Cohen, 2002; Schönberner, 2013). Similarly to depression in any other life period, postpartum depression is characterized by a combination of physiological, affective, and behavioural symptoms that may alternate during the disease course (APA, 2000). Specific symptoms of this time are lack of interest in the baby and fear of harming the baby (Murray et al., 1996).

The aetiology of PPD may be in part connected to the endocrine system, with the HPA axis playing a main role. It seems that levels of the placental corticotropin-releasing hormone (pCRH) at 25 weeks gestation, may predict postpartum depression (Yim et al., 2010; McCoy et al., 2003; Bloch et al., 2000). Other risk factors include prenatal maternal depression, prenatal anxiety, previous major depression, premenstrual dysphoria, stressful life events during pregnancy or shortly after delivery, poor social support, marital conflict, low income, immigrant status, and young maternal age (Beck, 2001; Robertson et al., 2004). First time mothers tend to feel isolated, guilty or ashamed in the occurrence of PPD (APA, 2000).

Diagnosing postpartum depression is challenging due to the overlap of symptoms with the normal postpartum period. Most depression at this time remains undetected. Of all properly diagnosed women, the majority will be diagnosed by the general practitioner or a health visitor (Boyd & Somberg, 2005). Treatment is often required when symptoms persist for more than two weeks. Several effective methods can be recommended to postpartum women (APA, 2000). Interpersonal therapy (Grigoriadis & Ravitz, 2007), CBT, and psychodynamic therapy (Dennis & Hodnett, 2007) are some examples of what may be offered as treatment. Pharmacological medication is also recommended, however, it may impose a barrier for breastfeeding mothers (APA, 2004). More recent research suggests that a minimal amount of antidepressants are transferred to the

breast milk, but they have not been associated with serious adverse events for the infant (Chad et al., 2013). Further studies highlight that, in general, psychological treatments show moderate recovery effects (Cuijpers et al., 2008) whereas medication has large recovery effects on postpartum depression (Bledsoe & Grote, 2006). In severe cases, inpatient treatment might be indicated. Some centres are able and prepared to receive mother and baby (Glangeaud-Freudenthal, Howard & Sutter-Dallay, 2014).

1.4 Mental health disorders in pregnancy and adverse birth outcomes

A considerable number of studies have shown the adverse consequences affective states may have on pregnancy and birth outcomes (Schetter &Tanner, 2012; O'Donnel, O'Connor & Glover, 2009). Several studies have demonstrated associations with low birth weight (LBW; < 2500g) and preterm birth (PTB; < 37 weeks) (Glynn et al., 2008; Schetter & Lobel, 2011; Schetter, 2009; Goedhart et al., 2010; Rogal et al., 2007).

Preterm delivery has been shown to be affected by anxiety and depression in pregnancy (Beydoun & Saftlas, 2008; Behrman & Butler, 2006). General anxiety predicts risk of spontaneous PTB with effects comparable to risk factors such as smoking and pregnancy complications. Similarly, prenatal depression also increased the risk of PTB after controlling for income and ethnicity (Schetter & Tanner, 2012). In combination with stress, these psychological disorders are associated with elevated rates of premature birth (Mancuso et al., 2004; Grote et al., 2010).

Birth weight is also influenced by the aforementioned disorders. Recent research has documented that high levels of prenatal anxiety and depression have been associated with low birth weight and smaller head size (a measure of brain development) (Peterson et al., 2000). Other negative effects also have been linked to psychological events in pregnancy. Psychosocial problems have been related to foetal structural malformation (Nimby et al., 1999), although this is rare. Prenatal anxiety and depression are associated with the risk of developing preeclampsia in a later stage of pregnancy (Hobel et al., 1999a; Mulder et al., 2002; Grote et al., 2010). In addition to these complications, prenatal depression was also linked with spontaneous abortion, higher uterine artery resistance, haemorrhage during gestation, and increased risk of instrumental delivery (Bonari et al., 2004).

1.5 Summary

Mental disorders are associated with a significant burden of disease morbidity and disability. During reproductive phases, extensive hormonal, psychological, and physical changes are related to the occurrence of these disorders. Particularly in pregnancy and postpartum, women are at increased

risk of a new onset or relapse of a mental illness. During gestation, depression is the most common mental disorder with an incidence of 10-12% and often remains underdiagnosed. Anxiety is frequently comorbid, and in combination with depression, contributes to a high level of suffering in pregnant women.

Postnatally, 50-80% of women face postnatal blues, a normal reaction to the drastic physical and hormonal changes after birth, which increases the risk of developing the most well-known reproductive mental disorder: postpartum depression. PPD not only affects the mother, but may potentially compromise the quality of care provided and the type of feeding given to the baby.

In sum, these perinatal mental disorders have deleterious effects on birth outcomes, affecting birth weight, stimulating early delivery and promoting far-reaching adverse neurodevelopmental outcomes. They may also implicate poorer choices of infant feeding and ways of coping with distress.

Chapter 2

Maternal mental health disorders and infant feeding

"Breastfeeding is nature's health plan"
- Author Unknown

This chapter discusses the association between maternal mental health disorders and infant feeding. Both are important variables for the two empirical studies that constitute the second part of this dissertation. It provides a succinct definition of infant feeding and describes the existent methods of nourishing an infant. Afterwards, a review of the literature on breastfeeding history and culture is presented, followed by a discussion about how infant feeding is affected by maternal mental health disorders and a comparison between evidence from human research with similar studies done with animal models.

2.1 Infant feeding: definition and methods

According to Haydu and Sundquist (2006; p.01), infant feeding is defined as "the feeding of a child from birth to one year of age."

Breastfeeding

The most common method of infant feeding, frequently called as the "physiological norm" or "normal" is breastfeeding (Lee et al., 2012). Breastfeeding is the feeding of a baby or a young infant with human milk coming from a female breast, and should be started within an hour after birth. Frequency of feeding varies generally decreases as the child gets older (United States [US] National Institute of Health, 2015).

Numerous health organizations (World Health Organization, American Academy of Paediatrics, the United States Department of Health and Human Services, American College of Obstetrics and Gynaecologists, American Academy of Family Physicians) actively promote breastfeeding. The WHO (2002a) recommends exclusive breastfeeding[1] until the sixth month of life. Continued breastfeeding, together with adequate complementary foods is encouraged until and beyond the completion of the second year of life. Human breast milk has been shown to be the best food for

[1] Exclusive breastfed babies do not receive any type of food supplementation (e.g. water, juice, tea), except for vitamins, minerals and medication.

infants. It is nutritionally complete, sufficient to support optimal growth and development and provides all essential nutrients needed during the first six months of life (Ip et al., 2007; Kramer & Kakuma, 2002). Breast milk is composed of a variety of enzymes, proteins, hormones, and other substances that are not found in formula (Schack-Nielsen & Michaelsen, 2008). The former improves essential body functions in the new-born such as immunity and gastrointestinal maturation (Gartner et al., 2005). It also has long-chain polyunsaturated fatty acids, which contribute to the infant's neural and cognitive development (Angelsen et al., 2001; Kramer et al., 2008). Moreover, numerous studies provide evidence that exclusive and continued breastfeeding may help prevent a number of health issues. These include diabetes (Horta et al., 2007; Ip et al., 2007), heart problems (Martin, Gunnel & Smith, 2005; Owen et al., 2008) and obesity in adulthood (Monasta et el, 2010), lower respiratory problems, ear and bacterial infections (Brown & Magnuson, 2000), diarrhoea (Gribble, 2011) and several allergies in infancy (Prescott & Tang, 2005). In a US health survey (Chauntry, Howard & Auinger, 2006); predominant breastfeeding was associated with lower disease rates in the first six months of life, while minimal breastfeeding[2] had no such effect. Mothers also benefit from breastfeeding, since reduced risks of ovarian and breast cancer (Collaborative Group on Hormonal Factors in Breast Cancer, 2002) as well as gestational diabetes (Ip et al., 2007) are associated with this feeding.

Globally about 38% of babies are exclusively breastfed during their first six months of life (WHO, 2014; Fig. 2). In the United Kingdom (UK), where the data for the empirical studies that form the foundation of this dissertation were collected, as of 2012/13 (UK Department of Health: Breastfeeding Statistics 2012/2013), 73.9% of women started breastfeeding, 47.2% exclusively breastfed until 6-8 weeks and 20.5% exclusively breastfed for six months. In Switzerland, where this dissertation is being presented, 95% of women initiate breastfeeding, over 50% had exclusively breastfed their babies until 12 weeks, and the mean total duration of breastfeeding was 31 weeks (Dratva et al, 2014).

Common barriers to breastfeeding are related to lack of support from partner, family and society, lack of basic knowledge about the benefits of breastfeeding (Lee et al., 2012), early return to work, lack of workplace feeding facilities, lack of confidence, poor previous breastfeeding experience, fear of change in lifestyle among others (Haydu & Sundquist, 2006).

[2] Minimal breastfeeding happens when infants receive more liquids and other foods than breastfeeding

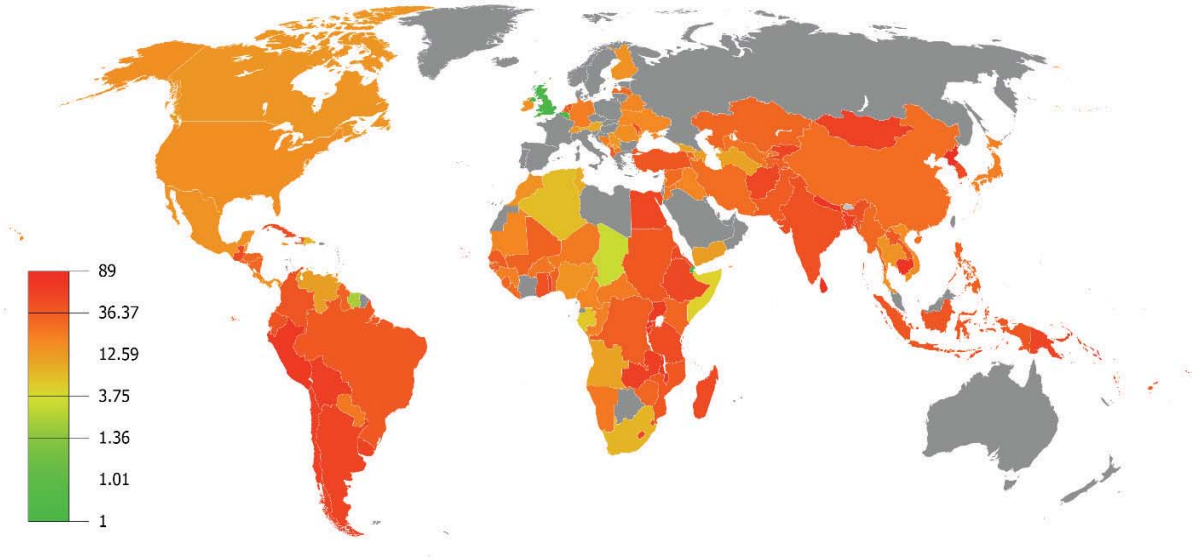

Figure 2. Percentage of babies exclusively breastfed for the first six months of life (2004 to 2011; in grey are the countries without available data) (adapted from WHO, 2014)

Formula feeding

Although breastfeeding is recommended by healthcare organisations worldwide, many infants are fully or partially formula fed (Haydu & Sundquist, 2006). Infant formula is a processed food product designed to feed babies and infants less than one year old. It is an adequate alternative to breastmilk, meeting babies' primary nutritional needs (Lee et al., 2012). In order to allow infants to achieve normal growth and health, formulas must include adequate amounts of protein, fat, vitamins, water, carbohydrate, and minerals (Haydu & Sundquist, 2006). According to formula manufacturers, infant formula composition is designed to simulate human breast milk; however there are great differences in terms of nutritional composition between both milks (Wells, 1996).

There are few indications for use of infant formula including cases when breastmilk is medically contraindicated. This can be the case due to mother (e.g. HIV infection) or baby diseases (e.g. galactosemia), when the baby is incapable of breastfeeding (e.g. birth defects), when the caregivers do not include the biological mother (e.g. foster care or adoption), as a supplement while the mother seeks help to solve breastfeeding problems and as a substitute for human milk when the mother chooses not to breastfeed at all or exclusively (American Academy of Pediatrics, 2009). Advantages frequently associated with formula feeding are the involvement of other family members in the child's feeding and, more freedom and rest for the mother after birth (US Food and Drug administration, 2014).

Mixed feeding and complementary foods

Mixed feeding occurs when breastmilk is given together with formula, baby food, water and other liquids (Lee et al., 2012). WHO (2002a) suggests that the optimal time to introduce complementary food is at six months of age while continuing to breastfeed. However, many mothers choose to offer mixed feeding (formula and breast) from birth.

The decision to introduce complementary food should be based on the infant's developmental stage and nutritional status as well as medical and environmental factors (Haydu & Sundquist, 2006). Around six months of age, most infants are capable of adapting to different food textures. Foods should be iron-rich in order to supply the nutritional requirements no longer satisfied by breast or formula feeding only (WHO, 2002b). Contrary to many mothers' beliefs, early introduction of food other than breast milk does not confer increased satiety, improved sleep patterns or developmental advances to infants (American Academy of Pediatrics, 2009).

2.2 Breastfeeding: history and culture across countries

Breastfeeding is a mix of biology and culture (Good Mojab, 2000). While it consists in a biological process prolonging the physical entwinement between mother and infant, the different approaches to breastfeeding found between and within societies are mostly based on cultural differences (Good Mojab, 2000). Having a historical view of breastfeeding evolution across the centuries contributes to a better understanding of how a biological construct has been subjected to cultural beliefs. The latter, despite being unrelated to the biological needs of mother and baby, do affect breastfeeding practices.

In ancient civilizations such as the Egyptian, Roman and Greek, breastfeeding - considered the norm among these populations for several centuries - started to be underappreciated and considered too commonplace to be done by royal females. As a consequence, wet nurses – women employed to breastfeed someone else's infant – became commonly used to breastfeed the royal children. The wet nurse "culture" was exported over the years, particularly to Western Europe where royals frequently made use of wet nurses' services. On the other hand, women from lower classes breastfed their own children, only making use of an external person for this purpose if they were physically unable to breastfeed (Goldsmith, 1990).

Similarly, during the colonization period (from the 17th to 19th century), European settlers would implement this same habit in the new colonies, where children from the richest families were breastfed by wet nurses, which were mostly slaves or indigenous women (Almeida, 1999).

In the 18th century, European governments were concerned that high rates of infant mortality would negatively impact the strength of their workforce. The high mortality rates were attributed to the use of wet nurses and their poor hygiene. At the same time, the emergence of the natural sciences led to the discovery of additional benefits of women breastfeeding their own children such as increased health. Breast milk was then considered the "miracle liquid" receiving the highest consideration among scientists of those times (Schiebinger, 1993).

Rapid urbanization and changes in the economic activities of the 20th century led to the emergence of the consumer society. With it, the use of bottle feeding ascended as a symbol of advance and modernism contradicting the scientific view, which recognized the health and emotional benefits of breastfeeding. Advancing industrialisation together with an effective marketing strategy helped the formula industry to disseminate the idea that formula feeding was more effective, more nutritious and of high cultural value than breast milk. Breastfeeding was then left in second plan, the practice being associated with lower classes and a lack of culture and education, especially in Western societies. From the 1960s onwards, breastfeeding has received a great support from international health associations that promote its practice based on significant evidence of breastfeeding benefits (Almeida, 1999; Nathoo & Ostry, 2009). Nowadays, several countries have as their national health developmental priorities, to increase breastfeeding initiation and continuation (WHO & United Nations Children's Fund, 2003).

Breastfeeding can be considered a cultural construct. The variety of breastfeeding approaches described worldwide in the most different societies are not only signs of modernism, but are also largely based on cultural differences. While some societies are culturally compatible with breastfeeding, others may discourage it (Good Mojab, 2000). Cultural beliefs and traditions are long described to influence health behaviours and many of them surround breastfeeding (Osman, El Zein &Wick, 2009).

Some cultural beliefs might contribute to early termination of breastfeeding or no initiation at all (Batal et al., 2006). The quantity of breast milk produced seems to be a common concern among mothers globally, with studies describing it as a frequent reason for early breastfeeding termination in countries such as Iran (Marandi, Affzali & Rossaini, 1993), Brazil (Paine & Dorea, 2001), Turkey (Yaman & Akcam, 2004), and the United States (Committee on Health Care for Underserved Women, 2006). Concerns about insufficient milk production are mostly related to infant crying, which mothers perceive as a sign of hunger (Sacco et al., 2006; Osman, El Zein & Wick, 2009). In other societies, the quality of the breast milk may contribute to breastfeeding duration (Paine &

Dorea, 2001). Beliefs that prescribed medication (e.g. pain medication), a balanced maternal diet, abdominal cramps, or bleeding nipples might harm the baby through the breast milk create an important source of distress to mothers, forcing some of them to abandon breastfeeding (Osman, El Zein & Wick, 2009). This is especially concerning since these are normal events in the postpartum period. Other potential sources of "decreased" quality of breast milk cited in the literature are sexual intercourse, a new pregnancy, and working in the sun (Geckil, Sahin & Ege, 2009). Also, in some cultures the colostrum is seen as unhealthy and is usually discarded (Hizel et al., 2006; Ergenekon-Ozelci et al., 2001). Furthermore, in Egypt there is a common belief that allowing the entrance of a menstruating woman into a house might harm the lactating mother or her baby, whereas in Turkey, the presence of another lactating woman can bring evil forces to mother and baby. The fear of transmitting the "evil eye" to the baby might force women to stop breastfeeding in these cultures (Geckil, Sahin & Ege, 2009).

2.3 Determinants of breastfeeding: the role of intention and attitudes towards breastfeeding during pregnancy

In recent years, researchers have persistently tried to identify which factors determine women's choice of the method of infant feeding (Shaker, Scott & Reid, 2004). Although this choice can be made either prior to pregnancy or after birth, most women (82-97%) decide on the infant feeding method during pregnancy (Bogen et al., 2010; Donath et al., 2004; Di Girolamo et al., 2005). Most studies investigating this issue focused on maternal socio-demographic characteristics (e.g. maternal age, education, socio-economic status and ethnicity), biomedical factors (e.g. birthweight, gestational age, parity, type of delivery) and hospital practices (e.g. early skin-to-skin contact, 24h rooming-in) (Galler et al., 2006; Shaker, Scott & Reid, 2004). According to one exemplary study, positive breastfeeding attitudes are highly correlated with maternal age, education level, income, ethnicity, marital status and the way the mother herself was fed (Sloan et al., 2006). Also, having a premature or low birth weight baby (WHO, 2015) as well as having previously had a successfully breastfed child might contribute to women's decision to breastfeed (Sloan et al., 2006). Although demographic and medical factors are strong determinants of choice of the feeding method, other complex variables such as maternal knowledge, attitudes and beliefs seem to be more important for infant feeding practices (Fairlie et al., 2009; Stuebe & Bonuck, 2011).

Studies focussing on the psychosocial aspects related to early termination of breastfeeding have recognised that maternal perceptions and views on the benefits and social acceptance of breastfeeding play an important role (Galler et al., 2006). Wen et al. (2009) found that women who

were aware of WHO recommendations to breastfeed exclusively in the first six months after birth were 5.6 times more likely to intend to breastfeed for six months. Similarly, other studies found that women's knowledge of breastfeeding benefits for infants' health outcomes predicted intention to breastfeed and to do it exclusively for at least six months (Sibeko et al., 2005). General breastfeeding knowledge, awareness of health benefits for the infant, and comfort in breastfeeding in social settings have also been associated with intention to initiate breastfeeding (Persad & Mensinger, 2008). Furthermore, maternal knowledge and attitudes have been shown not only to predict infant feeding decision, but to be even stronger predictors than sociodemographic determinants (Hill, 1988; Scott, Shaker & Reid, 2004).

A less studied factor in determining breastfeeding intention is the paternal role (Scott et al., 2001). Earlier studies showed that women who perceived their partners to prefer breastfeeding were more likely to intend to breastfeed and actually initiate it than women who perceived their partners to prefer bottle feeding or to be undecided (Scott et al., 2001). Fathers do participate and influence the choice of infant feeding. Moreover, they impact the duration of breastfeeding by acting as supporters throughout the lactating phase (Jordan & Wall, 1993). Their opinion about breastfeeding has been shown to be one of the most important factors related to breastfeeding initiation, regardless of age, education level, or ethnicity (Giugliani et al., 1995). Also, it was found that married women who have husbands supportive of breastfeeding were more likely to breastfeed than single mothers (MacGowan et al., 1991). Collectively, maternal and paternal attitudes, beliefs, and knowledge have been shown to anticipate intention to breastfeed (Shaker, Scott & Reid, 2004).

According to Osman, El Zein and Wick (2009), family members are also an important source of encouragement as well as discouragement to breastfeeding women. In some societies, women who were not breastfed as a child are frequently discouraged to attempt to breastfeed by their mothers who believe they are biologically incapable of it. The attitudes and advice provided from family, partner and friends of a new mother have a great impact on her decision to breastfeed and to maintain breastfeeding (Shaker, Scott & Reid, 2004). In sum, women worldwide hold a number of beliefs that might discourage them to attempt to breastfeed or to breastfeed successfully. These traditions are related to their culture and on how their societies are well matched with breastfeeding.

A theoretical framework which is very helpful to explain infant feeding behaviour is the "Theory of Reasoned Action" (TRA; Ajzen &Fischbein, 1977). Earlier studies supported the use of this theory to explain breastfeeding outcomes in relation to breastfeeding intentions (Lawson & Tulloch, 1995; Scott, Aitkins, Binns & Aroni 1999), The TRA suggests that there is one primary determinant

of behaviour, which is the individual intention to perform it. A strong behavioural intention (e.g. breastfeeding) is influenced by three constructs:

a) The individual's attitudes towards the behaviour,

b) The individual's perception of the normative pressure exerted on them to perform the behaviour and,

c) The individual's perceived behavioural control (Figure 3).

This theory was later expanded to become the "Theory of Planned Behaviour" (TPB; Ajzen, 1991), which is used for predicting behaviours over which people have incomplete volitional control. Many of the variables that affect women's intention to breastfeed are in the scope of the theory's constructs of attitudes (e.g. benefits and barriers to breastfeeding), normative pressure (e.g. family support) and control (e.g. over time and social barriers to breastfeeding), thus helping to explain breastfeeding intention based on factors that are specific to breastfeeding. Both the TRA and the TPB have been previously used to explain breastfeeding behaviour with a focus on determinants of breastfeeding duration (Khoury et al., 2005; Goksen, 2002; Dick et al., 2002).

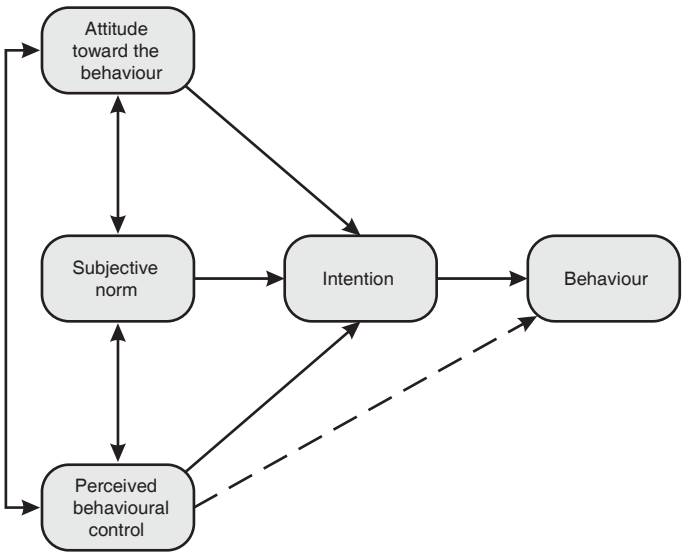

Figure 3. Theory of reasoned action (adapted from Ajzen, 1991)

2.4 The impact of prenatal mental disorders on infant feeding

Maternal depression has been recognised as a potential influence for maternal feeding attitudes (Bogen et al., 2010). As already mentioned, empirical evidence estimates that most women decide about infant feeding methods prior to delivery. Out of this subset, the vast majority (75-97%) stick

to their decision made during pregnancy (Donath et al., 2004; DiGirolamo, 2005). This evidence supports the assumption that prenatal mood disorders may affect women's intention to breastfeed and may compromise breastfeeding success (Fairlie et al., 2009). Little research has addressed this issue and even fewer studies have dealt with any disorder other than depression; however, all studies on the topic did result in similar findings.

Fairlie et al. (2009), when comparing women with antenatal depression (measured with the Edinburgh Prenatal Depression Scale [EPDS scores ≥ 13]) at the second trimester with women without antenatal depression, found that the depressed group were twice as likely to intend to formula feed as the non-depressed group. A score of 13 or above predicts clinical depression based on diagnostic criteria (Murray & Carothers, 1990) and was used in this study. Similarly, Insaf et al. (2011) have shown that women with probable major depression in early and mid-pregnancy (EPDS scores ≥ 15) were 20-23% less likely to breastfeed their babies. Ystrom (2012) reported that prenatal depression in late pregnancy was weakly linked to breastfeeding cessation at 3 months. Large-scale longitudinal studies that examined both antenatal and postnatal depression found that participants who experienced depressive symptomatology prenatally were less likely to initiate breastfeeding (Green & Murray, 1994; Seimyr, 2004). Galler et al. (2006) reported that mothers suffering from postnatal depressive symptoms were less likely to believe in breastfeeding benefits for the infants, considering it restrictive and private. As a consequence, these mothers tended to opt for formula feeding. Likewise, a Finnish study on mothers who were classified as being clinically depressed postpartum, reported more negative attitudes towards breastfeeding and more difficulties when they decided to breastfeed (Tamminem, 1988). Fairlie, Insaf and Ystrom's studies also examined pregnancy anxiety. All studies found that highly anxious women in early pregnancy were more prone to intend to formula feed. Also, prenatal depressed women who used antidepressants, mostly selective serotonin re-uptake inhibitors (SSRI), usually expressed a lower intention to breastfeed (Dennis & McQueen, 2009). Conversely, some studies (Pippins et al., 2006; Bogen et al., 2010; Dias & Figueiredo, 2015; Adedinsewo et al., 2014) demonstrated an equivocal association between antenatal depression and anxiety and intention to breastfeed.

These contradictory findings do not seem to follow a specific direction. Whilst Pippins and colleagues (2006) found depressive symptoms during pregnancy to be associated with breastfeeding duration, but not with initiation, Bogen et al. (2010) described a lack of association between depressive symptomatology during pregnancy and breastfeeding initiation and maintenance. Moreover, prenatal anxiety was not significantly associated with breastfeeding initiation, duration or exclusivity from birth to 12 months (Adedinsewo et al., 2014). The likely causes of these

contradictions could be various, but they are generally related to the limited number of participants with depressive symptoms and reduced ability to detect associations, non-generalizable samples, no assessment to pre-existing depression or anxiety, inadequate assessment of breastfeeding intentions and mostly, a lack of agreement on how to define breastfeeding levels (Dias & Figueiredo, 2015).

All in all, various studies suggest that prenatal mental disorders may influence maternal choice for breast or formula feeding by altering the mother's views about breastfeeding and reducing breastfeeding initiation. However, inconclusive findings were also reported in the literature suggesting that there is still a need for more definitive research on this topic.

2.5 Postnatal disorders and breastfeeding

Although postpartum disorders cause suffering to affected women, infants are particularly vulnerable to their consequences (Dennis &McQueen, 2009). For instance, depressed mothers are more likely to present impaired mother-baby interactions, to be less sensitive to the infant's needs (O'Hara & Swain, 1996), and to display behaviours which have a negative impact on their children (e.g. disengagement) (Gaynes et al., 2005). Additionally, mothers experiencing depressive symptomatology in the postnatal phase are at increased risk of poorer infant feeding outcomes whereas their infants are at increased risk of undernutrition (Rahman, Harrington & Dunn, 2002).

Breastfeeding rates are low worldwide (WHO, 2002a). Although breastfeeding initiation rates are usually high, there is a sharp decrease in the first postnatal weeks and continued breastfeeding at six months is rare (Barnes et al., 2010). A large body of literature confirms the link between breastfeeding practices and postnatal disorders (Figueiredo, Canario & Field, 2014; Hahn-Holbrook et al., 2013; Dennis & McQueen 2009; Dias & Figueiredo, 2015); however, the causal mechanism remains unclear. Some studies suggest that early breastfeeding termination is associated with higher rates of postpartum depression with depressive symptoms preceding the cessation of breastfeeding (Gagliardi et al., 2012; Figueiredo, Canario & Field, 2014). Moreover, breastfeeding problems, negative attitudes towards breastfeeding and lower self-confidence in breastfeeding were reported to be highly associated with postnatal depressive symptoms and consequently, are important predictors of breastfeeding termination (Flores-Quijano et al., 2008). Bottle feeding has also been consistently associated with increased depressive symptomatology in both early and late postnatal phase (Mancini, Carlson & Albers, 2007; Green, Broome & Mirabella, 2006; Groer & Morgan, 2007).

Regarding breastfeeding duration, postpartum depression has been shown to predict early breastfeeding discontinuation among diverse populations (Dennis & McQueen, 2009). A Canadian

study examining mothers six weeks after delivery, described that women with depressive symptomatology were more likely to discontinue breastfeeding than those without symptomatology (Dunn et al., 2006). Similar findings were reported by others (Taveras et al., 2003; Jardri et al., 2006). Evidence provided by Henderson et al. (2003), suggests that breastfeeding duration varies between women with early depression onset (mean duration: 26 weeks), women with late depression onset (mean: 28 weeks) and women without depressive symptomatology (mean: 39 weeks). The majority of studies measuring timing of postnatal depression found that depression preceded breastfeeding cessation (Yonkers et al., 2011; Groer, 2005; Hatton et al., 2005; Tammentie et al., 2002).

In the same way, postpartum depression is negatively related with breastfeeding exclusivity (Dias & Figueiredo, 2015). Little research has focussed specifically on this issue. The few existing studies conclude that exclusively breastfeeding mothers have lower EPDS scores compared to non-exclusively breastfeeding mothers (Alder & Cox, 1983; Alder & Bancroft, 1988). Also, it was found that depressive symptomatology in one week was negatively associated with exclusive breastfeeding at the same time (Hannah et al., 1992).

A decrease in depression scores was observed from birth to three month postpartum in women starting breastfeeding immediately after delivery. No changes were observed in women who did not initiate breastfeeding (Figueiredo, Canario & Field, 2014). According to Ystrom (2012), mothers who start breastfeeding are at lower risk of developing depression later in the postnatal phase. Field (2008) similarly suggests that breastfeeding might have an antidepressant and stress dampening effect due to hormones secreted in response to lactation. Other studies, however, do not support the causal link between exclusive breastfeeding and reduced postpartum depressive symptoms at 4-6 weeks (Groer & Davis, 2006) or at four months (McCarter-Spaulding & Horowitz, 2007). Ahn and Corwin (2015) investigated the impact of predominantly breastfeeding on postpartum depression and perceived stress. They found no benefits of breastfeeding over formula feeding across six months postpartum. Despite this inconsistency, which may be due to type of stressors presented and assessment methods used (e.g. laboratory tests, self-report scales), recent review suggests that in animal models, lactation has a stress dampening effect (Fodor & Zelena, 2014). This topic is explored in more detail in chapter three.

Unlike postnatal depression, postnatal anxiety has rarely been the subject of specific research that described its association with breastfeeding. Studies examining the role of anxiety in relation to breastfeeding as a separate condition to depression are comparatively scarce (Adedinsewo et al.,

2014). The limited literature on the topic agrees that anxiety is one of the main risk factors for early discontinuation of breastfeeding (Paul et al., 2013; Britton et al., 2007; Fairlie et al., 2009), with some findings associating higher anxiety scores with breastfeeding termination at three months (Ystrom, 2012). Recent research showed that postpartum maternal anxiety is associated with reduced odds of exclusive breastfeeding at six months and any breastfeeding at 12 months (Adedinsewo et al., 2014). Indeed, maternal anxiety has been associated with reduced breast milk production. It appears that the alteration of the release of oxytocin and prolactin may complicate exclusive breastfeeding (Lonstein, 2007; Stuebe et al., 2012). The constant inhibition of the milk-ejection reflex, which needs oxytocin to occur, leads to incomplete emptying of the breast and as a consequence, to a down-regulation of milk production (Dewey, 2001; Zhang et al., 2010).

The aforementioned evidence contributes to a better understanding of the direction of the relationship between breastfeeding and depression. Whether breastfeeding is *affected* by or is *affecting* depressive symptomatology or not, is an open question that was not properly investigated for many years. Some studies did address this issue, but they did so outside a specific context, using inconsistent methodologies and inadequate research designs. Meanwhile, conflicting findings favouring either hypotheses or none were reported (Dias & Figueiredo, 2015). A recent longitudinal study specifically designed to address this issue found a bidirectional relationship between breastfeeding and depression. Prenatal depression was found to predict premature breastfeeding termination and early breastfeeding initiation predicted less depression later in the postpartum (Figueiredo, Canario & Field, 2014). However, questions arise since the study sample and the effect sizes reported were small and important determinants of breastfeeding and depression were not taken into account. In short, it seems that if breastfeeding is initiated immediately after birth it might confer protection against later postpartum depression, whereas no initiation may increase the risk for the onset of a postpartum disorder. Yet, women prenatally affected by depression might lack the resources to initiate breastfeeding prolonging the prenatal depression to a postnatal one.

2.6 Summary

The feeding of a child in the early years is of vital importance for the infant's growth and development. Breastfeeding is the most recommended method of infant feeding due to its physical and emotional benefits for mothers and babies. Reductions of obesity and diarrhoea as well as fewer infections are some of the advantages conferred by breast milk to infants.

A glimpse into breastfeeding history deepens our knowledge of the reduction and rise of breastfeeding throughout the centuries whilst clarifying how and why formula became popular. Its

influence in our society was so profound that even with various worldwide campaigns favouring breastfeeding, formula is still the first choice of many physically capable mothers. Culture is also a crucial explanatory variable to understand the reasons why women from different countries persist or abandon breastfeeding practices.

There are several determinants influencing women's decision to breast or formula feed. Maternal socio-demographic characteristics, biomedical factors and hospital practices are relevant and very well studied aspects; however, knowledge about breastfeeding benefits together with maternal intention and positive attitudes towards breast are the strongest predictors of breastfeeding. Considering that most women decide on the type of infant feeding during pregnancy, it is reasonable to hypothesise that prenatal mental disorders may affect this decision. The few studies on this topic focussed mostly on prenatal depressive symptoms. Conflicting findings were reported with some studies confirming the negative association between prenatal depression and attitudes and/or intention to breastfeed, and others reporting null findings. In contrast, the relationship between postpartum disorders and breastfeeding where postpartum depression and anxiety negatively affect exclusivity and duration of breastfeeding practices, is firmly established. Recently, the bi-directionality between depression and breastfeeding was also confirmed, since it was shown that early breastfeeding initiation reduces the risk of later onset of postnatal depression.

Chapter 3

Maternal stress and breastfeeding

"The moment she had laid the child to the breast,
both became perfectly calm."
- Isak Dinesen

Life stressors have long been hypothesized to contribute to the development and exacerbation of symptoms of several psychiatric diseases (Glover, 2015). During pregnancy, stress can precipitate the onset of mental disorders such as depression and anxiety. Inadequate coping with stressors, lack of adjustment, impaired neuroendocrine functioning and heightened stress levels are some of the reasons leading to the pathogenesis of a mental disorder in gestation (Aneshensel, Rutter & Lachenbruch, 1991; Sontag et al., 2013). In this chapter, the theoretical construct of stress and its presentation during pregnancy is reviewed. The subsequent discussion of the neurobiology of stress during the gestational period and the effects of prenatal stress on birth and offspring outcomes are followed by an overview of findings on the effects of lactation on stress response.

3.1 Theoretical concept of stress

The umbrella term *stress* has a range of different, but related meanings (Glover, 2015). Having been the subject of scientific inquiry for several years and affecting everyday life, the concept of stress remains difficult to define (Koolhaas, et al., 2011). Although the knowledge and understanding of the subject have much increased in the past decades; a precise definition is still missing. Early stress theories focused on explaining the role of the nervous system in maintaining internal balance when facing external disturbances (Cooper & Dewe, 2008). This regulation capacity, so that internal conditions remain stable and constant, was later called *homeostasis* (Cannon, 1929).

Lazarus and Folkman (1984), postulate that stress is a two-way process that involves the production of *stressors* by the environment and the response to these stressors by the individual. Stress is essentially perceived as an overload caused by stressors impact on the biological or physiological system that requires a *stress reaction* from the human body (Lazarus, 1993). Earlier studies on stress assumed that different stressors would elicit the same physiological response. Lazarus and Folkman (1984), however, expanded their theory and demonstrated the importance of taking into account the individual's cognitive appraisal as an intermediary between stressor and

response. This means that individuals may respond differently to an identical stress stimulus (Huinzik, 2002) .The appraisal would allow the individual to personally determine whether the stressor is threatening (primary appraisal) or not and which resources are available to cope with the stressor (secondary appraisal). The degree of stress response also depends on genetic factors, previous experiences, social support, and personal characteristics (Mulder et al., 2002).

Stress has also been defined in physiological terms, involving the activation of the HPA axis and the sympathetic-adrenomedullary (SAM) system (Kaltsas, Chrousos & Sternberg, 2007). Other definitions have included a range of conditions such as anxiety and depression. However the latter have not always been associated with the activation of these physiological systems (Pizzagalli, 2014).

3.2 Maternal prenatal stress

Maternal stress commonly occurs during pregnancy. It is defined by the American College of Obstetricians and Gynaecologists as "the imbalance that a pregnant woman feels when she cannot cope with demands…which is expressed both behaviourally and physiologically" (2006, p.469). The complexity of a multidimensional concept which involves social, psychological and physiological features is what contributes to the small number of stress research with pregnant women. As a result, prenatal stress studies commonly focus on a single aspect of stress (Gold & Marcus, 2008).

Possible stress factors in pregnancy are hormonal alterations, physical changes, weight gain and pregnancy complications (Mulder et al., 2002), but social factors such as poverty, unfavourable employment conditions and having no partner may also affect pregnant women (Schetter & Tanner, 2012). Stressful events can differ in severity and duration and stress levels are likely to change over the course of gestation (Woods et al., 2010).

Signs of stress in pregnancy are similar to the ones presented at any other life phase and may be cognitive (e.g. pessimistic thoughts, poor judgement, constant worrying), behavioural (eating and sleeping alterations), emotional (e.g. moodiness, agitation, irritability) and physiological (e.g. pain, indigestion). Relaxation techniques and stress management therapies are recommended for women experiencing high levels of stress in the perinatal period (Yonkers, Vigod & Ross, 2012).

3.3 Neurobiology of stress in pregnancy and adverse birth and offspring outcomes

The stress response network comprises several interconnected circuits (Avishai-Eliner et al., 2002). The main biological systems responsible for the stress response regulation include the brain as well

as the neuroendocrine, immune, and vascular systems (Wadhwa et al., 2002). The neuroendocrine system, consisting of the HPA axis, is activated when receiving neurochemical signals from one of its many systems (e.g. limbic system). These signals inform the hypothalamus about potential threats and stimulate it to release corticotropin-releasing hormone (CRH) into the paraventricular nucleus. The latter in turn rapidly secretes adrenocorticotropic hormones (ACTH) into the body's blood stream. ACTH induces the secretion of cortisol from the adrenal glands, which assists in the mobilization of the body's energy resources in an attempt to regain homeostasis. When sufficient cortisol has been released and the body stressor is no longer perceived, the hypothalamus and the pituitary gland inhibit cortisol production turning off the HPA axis' stress-response. The adequate functioning of both activation and de-activation of the HPA axis is essential for dealing with acute stress as well as to avoid harmful effects of prolonged exposure to high levels of cortisol (Ehlert, 2013).

High concentrations of cortisol in pregnant women's body are naturally found and promote foetal growth and pulmonary maturation (Charil et al., 2010). This is due to an intensified activity of the placenta in producing CRH and cortisol as the gestation progresses (De Weerth & Buitelaar, 2005). The maternal HPA axis becomes less responsive to stress as the pregnancy progresses. The excess of cortisol in the maternal blood stream is mostly transformed into its inactive form (cortisone); however, when it reaches the foetus in high concentrations it may potentially alter his development and growth (Seckl & Holmes, 2007).

There is substantial evidence for negative effects of prenatal stress on infants' neurodevelopment outcomes through a process known as foetal programming (Misra, 2014). Based on findings relating adult deaths from cardiovascular diseases to infant low birth weight (LBW), David Barker and colleagues suggested that vulnerability to several diseases and conditions have a common origin in sub-optimal development in utero. The foetal programming hypothesis emphasizes that during critical periods in early foetal development, there are persisting changes in the body structure and function caused by environmental stimuli (Barker, 2004). The theory formulated around this hypothesis has evolved over the past decades and now encompasses other early life markers that relate to subsequent disease patterns (Godfrey & Barker, 2001). The foetal programming concept is directly related to the developmental plasticity concept, which says that genes can express different physiological or morphological states in response to intrauterine environmental conditions often through epigenetic changes (Byrne & Phillips, 2000; Ehlert, 2013). Exposure to prenatal stress can also contribute to altered gene expressions (Bale et al., 2010).

The hypothalamic neuropeptide CRH plays an important role in regulating the HPA axis activity in pregnancy (Wadhwa et al., 2002). Contrary to maternal hypothalamic CRH production, which is supressed by cortisol, placental CRH increases in the presence of glucocorticoids (GCs). Placental CRH is sensitive to stress, which means that maternal stress leads to higher foetal plasma CRH concentrations (Charil et al., 2010). The glucocorticoid barrier enzyme (11β-hydroxysteroid dehydrogenase; 11β-HSD2) protects the foetus from overexposure to maternal cortisol by transforming it into its inactive form cortisone. However, prenatal stress reduces the expression and activity of the 11β-HSD2 barrier in the placenta both in animal models and in humans, leaving the foetus less protected (Mairesse et al., 2007; Avishai-Eliner, 2002; O'Donnel et al., 2012). The down regulation of placental 11β-HSD2 activity may increase the placental and foetus exposure to glucocorticoids and contribute to preterm birth, intrauterine growth restriction and preeclampsia (Causevic & Mohaupt, 2007; Michael & Papageorghiou, 2008). Furthermore, preterm delivery has been shown to be affected by raised maternal CRH levels (Ruiz et al., 2015; Beydoun & Saftlas, 2008; Behrman & Butler, 2006). It has been suggested that shortened gestational length and preterm uterine activity occur as a result of high levels of this hormone in the first and third gestational trimester (Hobel et al., 1999b; Glynn et al., 2001, 2008; Davies et al., 2007).

Animal research has shown that adverse conditions during pregnancy has both short and long term effects on the offspring (Gold & Marcus, 2008). Studies using rat models demonstrated that exposure of the pregnant dam to stressful conditions frequently resulted in smaller litter size, growth retardation, structural malformation, LBW and alteration in the sex ratio (deCatanzaro et al., 2002). In a different study (Talge, Neal & Glover, 2007), pregnant rodents exposed to stress gave birth to progeny over-reactive to stressors, secreting more corticosterone and presenting other persistent physiologic and behavioural changes. These alterations induced by prenatal stress have been shown to influence offspring cognition (e.g. decreased learning), social behaviour (e.g. withdrawal) and emotion (e.g. higher anxiety; Koffman, 2002).

3.4 Maternal stress and breastfeeding

Animal studies dating from the 1960's have shown that a great advantage of lactation is a decrease in maternal neuroendocrine responses to physical and psychological stressors (Mezzacappa, 2004). Hormones secreted by the pituitary gland interact with the nervous system and with other hormones such as oxytocin, ACTH, oestrogens, glucocorticoids and progesterone in order to maintain lactation, mammary growth, lactogenesis and milk ejection (Neville, 2001; Crowley, 2015). One possible pathway by which breastfeeding reduces stress is suckling. In breastfeeding women,

suckling has been shown to increase oxytocin and prolactin levels whilst reducing ACTH and cortisol plasma levels. These alterations indicate a suppression of the HPA axis response to stress in lactating women (Heinrichs et al., 2001).

Studies on the influence of lactation in rodents suggest a stress-buffering effect induced by lactation (Mezzacappa, 2004). Various works have demonstrated an endocrine hyporesponsiveness to stress with weakened secretion of ACTH, oxytocin, prolactin, and catecholamine in lactating animals (Neumann et al., 1998; Tilbrook et al., 2006). Furthermore, lactation in rats was also associated with less oxytocin response to restraint stress (Deschamps et al., 2003), less plasma ACTH response to ether stress (Walker et al., 1992), lower corticosterone levels after exposure to an elevated plus maze stressor (Mezzacappa, Tu & Myers, 2003), and null corticosterone and ACTH responses to noise stress when compared with non-lactating rats (Windle et al., 1997). Fodor and Zalena (2014) also found in animal models that lactation has a stress dampening effect.

Prenatal exposure to stress also has long-term behavioural and neuroendocrine consequences for female rats. They are expressed during the lactation period and directly alter maternal behaviour (Bosch et al., 2007). Prenatally stressed rodents were shown to nurse significantly less and to spent less time with their offspring compared to non-stressed ones (Bosch et al., 2007). Similarly, the presence of chronic social stress in lactating rats was found to reduce maternal nursing behaviour and pup growth as well as to increase maternal anxiety-related behaviour at postpartum (Nephew & Bridges, 2011). Another study examining the effects of environmental stress in the last week of gestation on the maternal behaviour of lactating dams, demonstrated that prenatal stress decreased pup licking and grooming [3](LG) in high LG rat species. This research supports the hypothesis that gestational stressors can negatively alter maternal behaviour in lactating dams (Champagne & Meaney, 2006).

Human studies are limited in design and by ethics when examining stressors during pregnancy that might compromise infant feeding practices (Pardon et al., 2000; Pattin et al., 2002). However, there is sufficient evidence for the existence of a breastfeeding blunting effect on physiologic responses to physical stress (Mezzacappa, 2004). Altemus et al. (1995) were the first to demonstrate this relationship when subjecting breastfeeding versus non-breastfeeding women to a treadmill exercise one hour after a breastfeeding bout. All women were between 7-18 weeks postpartum. The breastfeeding group provided at least 90% of feeding through breastmilk and the non-breastfeeding sample, never breastfed or stopped breastfeeding 4 weeks prior to the start of the experiment. This

[3] Licking and grooming in rats is the basis for tactile stimulation, which is essential for pup physiology and for the development of its central nervous system.

test served as a physical stressor and ensured that the activation of the HPA axis and the sympathetic-adrenal-medullary was due to the exercise intensity. In response to the exercise stress, all women presented increased plasma ACTH, cortisol, vasopressin, norepinephrine, and epinephrine levels. However, women who were breastfeeding had attenuated ACTH, glucose and cortisol response to stress when compared to non-breastfeeding women. Also, in the baseline measurements, lactating mothers had lower basal norepinephrine. This result suggests that breastfeeding mothers have a blunted neuroendocrine response to a physical stressor as well as a lower baseline sympathetic activity compared to formula feeding mothers.

On the other hand, neuroendocrine alterations of psychosocial stress caused by breastfeeding seem to be less evident. In a similar experiment to the one previously described, Altemus et al. (2001) assessed psychological stress by means of the Trier Social Stress Test (TSST) in breastfeeding, non-breastfeeding and non-mother control groups at 24 to 46 weeks postpartum. Conditions between the maternal groups were the same as in the physical stress test reported above. Findings showed no differences between the breastfeeding and the non-breastfeeding groups in terms of HPA axis responses or heart rate and blood pressure levels, suggesting that lactation in humans did not attenuate reactions to psychological stressors. Heinrichs and colleagues (2001) designed a study to probe whether the endocrine stress hyporesponsiveness in breastfeeding women was caused by a short-term effect of suckling or by lactation in general. All subjects were actively breastfeeding, did not present menses, and were between 6 to 11 weeks postpartum. Women were assigned to either breastfeed or only hold their babies for 15 minutes before performing a psychosocial stress test (TSST) 30 minutes later. Once more, all women presented higher concentrations of plasma ACTH, norepinephrine, epinephrine, and cortisol. However, women who breastfed had lower cortisol responses than mothers who only held their babies. Thus, breastfeeding apparently reduces cortisol responses to psychological stress. Other studies also support these findings (Hahn-Holbrook et al., 2011; Mezzacappa, Kelsey & Katkin, 2005)

Beyond physiologic responses, maternal stress can also be measured by the subjective experiences individuals report (Mezzacappa, 2004). Initial studies describe breastfeeding mothers as calmer, less anxious and less stressed (Heck & de Castro, 1993; Modhal & Newton, 1979). More recent research provides further evidence that breastfeeding is associated with less perceived distress whilst bottle feeding is linked to more perceived stress (Mezzacappa et al., 2000; Mezacappa & Katkin, 2002; Mezzacappa, Guethlein & Katkin, 2002). These studies controlled for confounders such as age of the baby, parity, maternal work status, and maternal health behaviours. Other studies produced contradictory results not supporting that breastfeeding reduces postpartum depressive

symptoms at 4-6 weeks (Groer & Davis, 2006) or at four months (McCarter-Spaulding & Horowitz, 2007). Moreover, Ahn and Corwin (2015) found no advantages of breastfeeding over formula feeding across six months postpartum when investigating the impact of predominantly breastfeeding on postpartum depression and perceived stress. Despite this inconsistency, a recent review suggests that, at least in animal models, lactation has a clear stress dampening effect (Fodor & Zelena, 2014).

Altogether, available data suggest that breastfeeding suppresses the HPA axis response to a physical as well as to a psychosocial stressor. Breastfeeding was found to trigger the release of the lactogenic hormones oxytocin and prolactin, which have been linked to anxiolytic and antidepressant effects (Mezzacappa & Katkin, 2002). Importantly, lactating 30 minutes before the beginning of a psychosocial stress test considerably reduces cortisol response (Heinrichs et al., 2002). Lactation may exert a protective effect on maternal postpartum mental health since it attenuates neuroendocrine responses to stress, including cortisol, and may reduce depressive symptomatology (Heinrichs et al., 2002; Mezzacappa & Katkin, 2002).

3.5 Breastfeeding developmental advantages for babies

The advantages of breastfeeding for children's neurodevelopment and growth are well documented (WHO, 2015; Sacker et al., 2006; Horta et al., 2007). Whether the composition of maternal milk directly influences infant neurodevelopment or not remains uncertain (Hinde & Capitanio, 2010). The volume of milk and its energetic density affect infant growth rates since breast milk provides nutrients needed for the development of the immature brain (Neville et al., 2012). There is some evidence that specific types of long-chain polyunsaturated fatty acids such as arachidonic acid (AA) and docosahexaenoic acid (DHA), together with growth factors and hormones significantly influence infant's development and cognitive performance (Lo et al., 2012; Lucas et al., 1999; Larque et al., 2002). More specifically, DHA was shown to regulate levels of neurotrophins. Growth factors like the brain derived neurotrophic factor and the nerve growth factor, play a central role in the development and maintenance of the nervous system, while milk metabolic hormones seem to have long-term effects on body composition and metabolic function (Neville et al., 2012). Of the biologically active hormones contained in breastmilk, glucocorticoids[4] have been associated with infant behavior. However, the causal direction of this association remains uncertain (Hinde, 2013).

Crawford (1993) postulates that DHA and AA are the essential breast milk components that support the neurodevelopment of the newborn. Extensive research carried out with humans and

[4] Cortisol in humans and non-human primates and corticosterone in rodents

animal models confirms this hypothesis (Neumann, 2001; Neumann et al., 2005; Neville et al., 2012). Studies examining serum DHA concentrations document positive and significant correlations between DHA and performance on the Bayley mental and psychomotor scales as well as in visual acuity tests (Lo et al., 2012).

Whether breastfeeding has a lasting effect on children's neurodevelopment or not has been debated for decades (Feldman & Eidelman, 2003). Since the first publication by Hoefer and Hardy (1929), various large-scale studies have reported that breastfed children achieve higher scores in cognitive and intelligence tests from infancy to adolescence. Moreover, more pronounced results are associated with increased duration of breastfeeding (Kramer et al., 2008; Anderson et al., 1999; Eriksen et al., 2013; Oddy et al., 2011). Critics, on the other hand, have argued that maternal sociodemographic characteristics play a determining role in this association and after accounting for the effect of related confounding variables, breastfeeding effects on cognitive development are reduced (Der et al., 2006; Stumm & Plomin, 2015; Walfish et al., 2013). Their findings suggest that environmental factors, not breast milk alone, are important determinants of infant development.

The cognitive development of a child is a delicate and complex process during which a multitude of genetic and environmental factors interact with one another (Rey, 2003). This fact, in combination with the impracticability of carrying out randomized controlled trials due to the nature of the variables results in a limited validity of observational studies in this area (Kramer et al., 2008). Comparisons between breast milk and formula feeding are further complicated by the fact that most studies do not account for what is fed, who feeds and how it is fed (Rey, 2003). In a comprehensive literature review including studies from 1929 until 2002, Jain et al. (2002) emphasize the need to further explore potential mechanisms linking breastfeeding and infant development. They propose two main avenues of research that future studies should consider: First, to investigate the direct influence of breast milk components on infants' neural and cognitive functioning. Second, to study the positive effects of breastfeeding on the mother-infant interaction, which indirectly support cognitive growth (Jain et al., 2002).

Many studies tried to disentangle *real* and *confounding* effects of breastfeeding on infant cognitive development by running large-scale, long-term (Quinn et al., 2001; Mortensen et al., 2002) and randomized trials (promotion of exclusive breastfeeding vs. no promotion in mothers who decided to breastfeed) with significant findings linking breastfeeding with higher cognitive achievement after covariates adjustment (Kramer et al., 2008; Eriksen et al., 2013). However, more recent studies and a meta-analysis concluded that the observed association between both variables

was best explained by residual confounding (Stumm & Plomin, 2015; Walfish et al., 2013). Thus, the relationship between breastfeeding and infant cognitive development may not be causal in nature, but most likely reflects the interconnection of variables linked to breastfeeding, such as high maternal socioeconomic status and higher parental intelligence (Rey, 2003).

In closing, substantial evidence has shown that breast milk has numerous functions of biological importance for infant development. However, there still seems to exist a gap between what is known about these functions and their role in infant cognitive development. “Breast is best”, but findings are inconclusive as to whether breast milk per se promotes better infant neurodevelopment (Rey, 2003).

3.6 Association between stress, maternal mental disorders, and breastfeeding

Stress is present in our daily lives. It affects our health and behaviour on several levels (Ehlert, 2011). Different types of stress exposure may impair physical and psychological wellbeing. In the perinatal phase, it has been linked to psychopathological symptoms, namely maternal anxiety and depression (Glover, 2015; Sontag et al., 2008). Moreover, there is strong evidence that gestational exposure to stress provokes alterations in the infant neurodevelopment that may endure into adulthood (Barker et al., 2011; Lereya & Wolke, 2013; Rice et al., 2010).

As previously stated, lactation has been identified to alter the pattern of cortisol release via neural stimulus, which reduces the HPA axis circadian rhythm and consequently reduces stress response (Slattery & Neumann, 2008). Numerous animal and human studies involving physical and emotional stress have been able to demonstrate this association using biological parameters and self-reported data (Heinrichs et al., 2001, 2002; Altemus, 2001; Mezzacappa, 2004). The offspring suckling increases oxytocin and prolactin production in the maternal body whilst reducing ACTH and cortisol plasma levels suggesting a suppression of the HPA axis response to stress (Heinrichs et al., 2002). However, it remains unclear as to which extent the stress dampening effect benefits women’s mental health when they are depressed before initiating breastfeeding.

Taken together, both stress and mental health disorders in pregnancy and postpartum may potentially alter breastfeeding behaviour. The lactating body properly regulates stress responsivity, which reflects on maternal psychological wellbeing during breastfeeding. Yet, prenatally depressed women might not benefit from this stress reduction and wellbeing, since many might not start breastfeeding thus, perpetrating a prenatal disorder into a postpartum one.

3.7 Summary

The concept of stress has been a frequent object of study over the last decades and our understanding of it has evolved over the years. It generally describes both a range of different stressors and how they evoke a chain of physiological, biological, behavioural and cognitive responses.

In pregnancy research, stress has been widely explored since it is linked with maternal mental disorders, contributes to adverse birth and offspring outcomes, exerts a primary role in the foetal programming theory and interacts with breastfeeding. Due to a less responsive HPA axis activity in gestation, cortisol is naturally high in pregnant women. The foetus is protected against overexposure to cortisol by the barrier enzyme 11β-HSD2, which transforms cortisol into its inactive form, cortisone. However, excessive maternal stress decreases the activity of the 11β-HSD2 barrier, leaving the foetus less protected and more vulnerable to exposure to cortisol. Raised placental CRH and cortisol have both been associated with premature delivery, intrauterine growth restriction, preeclampsia and preterm intrauterine activity. Moreover, prenatal stress critically influences foetal programming leading to possible long-term consequences for an individual's health.

In postpartum women, breastfeeding exerts a stress dampening effect. Research has shown a stress attenuation regarding physical stressors and a reduction in terms of psychological stress. Suckling is one possible mechanism through which lactation inhibits the HPA axis functioning in breastfeeding women.

Finally, it remains unclear if cognitive development is among the advantages of breastfeeding. A large body of evidence suggests that breastfed children perform better in cognitive and intelligence tests from infancy to adulthood. However, there is also evidence documenting that this may be caused by environmental factors correlating with breastfeeding. Limitations in study designs preclude definitive findings, which could disentangle the real and confounding effects of breastfeeding and breast milk.

Chapter 4

Maternal coping styles

"It is not stress that kills us;
it is our reaction to it."
- Hans Selye

How people cope with stressful events can impact their emotional state (Faisal-Cury et al., 2004). Historically, coping has been considered a reaction to emotion. Individual coping strategy may be associated with stress increase or reduction (Yali & Lobel, 2002). Numerous studies have shown the correlation between stressful life events and mental disorders. These findings suggest that individual distress appraisal and coping strategies have a considerable impact on their mental health (Lazarus & Folkman, 1984). Coping plays an important role in the perinatal period and affects birth and child outcomes (Guardino & Schetter, 2014). In this chapter, the relationship between maternal coping styles and pre- and postpartum maternal mental health is discussed as well as how maternal coping is associated with birth and infant outcomes.

4.1 Definition of coping

Lazarus and Folkman (1984) define coping as a constantly changing behavioural and cognitive effort. Its purpose is to deal with demands of specific situations that the individual perceives as stressful. It involves mastery, management, and adaptation to stress (White, 1974). The choice of strategy implies an evaluation of personal competencies to confront problems (Matheny et al., 1986) and involves autonomy and internal organization (Caplan, 1974). Many conceptions characterize coping as cognitive and behavioural attempts to deal with a particular event, frequently calling it *behaviour* (Lazarus & Folkman, 1984). Others define coping as a consistent tendency to cope in a specific way, considering it a more stable trait rather than a dynamic process. This second conception is called *coping style* (Ben-Zur, 2009) and is the one used in the empirical work presented in the second part of this dissertation.

A great number of coping strategies have been identified in the literature (Carver & Connor-Smith, 2010), but most theorists have traditionally distinguished between two types: *problem-focused coping* and *emotion-focused coping* (Carver, 1997; Lazarus & Folkman, 1984). Problem-focused coping aims to alleviate situations which produce stress. It includes planning and finding

solutions for the problem. In contrast, emotion-focused coping attempts to ameliorate negative affective responses to stress. The latter typically includes expression of feelings towards others and positive reappraisal of the situation. A third coping dimension, which is often mentioned by researchers and considered a long-term maladaptive strategy is *avoidance.* Coping through avoidance may include person or task-oriented strategies. Seeking social diversion, for instance, may reduce stress levels in the short-term by escaping from the stressful event (Parker & Endler, 1992; Suls & Fletcher, 1985). By contrast, *approach or engagement coping* relates to attempts to directly or indirectly deal with the stressor (Suls & Fletcher, 1985; Roth & Cohen, 1986). While successful coping leads to less distress, unsuccessful coping can increase distress (Guardino & Schetter, 2014).

4.2 Maternal coping styles during pregnancy: associations with perinatal mental disorders and birth outcomes

Although pregnancy is frequently portrayed as a wonderful time in a woman's life, the demands and changes associated with it, as well as the social context in which pregnancy takes place, may increase stress and anxiety levels for many expectant women (Guardino & Schetter, 2014). The necessary adjustments to pregnancy and motherhood, daily hassles, and concerns about the baby's health, delivery and other responsibilities can have a detrimental impact on pregnant women's mental health (Huizink et al., 2002a). For instance, women with increased stress levels are likely to maintain insufficient health care during gestation. As a result, they are prone to smoking and to be sedentary (Lobel et al., 2008; Weaver et al., 2007).

How expectant mothers respond to stress may contribute to its reduction or increase (Guardino & Schetter, 2014). Frequent use of emotional coping during pregnancy (Da Costa et al., 2000) as well as coping through distancing, denial, blame, and substance use were shown to be associated with higher levels of prenatal depression (de Tychey et al., 2005). However, the most consistent set of findings relating coping styles with poor mental health are on coping through avoidance (Razurel et al., 2013; Rodriguez et al., 2010; Honey et al., 2003). Avoidant coping during pregnancy has been associated with lower general psychological wellbeing, increased distress, more frequent periods of depression, higher perceived stress and anxiety and other negative effects (Faisal-Cury, Savoya & Menezes, 2012; Hamilton & Lobel, 2008; Rodriguez, 2009). Moreover, Latendresse and Ruiz (2010) reported a link between greater use of avoidant coping style and increased maternal levels of pCRH, which are implicated in the timing of delivery and aetiology of premature birth. Another harmful way of coping with distress in pregnancy is the abuse of substances (Guardino & Schetter,

2014). Alcohol and tobacco use were associated with increased pregnancy-related distress and prenatal depression (Yali & Lobel, 1999), while coping through smoking, increased the risk for continuous smoking during pregnancy (Lopez, Konrath & Seng, 2011).

Some prenatal coping responses are indicators of better maternal psychological wellbeing (Gutierrez-Zotes et al., 2015). For example, coping through positive appraisal promotes personal growth by giving positive meaning to the stressful situation. Together with religious faith, they are associated with more favourable psychological adjustment, better maternal attachment, fewer depressive symptoms and lower distress (Pakenham et al., 2007; White et al., 2008). Problem-focused coping style presented mixed findings since it has been associated with both greater pregnancy-related distress and fewer depressive symptoms (Morling, 2003; Soliday, 1999).

In addition to confirming effects of coping on maternal mental health during gestation, Honey et al. (2003) found that coping through avoidance during the third pregnancy trimester was a significant predictor of more depressive symptoms at six weeks postpartum. This association was confirmed by Rodriguez et al. (2010). The latter demonstrated that women who cope through avoidance during gestation have an increased risk of postpartum depression. In their study, problem-focused coping during pregnancy was associated with conflicting findings as well. This style was related with both, lower and higher levels of postpartum depression (Honey et al., 2003; Rodriguez et al., 2010).

It has been suggested that different maternal coping styles could moderate the effects of prenatal stress on mental health outcomes (Pakenham et al., 2007; Spirito et al., 1999; Wells et al., 1997). The moderating effects model proposed by Pakenham (1999) states that the relationship between stress and mental outcomes will be moderated by coping resources and strategies. Two types of moderating effects were suggested: stress buffering and stress exacerbation. The former occurs when coping resources and strategies buffer individuals against the negative effects of high stress (Finney, Mitchell, Cronkite, & Moos, 1984). The latter is associated with the adverse effects of avoidant coping strategies at high stress (Pakenham, 1999). A lack of significant interaction between stress and coping was found in most studies that hypothesize a buffering effect of coping on mental health. However, Terry et al (1996) show that coping through avoidance has stress exacerbation effects, whereas problem-focused coping has stress buffering effects on postpartum depression.

Dole and colleagues (2004) found that avoidant coping mechanisms are predictive of preterm delivery. In their study, Afro-American women had a higher risk of preterm birth if they used avoidant coping or reported racial discrimination. Da Costa et al. (2000) also report that pregnant

women who were coping through avoidance had more labour and delivery difficulties. Poor coping skills were related to a high number of emergency caesarean section (Ryding et al., 1998), increased risk of low birth weight babies (Borders et al., 2007), and posttraumatic stress in postpartum (Ford et al., 2010). No significant evidence was found linking prenatal maternal coping styles with poorer pregnancy physiological markers (Zhang et al., 2010; Harville et al., 2009).

Studies on maternal coping styles and their effects on pregnancy and postpartum mental health produced conflicting and non-replicable findings. This may in part be due to the use of different research methods, variations in assessment timings, and the application of different measures to assess coping styles and behaviours (Guardino & Schetter, 2014). Moreover, the variability in results may be caused by the lack of agreement on the categorization of coping styles. Coping strategies that have different meanings across studies are sometimes given the same label (Yali & Lobel, 1999).

4.3 Maternal coping styles postpartum: influences on postnatal and infant outcomes

Motherhood is a life event that often triggers changes in family dynamics, finances, and working life as well as physical and psychological adjustments (Emmanuel et al., 2011). The birth of a child causes a major reorganization of roles and tasks, which commonly causes expecting mother's distress (Guardino & Schetter, 2014). Some women may feel that the transition to motherhood may exceed their personal resources. As a result they become insecure about their ability to provide for their infant (Emmanuel et al., 2011). Under these circumstances, women often become more vulnerable and may present depressive symptoms, anxiety and higher levels of stress (Meleis, 2007). After birth, mothers need to utilize different coping strategies that might contribute to their adjustment to the new role (Huizink et al., 2002b).

In a study performed with Swedish women, low levels of perceived coping ability after birth were linked to higher risk of elevated posttraumatic stress disorders (PTSD) (Soderquist et al., 2009). This finding agrees with three other studies that describe the relation between poor coping skills during pregnancy and higher levels of PTSD postpartum (Guardino & Schetter, 2014). Similar to those found during pregnancy, postpartum depressive symptoms were positively associated with maternal avoidant coping strategy as well as with blame and substance abuse coping strategies (Gutierrez-Zotes et al., 2015). Razurel et al. (2013) conclude from their review of postpartum depression and coping mechanisms that avoidance strategies are usually maladaptive and dysfunctional. Furthermore, avoidance and self-distraction are associated with a more frequent

occurrence of suicidal tendencies in women with postnatal depressive symptoms (Doucet & Letourneau, 2009). Folkman et al. (1986) characterized distancing as a form of detaching oneself and not focussing on the problematic situation. Postpartum women may perceive the pregnancy-birth-postpartum experience as stressful and non-modifiable, favouring the use of an avoidant coping style (Faisal-Cury et al., 2004). Additionally, increased use of emotion-focused coping style has been found to be a predictor of postnatal depression at 8 and 32 weeks, respectively (Gutierrez-Zotes et al., 2015). By contrast, positive appraisal coping strategies, including resilience, hope, and self-efficacy had protective effects against postnatal depression (Razurel et al., 2011). Taken together, these studies suggest that using certain coping strategies may increase women's vulnerability to stress and depression in response to negative events.

Maternal coping strategies are also important for infant developmental outcomes (Levy-Shef et al., 2002). If a mother makes use of a maladaptive coping style - which may increase her predisposition for a postnatal mental disorder - her emotional adjustment may be compromised and result in negative consequences for the infant (Guardino & Schetter, 2014). For example, it was shown that avoidant women presented weak attachments to their foetuses that continued beyond birth (Mikulincer & Florian, 1999). A longitudinal study that observed women from pregnancy until postpartum found that problem-focused coping across this time predicted better maternal adjustment to parenting. The effect included higher levels of maternal wellbeing, parenting efficacy and, caregiving behaviours (Levy-Shef et al., 1998). A second study by this team (Levy-Shef et al., 2002) assessed high-risk (e.g. diabetic participants) and low-risk pregnant women. It similarly found that maternal problem-focused strategies were associated with better infant cognitive development in one year olds. Moreover, the high-risk group's usage of problem-focused coping predicted infant psychomotor development at one year.

Postnatal maternal coping strategies were shown to be related to infant temperament, though a causal relation could not be determined. Ventura (1982) finds that mothers who perceive their infants as having more smiling and laughing behaviours and less distress with limitations used coping patterns such as being religious, thankful and content. Conversely, mothers who were anxious, depressed or both perceived their children as less soothable and as having more distress with limitations, making use of maladaptive coping patterns. Caring for a temperamentally difficult infant may gradually destroy a mother's perception of self-efficacy, extenuate her personal resources, and lead to the use of poor coping skills (Thomas, Chess & Birch, 1968). How a mother responds to stressful events is related to her mental health and her infant's behaviour and development. However, few studies focus on this causal link.

4.4 Summary

Coping can be characterized as any attempt - successful or unsuccessful - to manage situations which are perceived as exceeding an individual's personal resources. Pregnancy and postpartum have a great potential for stress. Daily hassles may heighten the disruptive influences imposed by these periods. Although many coping strategies have been described in the literature, most theorists distinguished between two types: problem-focused coping and emotion-focused coping. A third coping dimension, often reported in studies in the coping literature, is coping through avoidance.

Coping through avoidance during pregnancy was shown to be linked with prenatal depressive symptoms, poor psychological wellbeing and negative birth outcomes, such as low birth weight, more emergency caesarean section, and labour and delivery difficulties. Emotional coping also contributes to more depressive symptoms whereas studies on problem-focused coping generated mixed findings. Positive appraisal coping, on the other hand, showed a positive association with better parenting and caregiving behaviours.

Like in gestation, coping through avoidance in the postpartum period was associated with higher depressive symptoms, distress, and anxiety. It can influence infant development as well. While problem-focused coping was shown to be linked with better infant cognitive and psychomotor development, avoidance was associated with weak mother-baby attachment. Moreover, maternal coping styles seem to play a role in the development of infant temperament. Mothers using maladaptive coping styles described their children as less soothable and having more distress with limitations. However, few researchers have explored maternal coping styles in relation to infant behaviour and development.

Chapter 5

Maternal mental health disorders and infant temperament

"A child in the mother's womb
unfailingly takes some qualities from her."
- Ganda Proverb

About 45 years ago, Stott (1973; p.770) stated that:

> "The prenatal determinants of individual differences remain a 'grey area' of modern science, yet their importance is incontestable […]. Our knowledge of these determinants is central to our understanding of human development […]."

Over the last decades, substantial evidence has been found that connects the origins of many illnesses to prenatal adverse events. The programming effects maternal mental health has on the development of foetus and infant has been extensively investigated (de Weerth, van Hees & Buitelar, 2003). In the first study carried out with humans, Hart et al. (2004) suggested that another possible pathway for mothers to alter infant development is through lactation. The transmission of biochemical information from mother to infant via breast milk not only influences infant physiology, but also induces certain infant behaviours. The aim of this chapter is to contextualize prenatal and postnatal mental disorders that directly affect infant behaviour. An introduction to the concept of infant temperament is followed by a discussion of prenatal and postnatal disorders that have been found to be associated with infant temperament. The chapter concludes with an outline of potential breastfeeding effect and mechanisms through which breast milk might alter infant temperament.

5.1 Infant temperament: a definition

The concept of infant temperament cannot be understood without a basic understanding of the origins of temperament in general. The so-called *Behavioural phenotype* consists of the observable set of characteristics of a subject, which results from interactions between their genotype and the environment (Johnson et al., 1976). Behaviours or responses to stimuli that remain consistent across time and circumstances are considered a stable, trait-like quality of the individual (Hinde, 2013). A variety of terms are used to describe this particular set of behaviours including *personality, temperament, coping style, behavioural syndrome* and *behavioural disposition* (Weinstein &

Capitanio, 2008; Koolhaas et al., 2010). Figure 4 gives a brief overview about how behavioural phenotype accommodates overlapping categories of individual differences in behaviour that are stable across time and context.

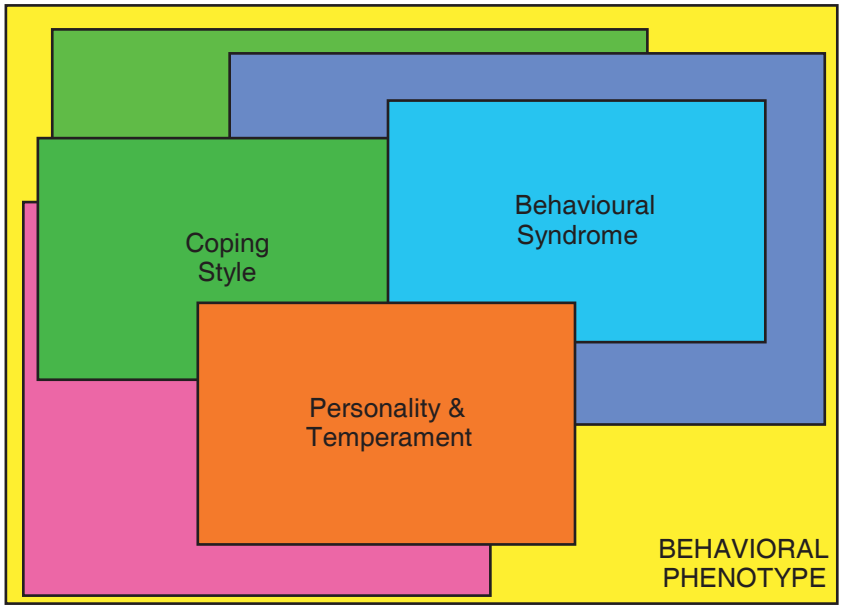

Figure 4. Behavioural phenotype accommodates overlapping terms of individual differences in behaviour that are stable across time and context (adapted from Hinde, 2013).

Due to this overlap, temperament remains a contested concept (Conture, Kelly & Walden, 2013; Austin et al., 2005). One definition considers *temperament* to be the infant's behavioural style (Milgrom et al., 2004). It is perceived to be rooted in the infant's neurophysiology and can be shaped by both genetic and environmental factors. Some researchers suggest that over time, temperament develops into a stable and predictable pattern of behaviour (Rothbart, Derryberry & Hershey, 2000; Austin et al., 2005). Thomas et al. (1963) describe nine individual differences of temperament: activity, adaptability, approach, distractibility, intensity, mood, persistence, rhythmicity, and threshold. Subsequent work re-categorised these dimensions into broader concepts. Difficultness referred to a negative mood, withdrawal and high intensity; adaptability, as an adaptation to novelty; and attention regulation, which reflected attention span and task persistence (Bates, 1989). Other researchers (Rothbarth et al., 2012; Kagan & Snidman, 2004) continued this re-categorization work, but underline the importance of the initial criteria of categorization.

5.2 Association between prenatal maternal mental health and infant temperament

There is substantial evidence that prenatal maternal mood can exert harmful effects on the infant's development and behaviour (Blair et al., 2011; Bergman et al., 2007; Barker et al., 2011). The effects of different types of maternal stressors and exposure to stress hormones can contribute to these negative consequences (Davis et al., 2004). Pioneering animal studies that assessed prenatal stress and offspring developmental outcomes demonstrated this relationship by delivering robust results (Weinstock, 2008; Crudo et al., 2013; Schneider, 1992a). The strongest finding produced by these studies is the life-long effect of prenatal stress on offspring behavioural adjustment and emotional reactivity (Weinstock, 2001). The literature reports different types of offspring disturbances associated with prenatal stress that goes well beyond behaviour. It includes cognitive and neurodevelopmental disorders as well as atypical sexual conduct (Hines, 2011; Davis et al., 2004, 2007). In rodents, for example, prenatal stress was shown to influence offspring's level of exploration in a novel environment (Wakschlak & Weinstock, 1990), behaviour under stressful conditions and to modify social and sexual responses (Weinstock & Fride, 1988). Similarly, prenatally stressed rhesus macaque infants exhibited abnormal responses in the face of novelty, altered behavioural adaptation, increased disturbance, and fearful behaviours (Schneider, 1992a). They developed a higher tendency to social withdrawal at six months of age (Schneider, 1992b). Also, non-human primates exposed to prenatal glucocorticoids were more irritable than non-exposed primates in a control group (Clarke & Schneider, 1993). Prenatal insults in early or mid-gestation in these taxa were associated with the offspring's reduced attention and delayed cognitive and motor development in the first year of life (Schneider et al., 1999). The appreciation of the relevance of the prenatal stress paradigm for the human situation is based on these findings.

Accumulating evidence from human studies shows that prenatal stress, depression and anxiety may shape the infant's behavioural patterns (Li et al., 2010; Blair et al., 2011; Rice et al., 2010). These findings suggest that prenatal maternal mood affects foetal development through alterations in maternal physiology (Davis et al., 2013). However, the exact mechanisms are not yet understood (Glover, 2015). The foetal programming hypothesis is in part related to this prenatal transmission. It postulates that relevant physiological markers can be readjusted by environmental events during foetal development. These changes can last into adulthood (Barker, 2004). Besides the programming hypothesis, other possible mechanisms linking prenatal mood and infant development were

proposed (Glover, 2015). Prenatal stress and anxiety increase the risk for shorter length of gestation as well as for reduced birthweight. Prematurity carries a large risk factor for later morbidity, including schizophrenia and ADHD whilst LBW is linked with mental and behavioural disorders (Nosarti et al., 2012; Lund et al., 2012). Another possible pathway that has become a primary candidate for foetal programming are pregnancy hormones (Owen et al., 2005). However, other systems, hormones and proteins are likely to be involved, including the cytokines (Glover, 2015). Different effects of maternal prenatal mood are observed at different pregnancy phases. This is due to the foetus's different developmental stages in which it presents different vulnerabilities (Van der Bergh et al., 2005). For instance, studies evaluating maternal cortisol across pregnancy and postpartum suggest that during the second and third trimester of pregnancy, exposure to higher cortisol levels predicted increased fussiness and negative behaviour in infancy (Rouse & Goodman, 2014; Davis et al., 2007).

The impact of prenatal experiences on infant temperament has a well-documented literature (Davis et al., 2007; Davies et al., 2007; Rouse & Goodman, 2014). Newborns born to prenatally depressed mothers have been shown to have increased irritability and excessive crying and fussiness already at birth (DiPietro et al., 1996). In a large longitudinal birth cohort, O'Connor et al (2002) found prenatal maternal anxiety to predict behavioural and emotional problems in children at four years of age independent of postnatal psychological state. Also, Graham et al (1999) showed infants of depressed mothers to be more irritable, to have growth delays, poorer motor and cognitive developments, etc., with persisting effects till the age of three. Similarly, studies evaluating maternal perceived stress concluded that women with higher levels of perceived stress had infants who had more difficulties in adapting to new situations, and the presence of strangers (Buitelaar et al., 2003), and cried more (Petzholdt et al., 2014). While investigating neurophysiological differences in infants of prenatally depressed mothers, Davidson (2000) suggested that a frontal electroencephalography (EEG) asymmetry pattern may be a marker for individual differences in stress responses from child to adulthood. Moreover, right frontal EEG activation pattern was shown to be linked with emotional dysregulation in infancy, lack of empathy in toddlerhood, and potential psychopathology in adults. Collectively, these findings demonstrate that prenatal maternal mood has persisting effects on infant functioning (Davalos et al., 2012). Early studies investigating the effects of stress during pregnancy (Meijers, 1985; Stott, 1973) reported long-term influences on offspring temperament, such as children showing more behavioural disturbances. Later studies have extended this initial work, including different disorders such as anxiety and depression, and examining other developmental dimensions.

The above findings provide a solid foundation for explaining the association of prenatal maternal mood and compromised infant temperament. However, it is essential to consider the infant as an important piece in this association. As outlined above, various studies have indicated a relationship between prenatal depression and negative developmental outcomes. It has been suggested that these aspects may increase maternal distress and contribute to a difficult infant temperament. Other neurodevelopmental factors linked with prenatal maternal depression may indirectly play a role in infant temperament. However, this issue has received little attention in the literature.

5.3 Association between postnatal maternal mental health and infant temperament

Children of mothers suffering from postpartum depression may experience severe long-term effects. The postpartum period is a very delicate phase for the infant's development (Lyon, 2008). During this time the baby is maximally dependent on others' care and highly sensitive to the quality of parental communication (Murray et al., 1999). Experiencing depression at any time is related to several interpersonal communication problems (Landman-Peeters et al., 2005). Being passive, unresponsive, and intrusive are some of the behaviours that postnatally depressed mothers display towards their child (Britton, 2011). They also show less emotional involvement, less eye contact, less communication, and lack of interest in the interaction with the infant (Hornstein et al., 2006). Optimal infant emotional development relies on new social and emotional opportunities and on a healthy synchronicity between the child and his main carer (McGrath, Records & Rice, 2008). Forming a high-quality interaction in the early years of life is a key aspect for the infant's social and emotional development as well as an important predictor of later relationship patterns (Berlin et al., 2007)

While prenatal maternal depression influences infant temperament through multiple biological processes, postnatal depression compromises the infant via different psychological pathways. Some depressed mothers have problems in developing a loving attitude towards their babies and avoid emotional interaction (Taylor et al., 2005). Feelings of hostility, rejection, anxiety, and dissatisfaction towards the infant were more common in mothers presenting depressive symptoms (Moehler et al., 2006). Murray et al. (1996) used video analyses to demonstrate that postnatally depressed mothers have problems in interacting with their babies during the initial months. These difficulties include hostile and intrusive communication and disengaged behaviour. Also, behavioural and social developmental difficulties in infants were found to be present up to the fifth year of life in children whose mothers were depressed in early postpartum (Murray et al., 1999;

Bornstein, 2014). In a similar study, Alpern and Lyons-Ruth (1993) described that teachers' reports of five year old children from low-income families whose mothers were assessed for depression at 18 and 60 months postpartum, showed that recent and past maternal depression were associated with high rates of behavioural problems. Notably, maternal depression in late infancy, but not at five years, was related with high levels of child anxiety. Hornstein et al. (2006) report that psychotic women show impaired interactions with their children. Consequently, these negative and insensitive interactions elicit reactions of fear, avoidance, distress, and excessive crying in their infants (Field, 2011). Exposure to negative maternal interactive behaviour may interfere with the infant's ability to process information in general and with the infant's capacity to develop behavioural self-control in particular (Bornstein, 2014). Thus, strong evidence associates postnatal mood disorders with poor mother-infant interactions and sensitivity to the infant, confirming a prolonged effect of these disorders on children's emotional and behavioural development (Beck, 1996; Murray et al., 1999, Field, 2011, Bornstein, 2014; Milgrom et al., 2004). Although temperament exhibits a degree of stability over time, it has been recognized that it can be affected by development, experiences and, genetic predisposition. Therefore, maternal compromised functioning has the potential to influence child temperament and in turn, temperament contributes to individual adaptation to the environment. Thus, infant temperament has been considered a risk factor for future psychopathology (Rothbarth & Bates, 2006; Tackett et al., 2013).

Postnatal depression may negatively affect a mother's perceptions of her infant's temperament. An infant who is active and demanding may seem more difficult to care for a mother who is experiencing depression and has therefore limited emotional resources. This may lead to increased stress, anxiety, and feelings of isolation (McGrath et al., 2008). Also, depressed women may be less able to mother effectively: depressive symptoms such as withdrawal and passiveness may prejudice women's maternal competence further contributing to a difficult infant temperament (Beck, 1996). A chronically depressed mood may cause mothers to negatively perceive the infant's amount of crying, sleep, and soothing, potentially affecting how they care for their infant (Rode & Kiel, 2015). Regardless of the accuracy of the depressed mother's infant temperament perception they may affect her mothering capacities (Rothbart & Bates, 2007). Given the close attunement between mothers and infants at the early postpartum phase and the dynamic way they influence each other, it is very difficult to clarify the direction of the relationship between postnatal depression and infant temperament (Rode & Kiel, 2015). In the late 1980's, Whiffen and Gotlib (1989) offered two possible explanations for this. First, depressed mothers have a higher disposition towards a negative perception of their parenting and their infant's behaviour. Second, they may in fact have infants with

more difficult temperament since their depressed mood affects the mother-baby interaction, causing distress in the infants. Depression can colour a mother's perspective on her infant. However, in most studies depressed and non-depressed mothers have been asked to describe their infant's temperament, adding some questions about the reliability of these reports (Rouse & Goodman, 2014). It is not clear that a depressed mother perspective on her infant's temperament is real or altered by her own mental illness. A number of instruments (e.g. Infant Behavioural Questionnaire-Revised) have dealt effectively with bias caused by depressive mothers (Gartstein & Marmion, 2008). Moreover, it has been argued that in being depressed, mothers may have an enhanced awareness of negative behaviours similar to their own in their children (Rouse & Goodman, 2014).

A third potential pathway assumes a lifelong effect of maternal postpartum depression on children. It is well known that infants raised by depressed mothers usually present more difficult temperamental characteristics (Beck, 1996; Murray et al., 1999, Field, 2011, Melchior et al., 2012). Long-term studies propose that difficult child temperament is associated with depression later in life. For instance, children presenting very low extraversion are more likely to experience depression at 18 years old (Mufson, Nomura & Warner, 2002). Fear of novelty, inhibition, and social withdrawal at age three are also associated with higher risk of mood disorders in the future (Caspi et al., 1996). The mechanisms underlying these associations are not clear (Hannington, Ramchandani & Stein, 2010). Intergenerational transmission of depression may occur by means of temperamental traits (Costello et al., 2002); or difficult temperament in infancy might change the way in which individuals respond to stimuli favouring depressogenic outcomes (Bornstein, 2014).

5.4 Maternal mood variation and infant temperament

A less investigated issue is how normal maternal mood variation in pregnancy and postpartum may influence infant temperament. A growing body of evidence has shown the effects prenatal and postnatal stress, anxiety, and depression have on infant temperament and behaviour (McGrath et al., 2008; Murray et al., 1996; Bornstein, 2014; O'Connor et al., 2002). Curiously, the long-standing assumption that mild levels of physiological and psychological stress have positive effects on growth and development in early childhood was excluded from this discourse (Di Pietro et al., 2006).

Physiological stress in intrauterine conditions (e.g. hypertension) has been shown to favour accelerated effects on organ development and neuromaturation (Allen & Donohue, 2002). Also, a series of studies comparing women who exercised with women who refrained from training during pregnancy showed that infants from women who exercised presented better neuromaturation at birth

and higher intellectual functioning (Clapp, 1996). Moreover, Ponirakis et al. (1998) reported that greater negative affectivity in pregnancy was associated with better Apgar scores.

Two theories may help to explain this positive effect. The first postulates that the infant postnatal brain requires some, but not excessive, psychological stress in order to have a better synaptic structure (Huether, 1998). The second suggests that a moderate exposure to intrauterine stress may promote infant optimal adaptation (Amiel-Tison, 2004). In short, it seems that mild exposure to stress might stimulate infant neurodevelopment while excessive exposure, might overwhelm the foetus's capacity to positively respond to it.

Maternal depression, anxiety, and non-specific stress during pregnancy within normal limits seem to pose no significant danger to early infant motor development or behaviour (DiPietro et al., 2006). To the contrary, there is an increasing fashion on the benefits for infant motor and cognitive development to be exposed to mild stress during pregnancy (Monk et al., 2003; Novak et al., 2004).

5.5 Relation between type of infant feeding and infant temperament

Early life experiences can have substantial influence on offspring temperament (Hinde & Capitanio, 2010). The type of feeding plays an important role in shaping infants' individual traits as their behaviours significantly change, depending on the feeding method (Kielbratowska, 2015). Breastfeeding is acknowledged for exerting effects on the infant's temperament, including his reaction and emotion regulation (Jonas et al., 2015).

Breast milk composition is likely to underlie this association since human milk contains a wide range of components such as hormones, growth factors, cytokines, fatty acids as well as immunological and immunomodulatory factors that contribute to the infant's growth and development (Sullivan et al., 2010a). However, the ways in which maternal milk composition influences infant temperament is less understood. Behavioural interactions between mother and offspring during lactation can influence milk removal and alter its synthesis (Hinde & Milligan, 2011). Moreover, GCs contained in breast milk were significantly related to the infant's temperament both in animal and in human studies. These findings suggest a potential lactational programming effect on infant temperament (Hinde & Capitanio, 2010). GCs are transferred from maternal plasma to milk, as there is no evidence for mammary synthesis (Hamosh, 2001). Breast milk GCs are reflective of maternal serum GCs, even though levels in human breast milk are lower than in plasma (Glynn et al., 2007).

A series of experimental studies in rodents indicated that ingestion of GCs via breast milk has positive effects on the offspring that persist into adulthood (Angelucci et al., 1985; Casolini et al., 1997; Catalani et al., 2000, 2002). More specifically, offspring exposed to GCs had lower glucocorticoids responses to stressors, less fearful behaviours, and better coping mechanisms during challenges later in life (Catalani et al., 2000, 2002). In primates, much less is known regarding the effects of breast milk on programming behaviour and temperament due to their long lifespan. Research on these taxa has reported only results from infants (Hinde, 2013). Studies conducted with rhesus monkeys related higher cortisol levels in breast milk to confident temperament in male offspring, but not in females. Additionally, among mothers rearing males, the higher the cortisol levels the more their infants were described as confident. Other traits such as being vigilant, nervous or gentle showed no association with cortisol in breast milk (Sullivan et al., 2011). Furthermore, Hinde and Capitanio (2010) indicated that milk energy density and yield predict behavioural outcomes for female and male infants of rhesus macaque. Offspring from mothers who produced greater milk energy in early postpartum coped more effectively and had greater confidence in stressful situations. The observed temperaments were reflective of milk energy measured in months prior to the assessment time, suggesting that nutrition has a programming effect on the offspring. In a different study (Sullivan et al., 2010b), a maternal diet high in fat (HFD) was shown to alter the central serotonergic system of offspring in monkeys, resulting in higher anxiety in response to novel objects in female offspring from HFD-fed mothers. This last finding has an important clinical implication, since it demonstrates that maternal HFD during lactation, independent of obesity, may increase the risk of the offspring developing anxiety.

Only three studies have suggested that breast milk cortisol may contribute to infant temperament in our own species. Hart et al. (2004) assessed neurobehavioral functioning in seven to eleven-day-old breastfed neonates. Infants ingesting higher levels of cortisol in breast milk had an increased ability to regulate their autonomic state and to control involuntary responses, suggesting that cortisol is positively associated with this behaviour. Glynn et al. (2007) used maternal plasma GCs as a proxy for milk GCs levels. They found that breastfeeding mothers with higher levels of cortisol reported their infants to be significantly more fearful at two months old than did mothers with lower cortisol concentrations. Notably, this relation did not exist when infants were formula-fed. Grey et al. (2013) found a positive association between breast milk cortisol and more negative affectivity in three months old girls, but not in boys. Collectively, these studies suggest that the transmission of biochemical information from mother to infant via breast milk not only influences infant physiology but also induces certain infant behaviours with possible sex-dependent effects. Additionally, these

data support the idea that cortisol ingested via breast milk has a lactational programming effect on infant temperament (Neville et al., 2012).

Behavioural and temperamental characteristics are already present in early life, but can be modified by the environment (Washington, Minde & Goldberg, 1986). These traits are reliable predictors of social development in later life (Rothbart & Bates, 1998). Observational research that compares temperament of formula fed and breastfed infants is inconclusive. Some studies indicated that in comparison to formula-fed infants, breastfed babies were less irritable (Field, Hernandez-Reif & Feijo, 2002), and more active (Worobey, 1998; Kielbratowska, 2015), and had an increased positive affect and easier temperament overall (Kielbratowska, 2015; Vandiver, 1997). On the contrary, Lee (2000) described breastfed babies with a more difficult temperament and higher levels of fussing and crying. In line with this finding, a recent report from the Cambridge Baby Growth Study suggested that breastfed and mixed fed infants at three months of age had more challenging temperaments with lower scores of positive affectivity and higher scores for negative. Compared to formula fed infants, the breastfed babies showed greater distress, less smiling, laughing and vocalization, were slower to calm down after distress and more difficult to soothe by caregivers (Lauzon-Guillain et al., 2012). Newborns seem to experience breastfeeding initiation as more stressful (DiPietro et al., 1987). However, some longitudinal studies showed that later in infancy, breastfed infants are more positive and social, less irritable, and temperamentally easier (Field, Hernandez-Reif & Feijo, 2002; Worobey, 1998). Thus, these data suggest that breastfeeding may be beneficial for children, yet neonates may not demonstrate behavioural signs that contribute to breastfeeding maintenance (Jones, McFall & Diego, 2004). In fact, newborns that respond with much distress to breastfeeding are at greater risk for short breastfeeding duration (Jones, McFall & Diego, 2004) and early introduction to solid food[5] (Kronborg, Foverskov & Vaeth, 2014). Although feeding problems in infancy are common, infants who are considered by their mothers as very temperamental are more likely to experience feeding difficulties throughout childhood (Farrow & Blisset, 2006). Difficult temperament was found to be one of the main factors for early introduction to solid food (Kronborg, Foverskov & Vaeth, 2014).

The reasons for the discrepancy in these findings are various. Initial studies used smaller sample sizes, with some using less than 60 infant-mother pairs (Worobey, 1998; Wells & Davis, 1995). Also, use of different instruments to measure infant behaviour may play a role in the different findings (Worobey, 1998; Wells & Davis, 1995). Additionally, the association between breast milk

[5] Introduction of solid food to the infant before 4 months of age.

and infant temperament may reflect genetic correlations between mother and infants, perception of suckling demand, maternal postnatal mood, or differences in maternal care. Nevertheless, a substantial body of evidence suggests the independent effect of mother's milk on infant behaviour (Hinde, 2013).

5.6 Summary

There is much disagreement about what constitutes *temperament*. However, researchers generally agree that it derives from the broader concept *behavioural phenotype*. One of many possible definitions for temperament is "constitutionally based differences in reactivity and self-regulation in the domains of affect, activity and attention" (Rothbart & Bates, 2006, p.321), that are stable across time.

Child temperament can be shaped as early as during pregnancy. Exposure to an adverse in utero environment (e.g. maternal mental health disorder in pregnancy) may have deleterious effects on the infant's development. Prenatal programming may be in part associated with it. During specific windows of development, the foetus is very sensitive and vulnerable to external influences. A substantial body of research has shown that infants prenatally exposed to stress, anxiety, and depression are less adaptable and more irritable. They often present greater fussing and crying observable immediately after birth. Similarly, animal models uncovered similar associations when investigating prenatal stress

In the postpartum phase, depression and anxiety have been linked to the perception of infants as temperamentally difficult, and a potential source of stress to their mentally ill mothers. On the other hand, being depressed at postpartum contributes to impaired mothering and compromised mother-infant interactions. This in turn, might increase the infant's difficult temperament. A third pathway of influences is that difficult temperament in infancy, as a consequence of being raised by a depressed mother, is a great risk factor for depression in adulthood.

Furthermore, the type of feeding might also be associated with infant temperament. Breast milk composition is likely to mediate this relation, but so far research has only focused on the effects of cortisol in breast milk. It is unclear why results from human studies differ so greatly from those with animals. The latter showed that ingestion of corticosterone produces more confident male offspring and use of better coping strategies in stressful situations. In humans, the few studies done linked breast milk cortisol with more fearful infants at two months old and negative affect in three months old girls. Although more research is warranted, these data support the hypothesis that cortisol

ingested via breast milk has a lactational programming effect on infant temperament. Comparative studies examining temperamental traits in breastfed and formula fed babies are conflicting, with some reporting breastfed babies as less irritable, more active, and with an easier temperament. On the other hand, others have indicated that breastfed infants present higher levels of fussing, crying and are in general more difficult. It has been speculated that neonates experience breastfeeding as a more stressful event. However, in late infancy, children who received breast milk are temperamentally easier. In summary, several lines of evidence suggest that maternal milk may have an effect on infant behaviour.

Chapter 6

Summary of theoretical background, study ideas and hypotheses

"Daring ideas are like chessmen moved forward.
They may be beaten, but they may start a winning game."
-Johann Wolfgang von Goethe

Based on animal and human studies in the last decades, it has been postulated that prenatal depression is associated with breastfeeding and, individually and together, they might also have a lasting effect on infant's temperament. In the last years, substantial evidence defined the influences postpartum depression exerts on breastfeeding practices. However, to date, it was not clearly elucidated how much of this effect is due to prenatal depression and how being depressed in pregnancy might affect the mother's attitudes towards breastfeeding. It is well known that most women decide about breastfeeding behaviour in pregnancy and from those who decided to breastfeed, the majority comply with their prior decision. So, it is reasonable to hypothesize that being prenatally depressed might affect mother's attitudes towards breastfeeding. Few studies examined the association between prenatal depression and breastfeeding. From those who did, contradictory findings emerged and methodological differences prevented a clear conclusion.

Similarly, prenatal depression has been shown to affect infant temperament and more recent findings suggest that breastfeeding might also affect infant temperament. Such effects may be due to prenatal programming, and in the last years this has been the most accepted model of transducing biological information from mother to baby. Less explored, however, is the role of maternal coping and mood variation in relation to infant temperament. Most studies focus on the depressed or non-depressed population dismissing a deeper examination on the ones who have been changing from one state to another. Assessing alterations in maternal mood and coping longitudinally may be a sensitive approach to determine if changes across time show differential outcomes on infants.

Thus, the general aim of this dissertation is to provide a new perspective on maternal mental health disorders, prenatal depression in particular, breastfeeding and infant temperament by focussing not only in the link they have with each other, but considering their association with the role maternal coping styles and attitudes towards feeding might exert. For this, we used two different samples that assessed women and their infants from mid-pregnancy until six months postpartum. Mothers responded to questionnaires from 20 gestational weeks until six months

postpartum (Maternal mood study) and from 18 weeks gestation until six months postpartum (ALSPAC study).

In the ALSPAC study (chapter 7), the aim was to clarify the independent impact of multiple potential prenatal predictors of breastfeeding, assessing breastfeeding from the first day after birth until six months postpartum. More specifically, the influence prenatal depressive symptoms, attitudes towards breastfeeding and socio-demographic factors have in predicting breastfeeding through six months was investigated. The main hypothesis of this study was that maternal age, prenatal depression and attitudes towards breastfeeding would have an independent higher impact on breastfeeding practices than the other predictors of breastfeeding analysed.

In the Maternal Mood study (chapter 8), the aim was to examine changes in maternal coping styles and maternal mood from pregnancy throughout the first six months postpartum and to explore their trajectories in relation to both breastfeeding and child temperament. The main hypotheses for this study were that mood changes in late pregnancy and early postpartum would mostly affect breastfeeding behaviour at one month; that mood fluctuations in mid-pregnancy would be associated with infant negative affect and extraversion/surgency temperament; and that coping variation would be associated to mood variation on all time points investigated.

PART II: EMPIRICAL STUDIES

Chapter 7

Antenatal psychological and socioeconomic predictors of breastfeeding in the ALSPAC Cohort

"In God we trust, all others must bring data"
- W. Edwards Deming

7.1 Introduction

Breastfeeding is widely acknowledged as beneficial for the physical health and emotional well-being of babies and children (Ip et al., 2007, Insaf et al., 2011; World Health Organization [WHO], 2002a; American Academy of Paediatrics, 1997; Pound, Unger & Canadian Paediatric Society, 2012; Health Canada, 2004). For example, it has been associated with higher infant cognitive development (Anderson et al., 1999) and lower blood pressure and lower body mass index (BMI) in children (Brion et al., 2011), and may also protect against obesity and diabetes in later life (Toschke et al., 2007). Exclusive breastfeeding is recommended for the first six months of life (WHO, 2002a), but few women achieve this (Dias & Figueiredo, 2015; Scott et al., 2006).

Breastfeeding through the infant's first six months depends on several factors associated with the mother, the baby and the social environment (Scott et al., 2006). Perinatal mental health is one probable cause that may interfere with a mother's decision to breastfeed and to maintain breastfeeding, and this is supported by several studies (Hahn-Holbrook et al., 2013; Figueiredo et al., 2014). If poor perinatal mental health is a robust predictor of breastfeeding, then there are potentially sizable implications for public health, as approximately 15% of women are depressed or anxious in the antenatal period (Bennet et al., 2004; Andersson et al., 2006). Similar numbers are also found postnatally.

The link between postnatal depression and breastfeeding is well established. In several studies (Feldens et al., 2011; Imbula et al., 2012; Zubaran & Foresti, 2013; Flores-Quijano et al., 2008), a shorter duration of breastfeeding was associated with postnatal depression. It has also been reported that postnatal depression not only decreases breastfeeding duration, but also increases breastfeeding difficulties and decreases the level of breastfeeding self-efficacy (Dennis & McQueen, 2009). However, the findings on the association between antenatal depression and breastfeeding are inconsistent (Dias & Figueiredo, 2015; Scott et al., 2006; Bogen et al., 2010). Pippins and

colleagues (2006) found that antenatal depression predicted early cessation of breastfeeding, and other studies (Lancaster et al., 2010; Fairlie et al., 2009; Deave et al., 2008; Larsson et al., 2004) indicated that antenatal depression was associated with reduced breastfeeding initiation, but a lack of association has also been reported (Bogen et al., 2010). These discrepant findings may be explained by different research methodologies, such as assessing depression via self-report measures or clinical interviews, only during pregnancy or postpartum and defining breastfeeding status according to different criteria. Therefore, further prospective longitudinal research with large samples is needed, which considers antenatal mental health and other psychological and socio-demographic predictors and confounding variables.

It has been reported that the majority of women (82-97%) decide on the infant feeding method during pregnancy (Bogen et al., 2010; Donath et al., 2004; Di Girolamo et al., 2005). Of those who have a favourable attitude towards breastfeeding at this time (75-97%), the majority do initiate breastfeeding after birth (Scott et al., 2006; Vogel, 2003). Previous research (Scott et al., 2004, De la Mora, 1999) has shown that maternal infant feeding attitudes are frequently strong predictors of choice of infant feeding method and duration of breastfeeding (Kloeben-Tarver, Thompson & Miner, 2002). However, the aforementioned research did not consistently consider the likely confounding influence of antenatal mental health and socio-demographic predictors. Several socio-demographic factors have been linked to higher rates of prolonged breastfeeding, including older age and higher education (Scott et al., 2006; Insaf et al., 2011), whereas other factors are negatively associated with breastfeeding practices, notably low socioeconomic status, smoking, and low social support (Dennis, 2002; Scott et al., 2006; Insaf et al., 2011). The degree to which antenatal mental health and attitudes towards breastfeeding predict independently of these socio-demographic factors is not yet clear (Galler et al., 1999).

Antenatal depression was previously found to be associated with higher intention to formula feed (Fairlie et al., 2009). Similar evidence was also found linking postnatal feeding attitudes to postnatal maternal mood (Galler et al., 2006), reporting a possible impact of depression on attitudes towards breastfeeding (Taminnen, 1988). The possibility that attitudes towards breastfeeding may be conditioned by depression, or that these variables might moderate or affect each other, should be considered, since it may help to better understand the independent role played by depression and attitudes towards breastfeeding in terms of predicting breastfeeding.

The current study aims to clarify the independent impact of multiple potential antenatal predictors of breastfeeding, assessing breastfeeding from the first day after birth until 6 months

postnatal. We hypothesise that maternal age, antenatal depression and attitudes towards breastfeeding will have a greater independent impact on breastfeeding practices than the other predictors of breastfeeding analysed. We analyse data from a large prospective longitudinal population study of pregnant women and their children, The Avon Longitudinal Study of Parents and Children (ALSPAC), which has extensive longitudinal data from the antenatal period.

7.2. Methods

7.2.1 Sample

The sample was obtained from the Avon Longitudinal Study of Parents and Children (ALSPAC), which is a large-scale study investigating biological and environmental influences affecting a person's health from pregnancy until later life. The study included all pregnant women living in the former county of Avon, South-West England who had an estimated delivery date between 1 April 1991 and 31 December 1992 and who agreed to take part. It was estimated that 80-95% of the population participated, resulting in a cohort of 14,541 pregnancies and 13,988 (52% boys and 48% girls) singletons/twins still alive at 12 months of age (Boyd et al, 2013). For our analysis, we used N= 9479 participants for whom data were available on all variables of interest. Participants had been followed via postal questionnaires since recruitment. The ALSPAC study website contains details of all of the available data through a fully searchable data dictionary (http://www.bris.ac.uk/alspac/researchers/data-access/data-dictionary/).

Ethical approval for the study was obtained from the ALSPAC Law and Ethics Committee and local research ethics committees before commencement of the study. Written informed consent was obtained at recruitment.

7.2.2 Measures and procedures

7.2.3 Maternal Depressive Symptoms

Maternal depressive symptoms were assessed using the Edinburgh Postnatal Depression Scale (EPDS, Cox, Holden, Sagovsky, 1987), a widely used 10-item self-report questionnaire designed to measure postnatal depressive symptoms. This measure was successfully validated for use during and outside of the postnatal period (Cox, Holden & Sagovsky, 1987), and each item is rated on a 4-point Likert scale (0-3), with a total score ranging from 0 to 30. A cut-off of 13 or above was used in the current study, since this score predicts clinical depression based on diagnostic criteria

(Murray & Carothers, 1990). For this study, we used the following time points: 18 and 32 weeks gestation and eight weeks postnatal, with scores ranging from 0 to 28.

7.2.4 Breastfeeding

At day one and weeks one, two, three and four after birth, women reported whether they were breastfeeding exclusively, non-exclusively (i.e., mixed breastfeeding and bottle feeding), or not breastfeeding at all; at six months, women reported whether or not they were engaged in any breastfeeding. The breastfeeding variable was dichotomised (0= no, 1= yes) to indicate exclusive breastfeeding through four weeks and any breastfeeding at six months. Due to the different response sets (i.e., exclusive breastfeeding through four weeks; any breastfeeding at six months), we report analyses of the six months breastfeeding data separately from the breastfeeding data through four weeks.

7.2.5 Attitudes towards Breastfeeding

Attitudes towards breastfeeding were measured once, at 32 weeks gestation, using the Attitudes to Infant Feeding scale, a measure designed and validated by the ALSPAC team (ALSPAC, 1991; http://www.bristol.ac.uk/alspac/researchers/resources-available/data-details/questionnaires/). This is a self-report questionnaire consisting of seven items rated on a 5-point Likert scale (1-5, strongly agree to strongly disagree). The statements in the questionnaire are “Breast-feeding stops a mother from having the freedom to do what she wants”, “Bottle-feeding allows the father to share the child more”, “Breast-feeding is difficult”, “Breast-feeding gives the mother a special relationship with her baby”, “A mother who does not breast-feed is inferior”, “Bottle-feeding is more convenient for the mother” and “Breast milk is better for the baby”. Our sample scores for the attitudes to breastfeeding infant feeding questionnaire therefore ranged from 7 to 35.

We first ran a factor analysis to check variability and correlation between the factors, which showed two main components (positive attitude towards breastfeeding and negative attitude towards breastfeeding). We reverse-scored the negative attitude items to create a single scale, which had an internal consistency (Cronbach’s alpha) of .73.

7.2.6 Covariates

Many potentially relevant antenatal, obstetric and psychosocial variables were included in the analysis. These variables were identified based on evidence from the literature regarding breastfeeding. These included: *Self-reported smoking*, defined as tobacco smoked in the first 3 months of pregnancy, collected at 18 weeks gestation, rated on a scale from 1-5 and coded as 1= no,

2= yes for cigarettes, 3= yes for cigars, 4= yes for pipe, 5= yes for other; *alcohol consumption*, defined as the total number of units of alcohol consumed per week in the first three months of pregnancy, collected at 18 weeks gestation, rated on a scale from 1-6 and coded as 1= never, 2= less than one glass per week, 3= more than one glass per week, 4= 1-2 glasses per day, 5= 3-9 glasses per day, 6= more than ten glasses per day; *mother and partner's education*, collected at 32 weeks gestation, rated on a scale from 1-5 and coded as 1= CSE (Certificate of Secondary Education), 2= Vocational education , 3= O-level (Ordinary level, qualification conferred as part of the General Certificate of Education), 4= A-level (General Certificate of Education - Advanced level) and 5 =University degree; *mother's age at delivery*, scaled in years and ranging from 16 to 43 years old; *maternal socioeconomic status (SES)*, collected at 32 weeks gestation, an ordinal variable ranging from one (highest socioeconomic status) to six (lowest socioeconomic status); *parity*, collected at 18 weeks gestation, scaled in number of children; *maternal medication*, collected at 18 weeks gestation, a continuous variable scaled in amount of medication taken during pregnancy, ranging from zero to nine; *maternal medication for anxiety*, collected at 18 weeks gestation, rated on a scale from 1-4 and coded as 1= yes in the first three months, 2= yes from four months to now, 3= yes, both time periods, and 4= no*; maternal medication for depression*, collected at 18 weeks gestation, rated on a scale from 1-4 and coded as 1= yes in the first three months, 2= yes from four months to now, 3= yes, both time periods and 4= no; *mother's type of work*, collected at 18 weeks gestation, an ordinal variable rated on a scale from 1-3 and coded as 1= part-time, 2= full-time, and 3= casual; *ethnicity*, collected at 32 weeks gestation, rated on a scale from 1-8 and coded as 1= white, 2= black Caribbean, 3= black African, 4= other black, 5= Pakistani, 6= Indian, 7= Bangladeshi, and 8= Chinese; *baby's sex*, coded as male or female; *gestational age* at birth scaled in weeks; *baby's head circumference* scaled in cm.

7.2.7 Statistical analysis

All continuous variables were normally distributed. Pearson correlations were conducted between depressive symptoms at various times, breastfeeding at different time points, antenatal attitudes towards breastfeeding, and relevant socio-demographic variables.

We conducted a logistic regression analysis with potentially relevant factors. Additionally, we added to the model an interaction variable between antenatal depressive symptoms (18 weeks) and attitudes towards breastfeeding, and between postnatal depressive symptoms (eight weeks) and attitudes towards breastfeeding in order to investigate whether one variable may be affecting the other. To analyse the robustness and consistency of the antenatal attitudes towards breastfeeding

variable, besides running logistic regression models with the complete sample, we also ran analyses using different subsets, including: only women with depressive symptoms (EPDS ≥ 13; Antenatal depressive symptoms N= 377; Postnatal depressive symptoms N= 554), only women without depressive symptoms (EPDS ≤ 13; N= 4770), women with any breastfeeding (N= 6181), only women with premature babies (gestational age ≥ 32 and ≤ 36 weeks; N= 302), only women with term babies (gestational age ≥ 37 weeks, N= 5869), women with antenatal depressive symptoms and term babies (N= 354). Due to limited sample sizes, it was not possible to analyse a subset of women with antenatal depressive symptoms and premature babies and women with antenatal and postnatal depressive symptoms.

7. 3 Results

The socio-demographic characteristics of the sample are presented in Table 1. The group is largely Caucasian, typical for this region of England at the time of recruitment.

Table 1. Socio-demographic characteristics of the sample with breastfeeding data (N= 9,479)

Variables	*N*	*%*	*Mean*	*SD*
Mother's Age	9,479	---	28.7	4.7
Parity	9,094	---	.77	.943
Ethnicity	9,031		---	---
Caucasian		92.7		
Socioeconomic Status	7,741		---	---
I		5.9		
II		28.6		
III (non-manual)		33.7		
III (manual)		5.6		
IV		6.6		
V		1.2		
Mother's Education	8,717		---	---
CSE		9.6		
Vocational		7.9		
O-Level		33.3		
A-Level		25.3		
University Degree		15.9		
Partner's Education	8,169		---	---
CSE		11.9		
Vocational		7.3		
O-Level		19.9		
A-Level		26.0		
University Degree		21.1		
Mother's type of work	8,703			
Full-time		60.0		
Part-time		28.5		
Casual		3.3		
Alcohol in pregnancy (Y)	9,185	54.1	---	---
Smoking in pregnancy (Y)	9,246	19.5	---	---
Medication in pregnancy (Y)	9,250	70.7	---	---
Anxiety Medication (Y)		0.6		
Depression Medication (Y)		0.5		
Baby's sex (M)	9,479	51.2	---	---
Gestational age at birth (week)	9,479	---	39.5	1.65
Baby's head circumference (cm)	9,479	---	34.8	1.46

Range (Min-Max): *Age*: 29 (15-44), *Parity*: 22 (0-22), *Gestational age at birth*: 43 (4-47), *baby's head circumference*: 35(19-54).

The pattern of breastfeeding at different time points is shown in Table 2. Breastfeeding data were available for N= 9,479 participants (73-76%) and missing for 24-26% of the whole cohort, at the different time points. Exclusive breastfeeding declined from 53.1% at day 1 to 32.4% at week four.

By six months, only 20.4% of women were carrying out any breastfeeding. Figure 5a shows the percentage of exclusive breastfeeding at different time points in groups who had depressive symptoms (EPDS $\geq$ 13) at 18 or 32 weeks antenatal compared with those who did not. The differences were generally about 10% and all highly significant ($p < 0.05$). Figure 5b shows a similar association between any breastfeeding at six months and postnatal depressive symptoms at eight weeks (22.7% women were breastfeeding and had depressive symptoms versus 29.4% women that were breastfeeding and did not have depressive symptoms).

Table 2. Infant feeding pattern at different time points (N= 9,479)

	Excl. Breastfeeding					*Any Breastfeeding*
Variables	*Day 1(%)*	*Week 1(%)*	*Week 2(%)*	*Week 3(%)*	*Week 4(%)*	*6 months (%)*
Breastfeeding	53.1	49.0	44.4	37.8	32.4	20.4
Bottle feeding	17.3	19.2	24.7	27.6	31.2	----
Mixed Feeding	3.5	7.1	6.4	10.2	12.9	----

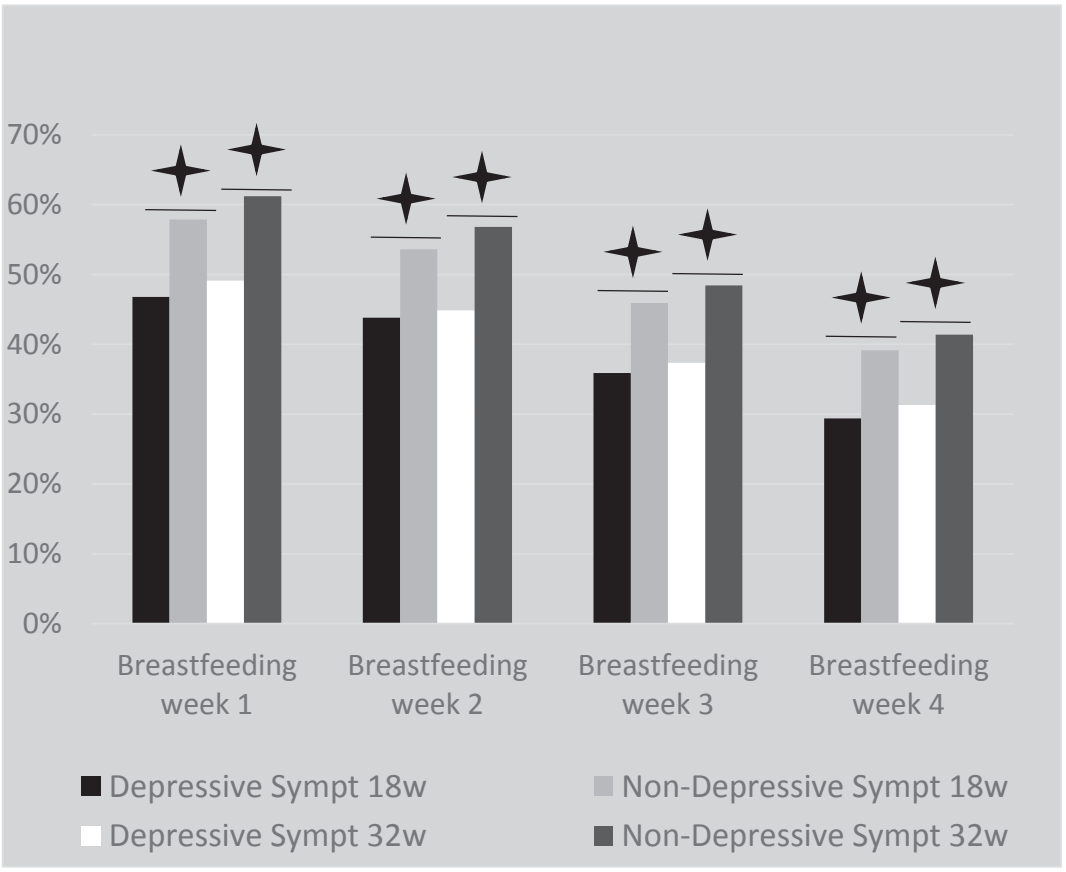

Figure 5a. Percentage of exclusive breastfeeding in women with symptoms of depression (EPDS ≥13) and without symptoms of depression. Women with depressive symptoms (EPDS ≥ 13) and women without depressive symptoms have a p≤.05

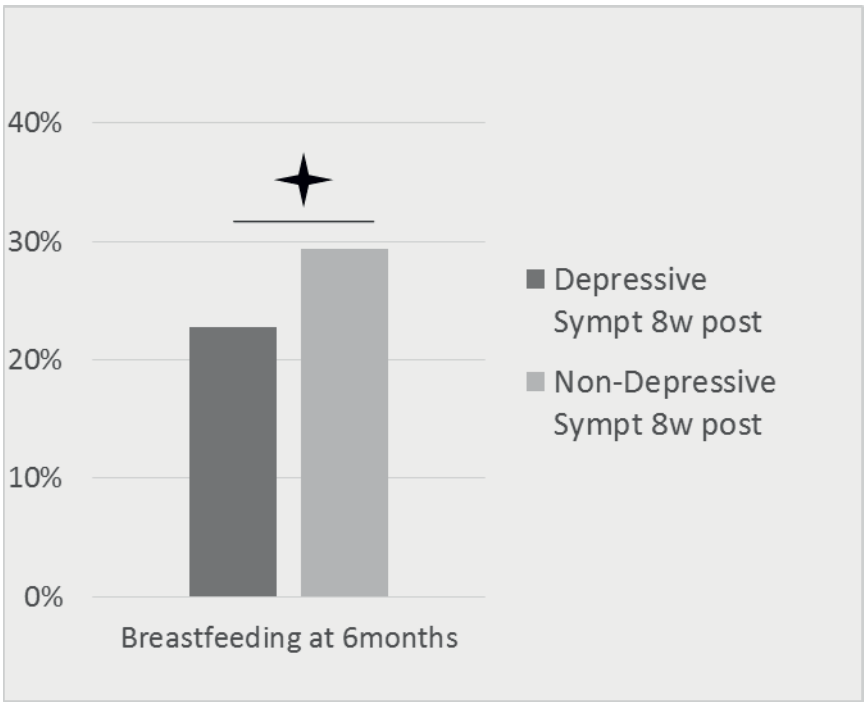

Figure 5b. Percentage of any breastfeeding (6 months) in women with symptoms of depression (EPDS ≥ 13) and women without symptoms of depression at the postnatal period (8 weeks postnatal). Women with depressive symptoms (EPDS ≥ 13) and women without depressive symptoms have a p≤.05

Table 3 shows the Pearson correlations between breastfeeding at different time points, antenatal and postnatal depressive symptom scores, antenatal attitudes towards breastfeeding and the socio-demographic variables shown in Table 1. All variables except for maternal ethnic group showed a significant correlation with breastfeeding at least at one time point; the large sample size meant that even very small effects were statistically significant.

Table 3. Correlations between attitudes towards breastfeeding, antenatal and postnatal depressive symptoms, socio-demographic variables and breastfeeding at various times

	Exclusive Breastfeeding			*Any Breastfeeding*
	Day 1	*Week 1*	*Week 4*	*6 Months*
Attitudes towards breastfeeding	.443*	.455*	.428*	.386*
Mother's Age	.212*	.210*	.217*	.244*
Parity	-.076*	-.059*	n.s	.043*
Maternal ethnic group	n.s	n.s	n.s	n.s
Mother's socioeconomic status	-.123*	-.117*	-.133*	-.114*
Mother's education	.272*	.276*	.279*	.297*
Partner's education	.210*	.215*	.238*	.247*
Mother's type of work	-.030*	-.020*	n.s	.022*
Maternal alcohol consumption	n.s	.015*	n.s	n.s
Maternal Smoking	-.161*	-.142*	-.139*	-.123*
Maternal Medication Anxiety Medication Depression Medication	.086* .023* .049*	.087* n.s .045*	.069* .021* .029*	.093* n.s .025*
Maternal antenatal depressive Symptoms (18 weeks)	-.101*	-.111*	-.105*	-.084*
Maternal antenatal depressive symptoms (32 weeks)	-.113*	-.113*	-.093*	-.077*
Maternal postnatal depressive symptoms (8 weeks)	---	---	---	-.049*
Baby's sex	.017*	n.s	n.s	.026*
Gestational age at birth	.279*	.241*	.157*	.030*
Baby's head circumference	.118*	.087*	.043*	.039*

*significant at $p \leq .05$

We then ran a series of logistic regression analyses using all the significant variables from Table 1 (antenatal attitude towards breastfeeding, parity, SES, mother and partner's education, mother's type of work, mother's age, maternal alcohol consumption, maternal medication use [general and specific for depression and anxiety], maternal smoking, gestational age at birth, baby's sex and baby's head circumference) as predictors of breastfeeding at the different time points, together with symptoms of depression at 18 weeks and 32 weeks antenatal and 8 weeks postnatal. As the results using the 18-week and 32-week EPDS scores were very similar, only those for 18 weeks are displayed in Tables 4a and 4b. Table 4a shows the associations with exclusive breastfeeding from day one to week four. Table 4b shows the associations with any breastfeeding at six months. The antenatal attitude towards breastfeeding had a sizeable effect on breastfeeding independently of antenatal depressive symptoms at all time points. Antenatal depressive symptoms were only associated with breastfeeding at day one after birth when all of the other variables were included.

We added to the model an interaction variable between EPDS at 18 weeks gestation and antenatal attitudes towards breastfeeding. This also showed a significant modifying effect of depressive symptoms on attitudes which was limited to day one after birth. Table 4c shows that postnatal depressive symptoms at eight weeks were not significantly associated with breastfeeding at six months when all of the other variables were included.

Table 4a (Part 1). Logistic regression with breastfeeding initiation (day 1 to week 4), antenatal depressive symptoms (18 weeks), interaction between depressive symptoms and attitudes towards breastfeeding and socio-demographic factors.

	Breastfeeding Day 1(N=6181)				*Breastfeeding Week 1(N=6176)*			
Variables	*B*	*S.E*	*OR(CI)*	*Sig.*	*B*	*S.E*	*OR(CI)*	*Sig.*
Age	0.043	0.009	1.04 (1.02-1.06)	0.00	0.029	0.008	1.02 (1.01-1.04)	0.00
Parity	-0.086	0.047	.918 (.83-.1.00)	n.s	-0.083	0.044	.921 (.84-1.00)	0.05
Mother's Social Class	-0.064	0.03	.938 (.88-.99)	0.03	-0.033	0.023	.968 (.92-1.01)	n.s
Mother's Education	0.241	0.035	1.27 (1.18-1.36)	0.00	0.227	0.033	1.25 (1.1-1.33)	0.00
Partner's Education	0.096	0.028	1.10 (1.04-1.16)	0.00	0.105	0.027	1.11 (1.05-1.17)	0.00
Mother's type of work	0.044	0.068	1.04 (.91-1.19)	n.s	0.123	0.063	1.13 (.99-1.28)	0.05
Alcohol	0.058	0.044	1.06 (.97-1.15)	n.s	0.083	0.041	1.08 (1.00-1.17)	0.04
Smoking	-0.357	0.071	.700 (.60-.80)	0.00	-0.221	0.068	.802 (.70-.91)	0.00
General Medication	0.009	0.023	1.00 (.96-1.05)	n.s	0.015	0.021	1.01 (.97-1.05)	n.s
Anxiety Medication	0.243	0.202	1.27 (.85-1.89)	n.s	0.022	0.196	1.02 (.69-1.50)	n.s
Depression Medication	0.053	0.177	1.05 (.74-1.40)	n.s	0.042	0.172	1.04 (.74-1.46)	n.s
Depressive S. 18w gestation	-0.083	0.044	.920 (.84-1.00)	0.05	-0.075	0.042	.927 (.85-1.00)	n.s
Baby's sex	0.110	0.069	1.11 (.97-1.27)	n.s	0.061	0.065	1.06 (.93-1.20)	n.s
Baby's head circumference	0.046	0.026	1.04 (.99-1.10)	n.s	0.033	0.024	1.03 (.98-1.08)	n.s
Gestational Age	0.263	0.022	1.30 (1.24-1.36)	0.00	0.158	0.021	1.17 (1.12-1.22)	0.00
Attitudes towards Breastfeeding	0.307	0.017	1.35 (1.31-1.40)	0.00	0.293	0.016	1.34 (1.29-1.38)	0.00
Depressive S. 18w X Att. Breastfeeding	-0.004	0.002	.996 (.99-1.00)	0.05	-0.003	0.002	.997 (.99-1.00)	n.s

*significant at p≤ .05

Table 4a (Part 2). Logistic regression with breastfeeding initiation (day 1 to week 4), antenatal depressive symptoms (18 weeks), interaction between depressive symptoms and attitudes towards breastfeeding and socio-demographic factors

	Breastfeeding Week 2(N=6183)				*Breastfeeding Week 3(N=6177)*			
Variables	*B*	*S.E*	*OR (CI)*	*Sig.*	*B*	*S.E*	*OR(CI)*	*Sig.*
Age	0.033	0.008	1.03 (1.01-1.05)	0.00	0.035	0.008	1.03 (1.02-1.05)	0.00
Parity	-0.058	0.043	.944 (.86-1.02)	n.s	0.021	0.042	1.02 (.94-1.10)	n.s
Mother's Social Class	-0.004	0.019	.996 (.960-1.03)	n.s	-0.016	0.021	.984 (.94-1.02)	n.s
Mother's Education	0.253	0.032	1.28 (1.21-1.37)	0.00	0.264	0.032	1.30 (1.22-1.38)	0.00
Partner's Education	0.127	0.026	1.13 (1.07-1.19)	0.00	0.133	0.026	1.14 (1.08-1.20)	0.00
Mother's type of work	0.091	0.062	1.09 (.97-1.23)	n.s	0.057	0.06	1.05 (.94-1.19)	n.s
Alcohol	0.062	0.04	1.06 (.98-1.15)	n.s	0.087	0.039	1.09 (1.01-1.17)	0.02
Smoking	-0.111	0.068	.895 (.78-1.02)	n.s	-0.202	0.068	.817 (.71-.933)	0.00
General Medication	0.005	0.02	1.00 (.96-1.04)	n.s	0.006	0.02	1.00 (.96-1.04)	n.s
Anxiety Medication	0.193	0.192	1.21 (.83-1.76)	n.s	0.488	0.202	1.63 (1.09-2.42)	0.01
Depression Medication	0.16	0.175	1.17 (.83-1.65)	n.s	-0.023	0.176	.977 (.69-1.37)	n.s
Depressive S. 18w gestation	-0.02	0.041	.980 (.90-1.06)	n.s	-0.035	0.039	.965 (.894-1.04)	n.s
Baby's sex	0.032	0.063	1.03 (.91-1.16)	n.s	0.061	0.061	1.06 (.94-1.19)	n.s
Baby's head circumference	-0.009	0.023	.992 (.94-1.03)	n.s	-0.022	0.023	.978 (.93-1.02)	n.s
Gestational Age	0.084	0.02	1.08 (1.04-1.13)	0.00	0.041	0.02	1.04 (1.00-1.08)	0.03
Attitudes towards Breastfeeding	0.279	0.016	1.32 (1.2-1.36)	0.01	0.272	0.016	1.31 (1.27-1.35)	0.00
Depressive S. 18w X Att. Breastfeed	0.00	0.002	1.00 (.99-1.00)	n.s	-0.001	0.002	.999 (.99-1.00)	n.s

*significant at p≤ .05

Table 4a (Part 3). Logistic regression with breastfeeding initiation (day 1 to week 4), antenatal depressive symptoms (18 weeks), interaction between depressive symptoms and attitudes towards breastfeeding and socio-demographic factors

	Breastfeeding Week 4(N=6206)			
Variables	*B*	*S.E*	*OR (CI)*	*Sig.*
Age	0.035	0.008	1.03 (1.02-1.05)	0.0
Parity	0.015	0.042	1.01 (.93-1.10)	n.s
Mother's Social Class	-0.032	0.026	.969 (.92-1.01)	n.s
Mother's Education	0.251	0.032	1.28 (1.20-1.36)	0.0
Partner's Education	0.168	0.026	1.18 (1.12-1.24)	0.0
Mother's type of work	0.038	0.06	1.03 (.92-1.16)	n.s
Alcohol	0.038	0.039	1.03 (.96-1.12)	n.s
Smoking	-0.183	0.07	.832 (.72-.955)	0.0
General Medication	0.010	0.02	1.01 (.97-1.05)	n.s
Anxiety Medication	0.592	0.221	1.8 (1.17-2.78)	0.0
Depression Medication	-0.044	0.184	.957 (.66-1.37)	n.s
Depressive S. 18w gestation	-0.006	0.039	.994 (.92-1.07)	n.s
Baby's sex	0.082	0.061	1.08 (.96-1.22)	n.s
Baby's head circumference	-0.002	0.023	.998 (.95-1.04)	n.s
Gestational Age	0.034	0.02	1.03 (.99-1.07)	n.s
Attitudes towards Breastfeeding	0.257	0.016	1.29 (1.25-1.33)	0.0
Depressive S. 18w X Att. Breastfeed	0.000	0.002	1.00 (.99-1.00)	n.s

*significant at p≤ .05

Table 4b. Logistic regression with breastfeeding duration (6 months), antenatal depressive symptoms (18 weeks), interaction between depressive symptoms and attitudes towards breastfeeding and socio-demographic factors

	Breastfeeding 6 Months (N=5793)			
Variables	*B*	*S.E*	*OR(CI)*	*Sig.*
Age	0.072	0.009	1.07(1.05-1.09)	0.0
Parity	0.016	0.045	1.01(.92-1.11)	n.s
Mother's Social Class	0.024	0.02	1.02(.98-1.06)	n.s
Mother's Education	0.381	0.037	1.46(1.36-1.57)	0.0
Partner's Education	0.168	0.03	1.18(1.11-1.25)	0.0
Mother's type of work	0.122	0.066	1.13(.99-1.28)	n.s
Alcohol	-0.039	0.044	.961(.88-1.04)	n.s
Smoking	-0.158	0.084	.854(.72-1.00)	0.05
General Medication	0.069	0.021	1.07(1.02-1.11)	0.0
Anxiety Medication	0.19	0.24	1.20(.75-1.93)	n.s
Depression Medication	0.018	0.246	1.01(.62-1.65)	n.s
Depressive S. 18w gestation	-0.005	0.044	.995(.91-1.08)	n.s
Baby's sex	0.176	0.069	1.19(1.04-1.36)	0.01
Baby's head circumference	0.034	0.027	1.03(.98-1.09)	n.s
Gestational Age	0.009	0.023	1.00(.96-1.05)	n.s
Attitudes towards Breastfeeding	0.247	0.018	1.28(1.23-1.32)	0.0
Depressive S 18w X Att. Breastfeed	0.00	0.002	1.00(.99-1.00)	n.s

*significant at p≤ .05

Table 4c. Logistic regression with breastfeeding at 6 months, postnatal depressive symptoms (8 weeks) and socio-demographic factors

	Breastfeeding 6 Months (N=8467)			
Variables	*B*	*S.E*	*OR(CI)*	*Sig.*
Mother's age	0.072	0.009	1.07(1.05-1.09)	0.00
Parity	0.042	0.045	1.04(.955-1.13)	n.s
Mother's Social Class	0.012	0.018	1.01(.978-1.04)	n.s
Mother's Education	0.380	0.037	1.46(1.36-1.57)	0.00
Partner's Education	0.170	0.030	1.18(1.11-1.25)	0.00
Mother's type of work	0.102	0.066	1.10(.97-1.26)	n.s
Alcohol	-0.035	0.043	.966(.88-.105)	n.s
Smoking	-0.192	0.084	.825(.70-.97)	0.02
General Medication	0.065	0.021	1.06(1.02-1.11)	0.00
Anxiety Medication	0.130	0.232	1.13(.72-1.79)	n.s
Depression Medication	-0.035	0.245	.966(.59-1.56)	n.s
Depressive S. 18w gestation	-0.024	0.043	.976(.896-1.06)	n.s
Baby's sex	0.163	0.068	1.17(1.03-1.34)	0.01
Baby's head circumference	0.020	0.026	1.02(.96-1.07)	n.s
Gestational Age	0.006	0.023	1.00(.96-1.05)	n.s
Attitudes towards Breastfeeding	0.248	0.017	1.28(1.24-1.32)	0.00
Depressive S 18w X Att. Breastfeed	0.00	0.002	1.00(.99-1.00)	n.s

*significant at p≤ .05

This model was tested in a range of subsets: only women with depressive symptoms (EPDS ≥ 13), only women without depressive symptoms (EPDS ≤ 13), women with any breastfeeding, only women with premature babies (gestational age between ≥32 and ≤ 35 weeks), only women with term babies (gestational age ≥ 37 weeks), women with antenatal depressive symptoms and premature babies, and women with antenatal depressive symptoms and term babies. In general, the results were similar to those shown in Tables 4a, 4b and 4c. In all subsets, despite some variability in the effect size (from OR= 1.2, [95% CI 1.24-1.32]; to OR= 1.3, [95% CI 1.31-1.40]; p=.00), antenatal attitudes towards breastfeeding were always significant and of a similar magnitude to that found for the whole cohort.

7.4 Discussion

This study investigated antenatal predictors of breastfeeding identified in previous studies, particularly antenatal depressive symptoms, antenatal attitudes towards breastfeeding, and socio-demographic factors. We showed that when depressive symptoms were considered in bivariate analyses, there was a significant difference in breastfeeding initiation and duration between those who reported depressive symptoms in the antenatal period and those who did not (Fig. 5). Similarly, a significant difference was found between those who had any breastfeeding at six months and

those who had depressive symptoms at eight weeks postnatal when depressive symptoms were considered in a bivariate analysis. However, this prediction was largely explained by co-occurring antenatal and obstetric factors. Moreover, we found that antenatal attitudes towards breastfeeding were a robust and important predictor of breastfeeding, being associated with a 20 to 30% increase in breastfeeding initiation and maintenance.

Thus, a central finding of the current study was the consistent and significant association between antenatal attitudes towards breastfeeding and breastfeeding practices. Previous studies concerning determinants of breastfeeding have recognised that attitude towards breastfeeding is a strong predictor of the choice for and duration of breastfeeding than other potential determinants (Baisch, Fox, Whitten & Pajewski, 1989; Hill, 1988; Scott, Shaker & Reid, 2004). A possible explanation for this may be found in the *Theory of Reasoned Action* (Ajzen, 1991), which asserts that the best predictor of showing a specific behaviour is the behavioural intention. Behavioural intention might be influenced by attitudes towards the behaviour and social perceptions about the behaviour (Montano & Kasprzyk, 2008). Earlier studies supported the use of this theory to explain breastfeeding outcomes in relation to breastfeeding intentions (Lawson & Tulloch, 1995; Scott, Aitkins, Binns & Aroni, 1999), but up to now, antenatal breastfeeding attitudes have not been considered together with major confounding factors, including depressive symptoms. In our study, antenatal attitudes towards breastfeeding were strongly associated with exclusive breastfeeding across multiple subsets, including a sub-sample of women with depressive symptoms, not only during the first four weeks after birth, but also until six months. Notably, this result was not substantially altered when we compared it with any breastfeeding over the same time period, showing that antenatal attitude towards breastfeeding is a very solid determinant of breastfeeding. Variables such as mother's age, mother and partner's education, and gestational age were also associated with an increasing likelihood of breastfeeding, which is consistent with previous studies in this area (Evers, Doran & Shellenberg, 1998; Hammer, Bryson, & Agras, 1999; Dennis, 2002). Of the determinants previously described in the literature as negatively associated with breastfeeding, only smoking was significantly associated with decreased breastfeeding from day one until six months postnatal.

When assessed together with all of the variables (antenatal attitude towards breastfeeding, parity, SES, mother and partner's education, mother's type of work, mother's age, maternal alcohol consumption, maternal medication use (general and specific for depression and anxiety), maternal smoking, gestational age at birth, baby's sex and baby's head circumference), EPDS at 18 and 32

weeks gestation was only significantly associated with breastfeeding at the first postnatal day. However, when considered alone, antenatal depressive symptoms both at 18 and 32 weeks gestation were significantly associated with decreased breastfeeding initiation and duration, as can be seen in Fig. 5a and Fig. 5b. This helps to clarify the currently inconsistent literature on the subject. Our long-term study involving a large number of participants was able to show that there is a longitudinal relationship between antenatal depressive symptoms and maternal breastfeeding initiation at day one. However, the prediction of sustained breastfeeding was accounted for by covariates. Postnatal depression is well established as being negatively associated with breastfeeding (Feldens et al., 2011; Imbula et al., 2012; Zubaran & Foresti, 2013;Flores-Quijano et al., 2008), but again, our analyses indicate that like antenatal depressive symptoms, the association with postnatal depressive symptoms may be accounted for by socio-demographic and other psychological factors such as attitude.

Our findings were consistent in showing that attitudes towards breastfeeding were not much affected by depressive symptoms or any other condition tested, did not change over time, and were an important predictor of breastfeeding. About 98% of women are physiologically able to breastfeed (WHO, 2011), and a great deal of research has shown that new mothers are aware of the health benefits of breastfeeding (Brown, 2015). Yet, rates of breastfeeding continue to be low worldwide. In our sample, breastfeeding duration rates were also low and below the recommended rates both in women with depressive symptoms and in women without depressive symptoms. It has been suggested that this may, in part, be caused by a formula-feeding culture, in which formula is not an occasional substitute for breast but the main way of feeding a newborn (Fomon, 2001), and may also be a product of a culture in which negative reactions to public breastfeeding occur (Acker, 2009).

This study has some limitations. First, the breastfeeding data reporting exclusive breastfeeding were only collected until one month postnatal rather than continuously until six months. Six months is the recommended period by the WHO for exclusive breastfeeding. However, we were able to investigate the duration of any breastfeeding given until six months. Second, the antenatal attitude towards breastfeeding was assessed using a single questionnaire. It would be of interest in future research to understand more about what other factors were associated with this attitude.

Finally, our data suggest that antenatal depression, when considered in isolation, exerts a long-term negative effect on breastfeeding initiation and duration. However, when other variables are

taken into account, the picture becomes more complex. These results underscore the significance of considering attitudes towards breastfeeding in programs to promote breastfeeding.

Chapter 8

Maternal coping stability and mood changes during pregnancy and postpartum: What are the effects on the infants?

"Statistical analysis allows us to put limits on our uncertainty,
but not to prove anything."
- Douglas G. Altman

8.1 Introduction

Pregnancy and postpartum bring important emotional and physiological changes to a woman's life, which have a high potential to produce distress (Razurel et al., 2011). One important aspect is how the woman deals with stressful events (Faisal-Cury et al., 2004). Coping refers to any attempt to manage internal or external situations generated by stressful events (Lazarus & Folkman, 1984). From a contextual perspective, coping is seen as a dynamic process likely to change over time and the course of stressful situations, whereas the dispositional perspective emphasizes that people can develop a constant pattern of coping (Moos, Holahan & Beutler, 2003). According to the latter, coping is assumed to be temporally stable, implying the use of the same strategy at different moments. It is also considered cross-situationally consistent, assuming that an individual copes in a similar way when experiencing different classes of stressors (Ptacek, Pierce & Thompson, 2006). There are many coping styles reported in the literature, but three major categories are emphasized. Firstly, *emotion-focused coping*, which is defined as the regulation of emotions and distress; secondly, *problem-focused coping*, which can be defined as the management of the problem that is causing distress, including planning and information seeking (Lazarus & Folkman, 1984). Thirdly, *avoidance* which is a coping dimension that refers to escaping from the stressful situation and avoiding confrontation (Suls & Fletcher, 1985).

Previous studies have reported that pregnant women use different coping strategies during early, mid- and late pregnancy in response to the changing demands of each gestational trimester (Hamilton & Lobel, 2008; Huizink et al., 2002). However, Yali and Lobel, (2002) found coping to be stable during the whole gestational period. How expectant mothers respond to stress may contribute to its reduction or increase (Guardino & Schetter, 2014). For instance, coping through avoidance was associated with indicators of poor maternal psychological wellbeing and greater psychological distress (Rodriguez et al., 2010; Besser & Priel, 2003; Morling et al., 2003).

Inadequate coping skills in pregnancy were linked with low birth weight babies, more emergency caesarean section (Ryding et al., 1998), and post-traumatic stress symptoms during the postpartum period (Ford, Ayers & Bradley, 2010; Soderquist et al., 2009). Conversely, a longitudinal study that observed women from pregnancy until postpartum found that problem-focused coping across this time predicted better maternal adjustment to parenting. The effect included higher levels of maternal wellbeing, parenting efficacy and, caregiving behaviours (Levy-Shef et al., 1998) as well as child motor development until one year of age (Levy-Shif et al., 2002).

The influence of perinatal mental disorders on child outcomes has been widely investigated, but uncertainty remains regarding the effects of normal mood changes (DiPietro et al., 2006). While some emotional changes may be seen as maladaptive during gestation (O'Hara, 2009; Segre, O'Hara & Losch, 2006), a variety of mood alterations occur and are regarded as normal (Ross et al., 2004). Some studies advocate that a certain amount of stress and anxiety are usual, due to natural fears that may arise with the prospective arrival of a new baby. These may not be seen as always harmful (Ross et al., 2006). For instance, Ponirakis et al. (1998) found that newborns from women presenting negative emotions in early (≤ 16 weeks), but not in late gestation (32-34 weeks) have better Apgar scores (a method to summarize the health of newborns) at birth. Also, prenatal maternal hypertension was shown to promote an accelerated effect on foetal organ development and neuromaturation (Allen & Donohue, 2002). Therefore, evidence supporting positive, although indirect, effects of maternal low to mild stress and anxiety on the offspring can be found, but interestingly they are not much published (DiPietro et al., 2006). Yet, little is known about how mood changes across pregnancy and postpartum might affect infant temperament and influence breastfeeding practices.

The negative associations between depression, depressive symptoms, and breastfeeding are well-known (Dias & Figueiredo, 2015; Hanh-Holbrook et al., 2013; Seimyr et al., 2004). Findings indicate that depressed pregnant women are less likely to intend to breastfeed (Fairlie et al., 2009; Insaf et al., 2011) or to maintain breastfeeding (Ystrom, 2012; Kehler, Chaput & Tough 2009), whereas postnatally depressed mothers have shorter breastfeeding duration and poorer breastfeeding practices (Dias & Figueiredo, 2015). On the other hand, women with no history of prenatal depression, who start breastfeeding after birth, seem to be protected against postpartum depression (Figueiredo, Canario & Field, 2014). Breastfeeding is related to lower neuroendocrine responses to stressors and decreased negative mood (Heinrichs et al., 2001). The heightened levels of oxytocin and prolactin associated with lactation may inhibit the hypothalamic-pituitary-adrenal (HPA) axis through actions within the brain and peripherally altering stress responses (Neumann, 2005; Torner

& Neumann, 2002). Moreover, breastfeeding mothers report less perceived stress and less negative moods compared to their formula feeding counterparts (Mezzacappa, Kelsey & Katkin, 2005). Positive mood and lower levels of stress after birth were suggested to be linked with breastfeeding (Mezzacappa, 2004). However, it should be noted that other studies found no association between breastfeeding and maternal reduced stress and depression (Groer & Davis, 2006; McCarter-Spaulding & Horowitz, 2007; Ahn & Corwin, 2015). Most research has been directed at detecting severe or no indicators of maternal distress, including anxiety, stress, and depression. Yet, the way women who experience less severe mood fluctuations in pregnancy and postpartum behave in relation to breastfeeding is under-researched and still needs to be explored.

There have been many studies linking prenatal adverse influences with long-term effects on infant's temperament (Luecken et al., 2015). Maternal anxiety and depression in pregnancy may shape the infant's behavioural patterns (Di Pietro et al., 2002; Monk et al., 2009). This finding suggests that women's psychological antenatal state can affect foetal development. The foetal programming hypothesis is in part related to it. It postulates that relevant physiological markers can be readjusted by environmental events during foetal development. These can last into adulthood (Barker, 2004). Newborns from prenatally depressed mothers have increased irritability and excessive crying and fussiness at birth (DiPietro et al., 1996). O'Connor et al. (2002) found prenatal maternal anxiety to predict behavioural and emotional problems in children at 4 years of age. In contrast, DiPietro et al. (2006) argued that maternal anxiety, depression, and non-specific stress in pregnancy within the normal limits poses no significant threat to infant early behavioural regulation. Remarkably, they found that mild levels of maternal anxiety, depression, and stress are associated with better motor and cognitive development. Amiel-Tison et al. (2004) proposed a model suggesting that moderate intrauterine exposure to stress would improve foetal maturation and optimal adaptation. Postnatally, maternal mood may also contribute or compromise infant care and consequently affect offspring temperament. Depressed and anxious mothers have been reported to have negative perceptions about their infant's temperament as well as to inadequately interact with them (Rode & Kiel, 2015). On the other hand, non-depressed or anxious mothers are usually reported to have a better perception of their children's temperament (McGrath, Records & Rice, 2008).

The current study adds to existing research by following the trajectories of maternal coping styles and maternal mood during the course of pregnancy until six months postpartum in a large, unselected group of pregnant women. There is evidence that maternal mood varies across gestation and after birth (Evans et al., 2001; Bennett et al., 2004). However, there are two potentially

important limitations of the existing literature. One is failure to consider the normal mood fluctuations occurring in pregnancy and postpartum. It may be that in only examining depressed or non-depressed samples the effects of the changes from being depressed to not being depressed are not considered. Assessing alterations in maternal mood and also in the mother's way of coping with distress longitudinally may be a more sensitive approach to determine if changes across time show differential outcomes on breastfeeding and infant temperament. The second limitation in most studies is the fact that estimation of maternal coping is limited to 1 to 3 assessments, usually at one point or in each trimester of pregnancy leaving out the postpartum period. This is a significant restriction because following the trajectories of maternal coping will best inform about potential consequences to breastfeeding and infant temperament by considering the probable wide variation from pregnancy to six months postpartum.

Thus, the aims of this study are twofold. First, we examined changes in maternal coping styles and maternal mood from pregnancy through the first six months postpartum; second, we investigated the association between maternal coping style and maternal mood with breastfeeding and child temperament. Our research extends from previous findings by providing new evidence and improving the literature in this area that is currently outdated. Thus, we hypothesize that: a) mood changes at late pregnancy and early postpartum will affect breastfeeding behaviour at one month; b) mood fluctuations in mid-pregnancy will be associated with infant negative affect and extraversion/surgency; c) coping variation will be related to mood variation at all time points investigated.

8.2. Methods

8.2.1 Sample

This is an observational prospective longitudinal research including unselected pregnant women and their child. Pregnant women were recruited at about 20 weeks gestation from the antenatal ultrasound clinic at Queen Charlotte's Maternity Hospital in London, UK and were followed until six months postpartum. If potential participants fulfilled the inclusion criteria and agreed to be included in the study, they would then fill in online questionnaires from the 20th gestational week until six months after birth. Inclusion criteria were: to be between 18-45 years old, to be computer literate, to have a computer with internet access at home and to speak and write English. Exclusion criteria were: twin pregnancies, a severe medical disorder (e.g. lupus, epilepsy), in vitro fertilization, a medical disorder in pregnancy (including abnormal foetus), severe psychological disorder (e.g. psychosis or drug addiction), computer illiteracy and not speaking and writing

English. For the completion of postnatal questionnaires, women with premature babies (≤ 35 weeks) and/or a baby with any severe disorders (e.g. heart defect, respiratory distress) were excluded. The recruitment took place from June, 2013 until April, 2014.

From the N=368 participants starting this study, N=162 remained until the last time point at six months postpartum (Fig. 6). Our retention rate was 44.3% of participants.

Ethical approval was obtained from Imperial Healthcare Trust ethics committee and national research ethics committee before commencement of the study. Written informed consent was obtained at recruitment and an online re-confirmation of consent was asked before fulfilment of questionnaires.

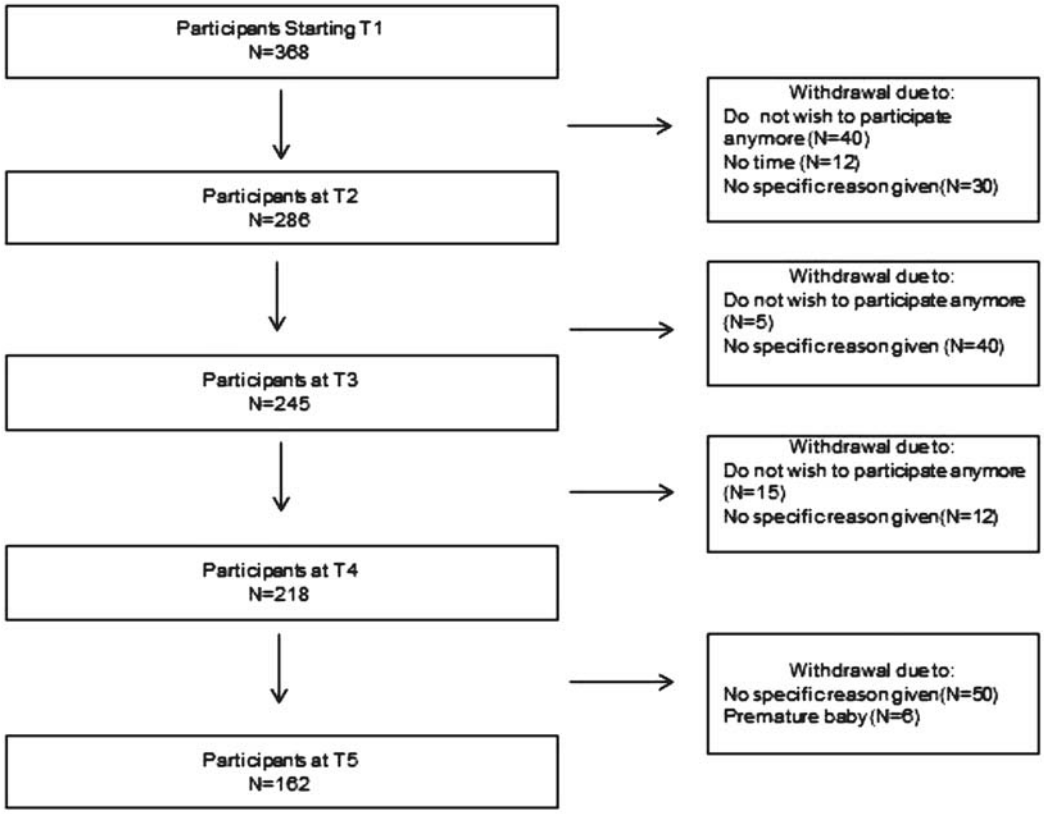

Figure 6. Overview of the sample variation across time

8.2.2 Measures and procedures

8.2.3 Maternal Mood

Maternal mood was assessed with the Edinburgh Postnatal Depression Scale (EPDS; Cox, Holden & Sagovsky, 1987), a widely used 10-item self-report questionnaire designed to measure postnatal

depressive symptoms. The scale quantifies the intensity of these symptoms within the last seven days (Tendais et al., 2014). This measure has been successfully validated for assessments during and outside of the postnatal period, including pregnancy (Cox, Holden & Sagovsky, 1987), and each item is rated on a 4-point Likert scale (0-3), with a total score ranging from 0 to 30. Examples of the scale statements are “I have been able to laugh and see the funny side of things”, “I have been anxious or worried for no good reason” or “I have been so unhappy that I have been crying”. A cut-off of 13 or above was used in the current study, since this score predicts probable clinical depression based on diagnostic criteria (Murray & Carothers, 1990). Depressive symptoms were measured at 20 (T1), 28 (T2) and 36 (T3) weeks gestation and at one (T4) and six (T5) months postnatal (Fig. 7).

Figure 7. Timeline of the data collection with measures assessed at each time point. EPDS: Edinburgh Postnatal Depression Scale; IBQ: Infant Behaviour Questionnaire; IFS: Infant Feeding Scale; Socio Info: socioeconomic information.

8.2.4 Breastfeeding

Breastfeeding was measured with the Infant Feeding Scale (IFS), which was partially based on the Labbock and Krasovec (1990) definition of breastfeeding. This scale was used successfully in previous research from our group. It is a 3-item self-report questionnaire asking women which method of feeding was provided from birth until present, which method is given at the moment and which method is intended for the next months. Each item is rated in a 5-point scale with the options: “solely breastfeeding”, “mainly breastfeeding”, “both (50/50)”, “mainly formula feeding” and “solely formula feeding”. For our analysis, we transformed the infant feeding variable into a categorical variable divided into three groups: exclusive breastfeeding, mixed feeding (including “mainly breastfeeding”, “both [50/50]” and “mainly formula feeding”) and exclusive formula feeding. The infant feeding method was assessed at one (T4) and six (T5) months postnatal,

however, at one month we also asked participants about feeding method in the first three weeks postnatal. Thus, we have infant feeding data on the first three weeks after delivery, at one month and at six months postnatal.

8.2.5 Infant Behaviour Questionnaire Revised (IBQ-R): very short form

The Infant Behaviour Questionnaire (IBQ; Rothbart, 1981) was developed to assess infant temperament. After the initial version, Rothbart and colleagues (1998) refined and revised this instrument originating the IBQ-R, which was the basis for the short and very short form versions. The very short form of the IBQ-R used in this study is a 36-item self-report questionnaire divided in 3 temperament scales: surgency/extraversion, negative affect and effortful control (Putnam et al, 2008). It is an 8-point Likert scale ranging from "never" to "always", which asks parents to rate the frequency of specific temperament-related behaviours observed over the past week. Some of the questions asked are: "When tired, how often did your baby show distress?", "How often during the last week did your baby move quickly towards new objects?" or "After sleeping, how often did the baby cry if someone doesn't come in within a few minutes?". Infant temperament was assessed at six months of age (T5).

8.2.6 Maternal coping styles

Coping styles were measured with the English version of the Utrecht Coping List-19 (UCL-19; Schreurs et al, 1988), which is a short form of the Utrecht Coping List-30. This is a validated Dutch self-report questionnaire, which assesses coping styles for problems and unpleasant events in daily life. The subscales describe an individual tendency for five coping strategies: emotional coping (Cronbach's α=.65), avoidant coping (Cronbach's α=.67), palliative coping (Cronbach's α=.68), problem-focused coping (Cronbach's α=.68) and social coping (Cronbach's α=.77). High scores indicate a high tendency to apply the specified coping style. The 4-point Likert response scale ranges from "never" to "very often" and was successfully used in research involving pregnant and postnatal women (Huizink et al., 2002). This 19-item questionnaire was filled out from the 20th gestational week (T1) to six (T5) months postpartum and women were asked to describe their coping style in each time point investigated. Some of the questions were: "Do you work goal-directed to solve a problem?", "Do you share your worries with someone?". The factor structure from the original questionnaire was reviewed and it was reanalysed for our population, as suggested by the authors (see results section).

8.2.7 Covariates

We collected socio-demographic information from participants at their first assessment at 20 weeks gestation and information about birth outcomes and the baby's health from the participant's medical records immediately after birth. These included: *marital status*; *ethnic group*, coded as 1=Caucasian, 2=other; *number of pregnancies*, reported on a continuous scale; *parity*, scaled in number of children; *monthly income*, categorised as 1= Less than £ 1,500, 2= £1,500-£2,100, 3= £2,100-£3,600, 4= £3,600-£5,000, 5= £5,000-£8,000,6= More than £8,000,7= Do not wish to say; *self-reported currently smoking*, defined as tobacco smoked at 20 weeks gestation, rated on a scale from 1-5 and coded as 1= No, 2= Less than 5 cigarettes a day, 3= 5-10 cigarettes per day, 4= 10-20 cigarettes per day, 5= More than 20 cigarettes per day; *ever smoked*, coded as 1= Yes, 2= No; *currently drinking alcohol*, coded as 1= Yes, 2= No; *mother's education*, rated on a scale from 1-6 and coded as 1= Left before GCSE/O-Levels (General Certificate of Secondary Education and Ordinary level, qualification conferred as part of the General Certificate of Education), 2= GCSE/O-Levels, 3= A-level (General Certificate of Education - Advanced level), 4= Vocational training, 5=University degree, 6= Higher degree (MSc /MA/ MRes/PhD); *mother's age*, scaled in years and ranging from 18 to 45 years old; *baby's sex*, coded as male or female; *baby's weight* scaled in kg, *type of birth*, coded as 1= Natural, 2= Instrumental Delivery, 3= Planned C-section and 4= Emergency C-section.

8.2.8 Statistical Analysis

We examined the factor structure of the UCL-19 by means of exploratory factor analysis. We subsequently tested the goodness of fit between the hypothesized structure and the sample data in order to provide information on the reliability of the scale.

Since our continuous variables were not normally distributed, except for the coping variable, we applied non-parametric statistics or bootstrapping for all analysis. The bootstrap method consists in random sampling with replacement and is applied to a wide variety of parameters. Its main goal is to make an inference about the population parameter based on the sample distribution. We used this non-parametric technique to do the estimation of the sample distribution by using 1000 samples. The significance of our results was always based on 95% bias-corrected confidence interval that did not include zero.

Spearman correlations were carried out between maternal mood at 20, 28 and 36 weeks gestation and one and six months after birth, infant feeding at one and six months, maternal coping styles at

20, 28 and 36 weeks gestation and one and six months postpartum, covariate variables, and the IBQ subscales: extraversion/surgency, negative affect and effortful control at six months. The analysis of change across time for maternal mood was carried out using Friedman's variance analysis and post hoc tests adjusted for Bonferroni correction. Maternal coping changes from pregnancy until postpartum were tested with general linear model (GLM) repeated measures. The associations between maternal mood and coping styles with infant temperament and breastfeeding were examined with hierarchical regression after applying a stepwise selection.

8.3 Results

The socio-demographic information of the sample can be seen in Table 5.

Table 5. Socio-demographic information of the sample (N=162)

	%	*Mean (SD)*		*%*	*Mean (SD)*
Mother's age	---	34.2 (4.01)	**No. previous pregnancies (0)**	40.6	---
Marital status			**Currently smoking (Y)**	0.6	---
Married/Living with partner	95.7	---			
Parity	---	1.5 (.67)	**Currently drinking alcohol (Y)**	17.3	---
Ethnicity			**Currently taking prescribed medication (Y)**	32.5	---
Caucasian	68.8	---			
Monthly income		---	**Type of delivery**		---
Less than £ 1,500	2.5		Natural	53.7	
£1,500-£2,100	5.6		Instrumental	19.4	
£2,100-£3,600	12.5		Elective C-section	7.4	
£3,600-£5,000	20.0		Emergency C-section	19.4	
£5,000-£8,000	29.4				
More than £8,000	18.8				
Do not wish to say	11.3				
Mother's education		---	**Baby's birthweight**	---	3435.4 (631.0)
Left before GCSE/O-level	1.2				
GCSE/O-level	4.9				
A-Level	5.6				
Vocational	1.9				
University Degree (BSc, BA)	53.7				
Higher Degree (MSc, PhD, MA)	32.7				
Currently working (Y)	89.5	---	**Baby's sex (F)**	64.5	---

8.3.1 Factor Structure of Coping

Exploratory factor analysis was used to determine the factor structure of the coping inventory for our population. Principal factor analysis with orthogonal rotation yielded six factors with eigenvalues greater than one that explained 63% of the total variance. However, two of these factors consisted of two items each and showed only a small contribution to the total explained variance (7.4% and 7.1% and respective eigenvalues of 1.41 and 1.36); these two factors were not considered meaningful and were dropped out of the analysis. Subscales were created by summing the items on each factor if their loadings were at least 0.40. One item did not load in any factor whereas two items loaded in more than one being both retained in the factor with the highest loading. Factors 1-4 formed coherent and interpretable coping subscales which were labelled: Problem-focused, Avoidance, Emotional-focused and Social. Problem-focused coping consisted of five items, had an eigenvalue of 3.1 and explained 16.4% of the variance, Avoidance consisted of three items, had an eigenvalue of 1.7 and explained 9.05% of the variance, Emotional coping contained two items, had an eigenvalue of 1.6 and explained 8.5% of the variance and Social coping has five items, had an eigenvalue of 2.7 and explained 14.4% of the variance. Additionally, we examined the internal reliability of each subscale which resulted in a Cronbach's α=.78 for the Problem-focused subscale, Cronbach's α=.81 for the Social coping; Cronbach's α=.70 for Emotion-focused coping and Cronbach's α=.64 for Avoidance. Cronbach's α was similar or higher across the time points investigated. Based on the factor analysis, three items loaded for Avoidance coping, however one of these items needed to be dropped out in order to improve internal consistency - from Cronbach's α=.58 to Cronbach's α=.64 - of the subscale.

8.3.2 Maternal mood changes across time

There was a statistically significant difference in mood changes from pregnancy throughout postpartum X^2 (4) = 12.478, p=.014 (Table 6). Post hoc analysis with Wilcoxon signed-rank tests was conducted with a Bonferroni correction applied, resulting in a significance level set at $p < 0.01$. There were no significant differences in changes between T1 and T2 (Z= -.574, p=.56); T2 and T3 (Z=.997, p=.31); T3 and T4 (Z= -2.17, p=.029). However, there was a statistically significant difference in changes between T4 and T5 (Z=-3.49, p=.00).

Table 6. Maternal mood changes across time (N=162)

	Maternal Mood			
	M	*SD*	*CI (95%)*	*EPDS ≥13 (%)*
T1	6.5136	4.3	6.0-6.9	10.6
T2	6.3776	4.4	5.8-6.8	9.8
T3	6.0980	4.5	5.5-6.6	9.4
T4	6.4220	4.4	5.8-7.0	9.6
T5	5.2222	4.0	4.5-5.8	5.6

Scale ranges from 0-30. Cut off ≥13. Bootstrapping CI.

8.3.3 Maternal coping changes across time

GLM repeated measures with a Greenhouse-Geisser correction determined that problem-focused coping differed statistically significantly between time points (F (3.83, 632.6)= 2.78, p=.02). Moreover, within-subject contrasts showed a statistically significant linear change across time (F (1, 165)= 8.573, p= .04). Similarly, Greenhouse-Geisser correction also determined that social coping differed statistically significantly between time points (F (3.82, 630.6)= 2.92, p= .02). Within-subject contrasts showed a statistically significant quadratic change across time (F (1, 165)= 6.08, p= .01). On the other hand, avoidant coping did not present statistically significant changes across time. However, emotional coping differed statistically significantly between time points as shown in the Greenhouse-Geisser correction (F (3.81, 630.1)= 4.88, p= .00) and the within-subject contrasts showed a statistically significant linear (F (1, 165)= 8.096, p= .00) and quadratic (F (1, 165)= 4.388, p= .03) trajectory over time. In figure 8, we present the trajectories of each coping style in each time point.

Most coping styles have significantly changed from pregnancy to postpartum. However, there was only a small amount of variation between time points, as can be seen in Table 7 and Fig. 8. Also, we could see a trend in the use of problem-focused coping, with 37-50% of our sample scoring above the mean in all time points investigated; and social coping with 29- 48.8% of women also scoring above the mean across time.

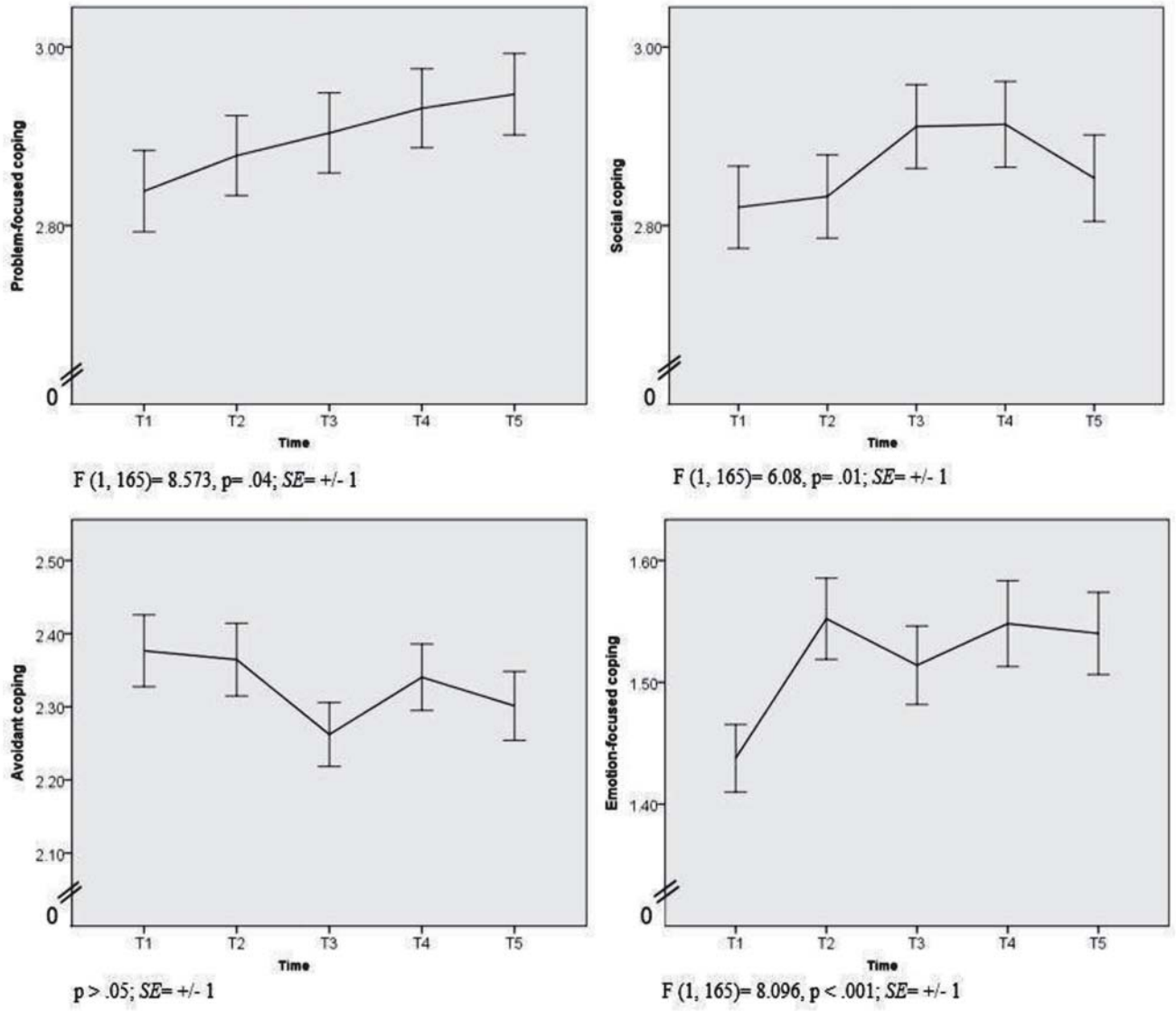

Figure 8. Trajectories of coping styles from pregnancy throughout postpartum (N=151)

Table 7. Maternal coping styles means across time

	Prob.Focused Coping			*Social Coping*			*Emotional Coping*			*Avoidant Coping*		
Time Points	*M*	*SD*	*CI (95%)*	*M*	*SD*	*CI (95%)*	*M*	*SD*	*CI (95%)*	*M*	*SD*	*CI (95%)*
T1	2.83	.58	2.7-2.9	2.82	.59	2.7-2.9	2.37	.63	2.2-2.4	1.43	.35	1.3-1.4
T2	2.87	.57	2.7-2.9	2.83	.60	2.7-2.9	2.36	.64	2.2-2.4	1.55	.42	1.4-1.6
T3	2.90	.57	2.8-2.9	2.91	.60	2.8-3.0	2.26	.56	2.1-2.3	1.51	.41	1.4-1.5
T4	2.93	.56	2.8-3.0	2.91	.61	2.8-3.0	2.34	.58	2.2-2.4	1.54	.45	1.4-1.6
T5	2.94	.58	2.8-3.0	2.85	.62	2.7-2.9	2.30	.60	2.2-2.3	1.54	.43	1.4-1.6

Scale ranges from 1-4

8.3.4 Correlates of mood changes

Spearman correlations were calculated between maternal mood and infant temperament as can be seen in Table 8. Breastfeeding did not significantly correlate with mood changes at any time point and was not included in this table. However, exclusive breastfeeding was given to 54.6% of the infants in the first three weeks after birth, mixed feeding was given to 42.2% and exclusively formula was given to 3.2%. At one month, 51. 8% of the infants received exclusively breastfeeding, 33.8% received mixed feeding and 14.2% received only formula. Finally, at six months, 25.9% of the babies were exclusively breastfed, 33.3% received mixed feeding while 40.7% received exclusively formula.

Table 8. Spearman correlations between maternal mood across time and infant temperament (N=162)

Variables	*Extraversion/ Surgency*	*Negative Affect*	*Effortful Control*
Maternal Mood T1	.158*	.110	-.140
Maternal Mood T2	.091	.033	-.121
Maternal Mood T3	.177*	.113	-.158*
Maternal Mood T4	.104	.162*	-.041
Maternal Mood T5	-.011	.212*	-.194*

*p≤ .05

We also correlated maternal mood changes with maternal coping and found that increased use of problem-focused coping at all time points was significantly correlated with better maternal mood from pregnancy to postpartum. Increased use of emotion-focused coping at all pregnancy measurements was significantly correlated with worse maternal mood in pregnancy. However, use of emotion-focused coping at one and six months postpartum was only correlated with worse mood at six months after birth. Increased use of social coping at all pregnancy time points was significantly correlated with better mood at T1 and T3. Both postnatal social coping measurements were correlated with better mood at six months. Avoidant coping was not significantly associated with maternal mood at any time point.

8.3.5 Associations between mood changes, breastfeeding and infant temperament

Due to insufficient variation from pregnancy to postpartum, it was not possible to analyse the outcome variables in relation to mood longitudinal changes over time. However, since our repeated mood measurements are significantly correlated between time points, a hierarchical linear regression could be carried out.

Correlation coefficients between mood changes, covariates and the outcome variables were calculated. Initially, stepwise selection was used to construct the preliminary models based on the variables, which correlated with maternal mood at at least one time point. By using hierarchical regression, we initially tested if maternal mood at different time points predicted infant temperament. However, none of the socio-demographic variables correlated with mood (maternal age, education, monthly income and past smoking) as well as social and emotional coping, helped to construct a significant model. Thus, we added problem-focused coping - previously correlated with mood - and maternal mood measured at the same time as infant temperament as possible

confounders. This resulted in a significant model. Maternal mood at 20 weeks gestation was associated with infant's surgency/extraversion at six months (B= .047, p= .004; Bootstrap [95%CI= .019-.076]). Thus, worse maternal mood at T1 was associated with increased infant's surgency/extraversion, as can be seen in Figure 9. In our study, the surgency/extraversion mean was of 4.5 (SD= .71; range= 2.4-6.0). No statistically significance was found between maternal mood at other time points, and any other infant temperament subscale. Maternal mood predicted infant temperament independent of maternal problem-focused coping.

Regarding breastfeeding, we ran hierarchical regressions including potential confounders (e.g. maternal age, education, monthly income, past smoking), but none of the variables included predicted breastfeeding practices to a statistically significant degree.

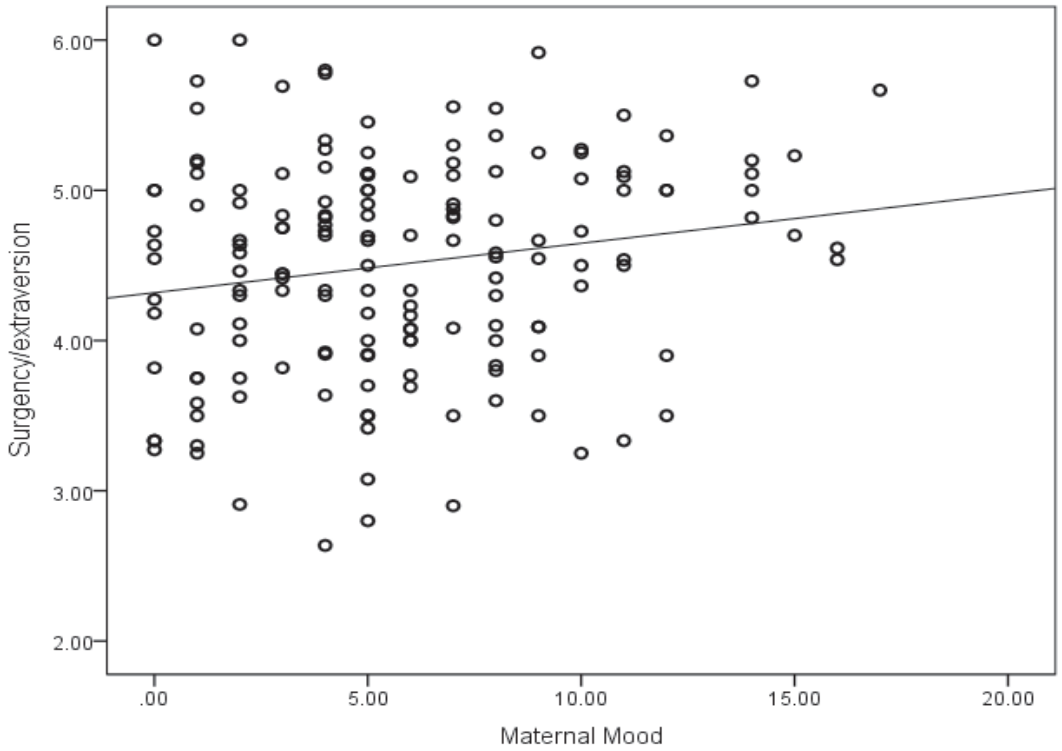

Figure 9. Maternal mood at 20 gestational weeks and infant surgency/extraversion temperament (N=162)

8.3.6 Associations between maternal coping changes, breastfeeding and infant temperament

Correlation coefficients between coping changes, covariates and the outcome variables were calculated. Maternal age, education, monthly income and past smoking were correlated with coping changes and infant outcomes, and were entered into the model as possible confounders. We also

included maternal mood measured at the same time as the maternal coping being tested as well as at six months postpartum. After controlling for all covariates, hierarchical regression showed a significant prediction of negative affect and effortful control temperament by problem-focused coping at 20 and 28 weeks gestation (see Table 9). The potential confounders were not significant predictors of infant temperament, and coping predicted infant temperament independent of maternal mood.

We also carried out hierarchical regression between maternal coping styles and breastfeeding, but none of the models attempted predicted scores on breastfeeding to a statistically significant degree.

Table 9. Hierarchical regression between maternal coping style and infant temperament (N=156)

Variables	*Problem- focused coping*					
	T1			*T2*		
	B	*p*	*CI (95%)*	*B*	*p*	*CI (95%)*
Negative Affect	-.068	.007	-.115- -.019	-.086	.002	-.140- -.032
Effortful Control		------		.051	.007	.013-.090

*p≤ .05; Bootstrapping CI

8.4. Discussion

The main findings of the present study are that in a relatively mentally healthy population, both maternal mood and coping styles during pregnancy were associated with infant temperament at six months. There were no significant associations between maternal mood and coping styles with the amount of breastfeeding given.

The stable coping styles from pregnancy throughout postpartum and the use of healthy coping strategies by most women, mainly problem-focused and social coping may be associated with our mentally healthy sample. Problem-focused coping had a linear variation across time whilst social coping had a non-linear change. Most women provided exclusive or any breastfeeding at both time points postpartum, independent of maternal mood. The high level of breastfeeding in our sample may be caused by the combination of mentally healthy mothers and use of adequate coping strategies since mid-pregnancy. However, at no time did maternal coping and mood predict breastfeeding behaviour.

We examined longitudinally two relatively interrelated aspects present in the perinatal period as potential predictors of infant temperament and breastfeeding. Maternal mood showed little variation

during pregnancy. Most women remained below the EPDS cut off score of 13 for probable clinical depression and decreased symptoms during postpartum. This finding of changing positive and negative moods across time is notable. Mood is typically considered a unidimensional concept with negative and positive affect standing in opposite sides of a continuum (Wilkinson, 1999). Watson (1992) proposed that negative affect should be seen as a general dimension of distress consisting of negative emotions whereas positive affect would be orthogonal to negative affect. Thus, the mood fluctuation described in the perinatal phase should be understood as an experience of both positive and negative affect occurring at the same time. In line with this hypothesis, Wilkinson (1999) suggests that perinatal mood is best understood as mixed mood states comprising normal levels of both positive and negative affect. Although we did not specifically assess positive mood, our study seems to agree with this conclusion, since most of our participants presented mood alterations (worse mood and better mood) within the normal range across the time points investigated.

In our sample, maternal coping presented a relatively stable pattern from pregnancy to postpartum concurring with the coping dispositional perspective. It emphasizes that people can develop a constant pattern of coping when facing stressful events (Moos, Holahan & Beutler, 2003). In this perspective as well as in our study, coping is assumed to be temporally stable and cross-situationally consistent (Ptacek, Pierce & Thompson, 2006). Our results showed a small amount of variation of coping styles across time with heightened use of problem-focused and social coping. Recent studies go in line with this finding. For instance, O'Brien et al. (2009) reported that Australian mothers use different cognitive and behavioural coping skills, such as problem-solving, seeking knowledge and goal setting when dealing with the challenges of early mothering. Currie (2009) described that for Australian first time mothers, obtaining help, planning and taking free time were strategies used to achieve wellbeing in the perinatal phase. Literature on the topic suggests that social support from family, friends and the partner in particular, are also a great source of help to adjust and deal with the potential distressful events presented during pregnancy and postpartum (Hung, 2005; Poof, Espejo & Godoy, 2008). Moreover, it was demonstrated that the use of effective coping styles, such as problem-focused and social coping, contributes to fewer health problems (Ospina et al., 2012). This could be a possible reason for our mentally healthy sample. On the other hand, coping through avoidance, which was associated with indicators of poor maternal psychological wellbeing and greater psychological distress (Rodriguez et al., 2010; Besser & Priel, 2003; Morling et al., 2003), did not show a significant change across time, with few women choosing this strategy.

Increased use of problem-focused coping at 20 and 28 weeks gestation was found to predict lower infant's negative affect. The negative affectivity trait is correlated with negative mood, introspection and dissatisfaction in children. It also appears to be consistently related to unhealthy coping styles, such as avoidance and substance abuse later in life (Watson & Pennebaker, 1989). Thus, our findings suggest that maternal inadequate coping styles as early as in gestational life have a negative association with infant temperament. Higher effortful control temperament, however, has been significantly associated with increased use of maternal problem-focused coping at 28 gestational weeks in our study. This finding goes in line with Lengua et al (1999), who reported that the concept of effortful control is linked to greater use of more active coping styles. Moreover, use of constructive coping was predicted by high self-regulation, included within the concept of effortful control, and low negative emotionality (Eisenberg et al., 1996).

At first sight, the effects of the minor variation in terms of maternal mood seemed to be few regarding the outcomes investigated. Yet, we found maternal mood at 20 weeks gestation to be associated with infant's surgency/extraversion at six months. Worse maternal mood was associated with increased infant's surgency/extraversion. The foetal programming hypothesis is in part related to it. It postulates that relevant physiological markers can be readjusted by environmental events during foetal development, which can last into adulthood (Barker, 2004). Infant's surgency/extraversion trait comprises the approach, high intensity pleasure, and smiling and laughter domains (Rothbart, 1981). This construct has been found to develop into impulsivity and intense experience in toddlers, seeking of novel stimuli in older children, and seeking of excitement in form of risky sports in teenagers (Putnam, Ellis & Rothbart, 2001). Impulsivity is one aspect of temperament commonly described as a disposition to respond immediately and without considering the consequences (Gray, 1987). High impulsivity has been associated with different pathologies. They include addiction and ADHD (Nasser et al., 2004). The latter is also known to be affected by high levels of prenatal anxiety and depression (Sullivan et al., 2015). Furthermore, Sullivan et al. (2015) suggest that ADHD is rooted in early development, probably via temperament. Remarkably, maternal mood and coping were found to exert independent effects on the infant's temperament in the current study. Maternal mood was only associated with the extraversion/surgency temperament dimension, whilst problem-focused coping was a predictor of the effortful control and negative affect dimensions, after allowing for confounders. Thus, we found that not only maternal mood, but also maternal coping styles affect infant temperament.

To precisely define during which period of pregnancy, exposure to maternal mood changes matter most in affecting infant's temperament is difficult. It may depend of which dimension of

temperament is being measured. In monkeys, a higher sensitivity to prenatal stress was reported at early pregnancy while a reduction was found later in gestation (Schneider et al., 1999). Glynn et al. (2001) reported that stress experienced at early gestation was related to shorter pregnancy length in the California earthquake in 1994. We found the strongest effects of maternal coping and mood on the infant's temperament in mid-pregnancy. O'Connor et al. (2002) found prenatal maternal anxiety at 32 weeks to predict behavioural and emotional problems in children at four years of age, which could be comparable to our results.

Surprisingly, breastfeeding behaviour did not correlate or was predicted by maternal mood and coping strategies in the current study. Substantial evidence describes the negative associations between depression, depressive symptoms, and breastfeeding (Hanh-Holbrook et al., 2013; Dias & Figueiredo, 2015) as well as the stress dampening effect exerted by lactation (Heinrichs et al, 2001). Breastfeeding is related to lower neuroendocrine responses to stressors and decreased negative mood (Heinrichs et al, 2002). Also, breastfeeding mothers report less perceived stress and less negative moods compared to their formula feeding counterparts (Mezzacappa, Kelsey & Katkin, 2005). These results are supported by rodent models in which lactating dams have a blunted stress response after exposure to stressor. They are calmer, less anxious and less aggressive (Windle et al, 1997). The fact that our participants used stable and adequate coping styles while maintaining normal levels of mood is possibly related with the increased rate of exclusive and mixed breastfeeding given. Fahy and Hoschier (1988) suggest that successful breastfeeding is a consequence of the mother's ability to accept and cope with postpartum difficulties rather than a problem-free period. Hegney, Fallon and O'Brien (2008) investigated further and reported a relationship between coping successfully with breastfeeding problems and goal-setting, one strategy within the problem-focused coping dimension.

There are clear limitations to the present study. The insufficient variation in maternal mood levels and maternal coping styles from pregnancy to postpartum did not allow us to analyse the outcome variables in relation to the longitudinal changes as aimed. However, since our repeated mood measurements are significantly correlated between time points, analyses between the independent variables and the outcome measures could be carried out via hierarchical regression per time point. Moreover, the infant temperament assessment was limited to one time period reducing the possibility to examine the persistence of the effects already presented at six months. Notably, it has been established that infant temperament has its foundations in the underlying neural networks and is comparable to personality (Rueda & Rothbart, 2009). Although altered over time by heredity and experience, infant temperament was shown to be stable across the lifespan (Rothbart,

Derryberry & Hershey, 2000). For instance, temperament measures collected in infancy were shown to predict those in 6-7 years old infants, and those reported in preschool children predicted temperament at 18 years old (Evans & Rothbart, 2007).

Our findings underline the importance of the study of relatively minor maternal mood changes in pregnancy and postpartum in combination with maternal coping styles in the identification of consequences to breastfeeding and infant temperament. In the future, studies investigating prenatal and postnatal maternal mood should focus in the outcomes of normal mood variation and its effects on other aspects of infant development. Few studies have analysed mood variation and from those who did, the majority was carried out more than two decades ago and did not examine infant outcomes. Also, more research involving breastfeeding in consideration of maternal mood fluctuations should be developed in order to provide a third perspective in the bi-dimensional concept of severe or no disorder. Thus, the present study is of paramount relevance given the innovative findings presented.

PART III: GENERAL DISCUSSION

Chapter 9

Summary of findings

"A person's fate is his own temper."
- Benjamin Disraeli

The present dissertation provides evidence of the effects prenatal maternal depression has on breastfeeding practices and on infant's temperament at six months. In the first study, it was found that when prenatal depressive symptoms were considered in isolation, there was a significant difference in breastfeeding initiation and duration between those who reported depressive symptoms in the prenatal period and those who did not. Similarly, a significant difference was found between participants with and without depressive symptoms at eight weeks postpartum, who reported any breastfeeding at six months. However, this prediction was largely explained by co-occurring prenatal and obstetric factors, such as parity, SES, mother's and partner's education, mother's type of work, mother's age, maternal alcohol consumption, maternal medication use (general and specific for depression and anxiety), maternal smoking, gestational age at birth, baby's sex and baby's head circumference. Furthermore, antenatal attitudes towards breastfeeding were found to be a robust and important predictor of breastfeeding behaviour. They were associated with a 20 to 30% increase in breastfeeding initiation and maintenance.

In the second study, maternal mood showed a significant changing trajectory, being lower at six months postpartum. Worse mood at 20 weeks gestation predicted higher infant's extraversion. Stable maternal coping styles from pregnancy throughout postpartum and the use of healthy coping strategies by most women, mainly problem-focused and social coping were probably associated with the mentally healthy sample. Increased use of problem-focused coping predicted lower infant's negative affect at 20 and 28 weeks gestation whilst was associated with higher infant's effortful control at the 28th gestational week, after allowing for confounders. The high rates of breastfeeding may be explained by the combination of mentally healthy mothers and their use of healthy coping strategies since mid-pregnancy. Most women provided exclusive or any breastfeeding at both time points investigated. However, at no time did maternal coping and mood predict breastfeeding behaviour.

In the final part of this dissertation, the main empirical findings will be integrated into the current literature followed by a discussion of the methodological limitations and strengths of the studies. Lastly, the relevance and implications of the studies' results for future research and practice will be considered.

Chapter 10

Discussion and integration of findings

"The aim of argument, or of discussion,
should not be victory, but progress."
- Joseph Joubert

The present dissertation aimed to provide a new perspective on prenatal depression, breastfeeding and infant temperament by focussing not only on the link they have with each other, but considering their association with the role maternal coping styles and attitudes towards feeding might exert. These findings complement existing research by adding novel information about the extent to which breastfeeding behaviour is predicted by maternal prenatal depression and the alterations it might cause on breastfeeding practices; and in investigating how maternal mood variation from pregnancy to postpartum is linked with breastfeeding and infant temperament. Particularly, the effects of prenatal attitudes towards breastfeeding in combination with prenatal depressive symptoms have been emphasized, differing from previous research, which explored this relationship in the postpartum phase (study 1). Also, the relevance of healthy coping strategies for maternal mood and infant outcomes were outlined in the second study. In order to clarify the pathways through which these associations arise, a discussion and integration of the main findings will be provided in the current chapter.

The first empirical finding unfolded the real and confounding role of maternal mental health on breastfeeding. Breastfeeding behaviour had previously been shown to be altered by the occurrence of prenatal maternal depression, which is responsible for reducing in 20-23% women's intention to lactate (Fairlie et al., 2009; Insaf et al., 2011). Moreover, Ystrom (2012) reported that prenatal depression in late pregnancy was linked with breastfeeding cessation at three months. Others have described that participants who experienced depressive symptomatology prenatally were less likely to initiate breastfeeding (Green & Murray, 1994; Seimyr, 2004). By contrast, more recent studies neither found a relationship between prenatal depression and breastfeeding initiation (Fairlie et al., 2009; Pippins et al., 2006) nor between prenatal depression and breastfeeding intention, initiation and maintenance (Bogen et al., 2010; Adedinsewo et al., 2014). Methodological differences such as duration of the study, exclusion of measures such as depression at postpartum, and attitudes towards breastfeeding, might contribute to this lack of agreement in the literature. Interestingly, none of the

studies reviewed had included a complete set of prenatal, postpartum, and obstetric measures needed to provide a full understanding of this issue. Nevertheless, our central finding about the consistent and significant association between prenatal attitudes towards breastfeeding is in accordance with a series of studies reporting determinants of breastfeeding. These studies have recognised that attitude towards breastfeeding is a stronger predictor of the choice and duration of breastfeeding than other potential determinants (Cox, Giglia & Binn, 2015; Hill, 1988; Scott, Shaker & Reid, 2004; Vijayalakshmi, Susheela & Mythili, 2015). We found prenatal attitudes towards breastfeeding to be consistently associated with exclusively breastfeeding, independent of the level of maternal depressive symptomatology, until six months postpartum. From a psychological perspective, the *Theory of Reasoned Action* (Ajzen, 1991), might offer a possible explanation, since it asserts that the best predictor for showing a specific behaviour is behavioural intention. Yet, to date prenatal attitudes towards breastfeeding have not been considered in combination with major confounding factors, including prenatal depressive symptoms. Remarkably, the predictive value of attitudes towards breastfeeding remained unaltered when compared to any breastfeeding given during the first four weeks after birth until six months.

This finding raises the question to which extent prenatal depression then predicts breastfeeding practices, after accounting for attitudes towards breastfeeding and other significant covariates. When considered in isolation, prenatal depressive symptoms were significantly associated with decreased breastfeeding initiation and duration. However, when we accounted for all variables included (antenatal attitude towards breastfeeding, parity, SES, mother's and partner's education, mother's type of work, mother's age, maternal alcohol consumption, maternal medication use [general and specific for depression and anxiety], maternal smoking, gestational age at birth, baby's sex and baby's head circumference), depressive symptoms at both 18 and 32 gestational weeks were only associated with breastfeeding at the first postpartum day. This finding helps to clarify the currently inconsistent literature on the subject. Dias and Figueiredo (2015) stated in their comprehensive review that scarce research combined with methodological differences contributed to unclear results regarding prenatal depression and breastfeeding initiation and duration. Thereby, our long-term study involving more than 9,000 participants was able to show that there is a longitudinal relationship between prenatal depressive symptoms and maternal breastfeeding initiation at the first day after delivery. However, the prediction of sustained breastfeeding was accounted for by a variety of covariates.

Our second empirical study brings first-hand evidence by following maternal mood trajectories from pregnancy throughout postpartum and investigating the effects of mood on breastfeeding and

infant temperament. Previous studies in this field, focused on examining only depressed or non-depressed samples neglecting considerable potential effects of the changes from one state to another. In particular, we found a significant change in maternal mood across time, with a decrease in the postpartum period; however, due to insufficient variation we could not analyse the outcome variables in relation to these changes. Lower maternal mood at 20 weeks gestation predicted infant's higher extraversion. Such effect may be due to prenatal programming (Barker, 2004), and in the last years this has been the most accepted model of transducing biological information from mother to baby. Moreover, the infant surgency/extraversion trait has been found to develop impulsivity and intense experience in toddlers, seeking of novel stimuli in older children and seeking of excitement in form of risky sports in teenagers (Putnam, Ellis & Rothbart, 2001). High impulsivity has been associated with different pathologies including addiction and ADHD (Nasser et al., 2004). The latter is also known to be affected by high levels of prenatal anxiety (O'Connor et al., 2002) and depression (Barker et al., 2011) as demonstrated by our results.

We also followed maternal coping trajectories and found a stable pattern from pregnancy to postpartum. This concurs with the coping dispositional perspective, in which coping is assumed as temporally stable and cross-situationally consistent (Ptacek, Pierce & Thompson, 2006). Our results showed little variation of coping styles across time with heightened use of problem-focused and social coping. These healthy coping styles may have been associated with our mentally healthy sample. Furthermore, increased use of maternal problem-focused coping at 20 and 28 weeks gestation was associated with infant's lower negative affect, which in turn seems to be consistently related to lower mood and unhealthy coping styles (Watson & Pennebaker, 1989). Based on this consideration, our findings suggest that maternal inadequate coping styles as early as in gestational life have a negative association with infant temperament at six months. In the current study, higher effortful control temperament has been also associated with increased use of maternal problem-focused coping at the 28th gestational week and is linked with greater use of more active coping styles (Lengua et al., 1999). Remarkably, maternal mood and coping were found to exert independent effects on the infant's temperament. Maternal mood was only associated with the extraversion/surgency temperament dimension, whilst problem-focused coping was a predictor of the effortful control and negative affect dimensions after allowing for confounders. Thus, we found that not only maternal mood, but also maternal coping styles affect the infant's temperament.

Differing from our first study, breastfeeding behaviour did not correlate or was predicted by maternal mood. Most investigations in this area report negative associations between depression, depressive symptoms and breastfeeding (Figueiredo, Canario & Field, 2014; Hanh-Holbrook et al.,

2013; Dias & Figueiredo, 2015). Positive benefits of lactation to maternal mental wellbeing were also described, with breastfeeding women without history of prenatal depression appearing to be protected against postpartum depression (Figueiredo, Canario & Field, 2014). Thus, the absence of association was unexpected. There are several possible explanations for these negative findings. Firstly, it was a much smaller sample (N=162) than the first study (N=9,479), and most women breastfed, so there was less opportunity to study causes of formula feeding. For instance, 20.4% of women provided any breastfeeding at six months in the first study whilst in the second, 59.2% of babies were receiving exclusive or any breastfeeding at the same time. Moreover, the sample from the second study comprised mostly mentally healthy pregnant and postpartum women. They had lower EPDS scores compared to participants from the first study, they used adequate and temporally stable coping styles and presented a mood variation across time within the normal range. This surely favoured the heightened levels of breastfeeding provided from one to six months. The fact that data from the second study was collected 20 years later than the first study might also influence on the breastfeeding rates. Governments and healthcare institutions were more committed to emphasize breastfeeding benefits in the last years. During the postpartum phase, lactation may have contributed to blunted maternal stress response, which resulted in better maternal mood. The heightened levels of oxytocin and prolactin associated with lactation may inhibit the hypothalamic-pituitary-adrenal (HPA) axis through actions within the brain and peripherally altering stress responses (Neumann, 2003; Torner & Neumann, 2002). In line with this, it was shown that breastfeeding mothers report less perceived stress and less negative moods compared to their formula feeding counterparts (Mezzacappa & Katkin, 2002). Finally, due to our participants' consistent use of stable and healthy coping styles while maintaining normal levels of mood, they seemed to be more prone to cope with breastfeeding difficulties. This helped to increase the rate of exclusive and any breastfeeding given. Successful breastfeeding is a consequence of the mother's ability to accept and cope with postpartum difficulties rather than a problem-free period (Fahy & Hoschier, 1988).

In both studies, prenatal depressive symptoms, as reflected by the EPDS scores, were associated with certain negative outcomes. Our first study helped to clarify the previous conflicting findings over the initial and long-term influence of prenatal depressive symptoms in relation to breastfeeding practices. We concluded that there is a longitudinal relationship between prenatal depressive symptoms and maternal breastfeeding initiation, but no relation was found with breastfeeding duration. This pattern of association disagrees with earlier studies, which reported no influence of prenatal depression on breastfeeding initiation (Fairlie et al., 2009; Pippins et al., 2006) and a reduced breastfeeding duration when women were prenatally depressed (Pippins et al., 2006;

Mathews, Leerkes, Lovelady & Labban, 2014). In the second study, lower maternal mood at 20 weeks gestation was shown to be a predictor of higher infant's surgency/extraversion, a temperament trait related to higher impulsivity and psychopathology. This is not in line with DiPietro et al. (2006), who argued that maternal anxiety, depression, and non-specific stress during pregnancy within the normal limits poses no significant threat to infant early behavioural regulation. However, DiPietro and colleagues did not assess infant temperament and it may be that there are different associations with different outcomes. Our findings are in accordance with a large body of evidence linking stress and affective disorders in the prenatal period with negative outcomes on infant's temperament. All in all, in our empirical studies prenatal depressive symptoms played a major role in altering breastfeeding initiation and heightening infant's extraversion/surgency trait.

Attitudes towards breastfeeding and coping styles acted as auxiliary measures in our studies. In the first study, measuring maternal attitudes towards breastfeeding was essential to unfold the effects of prenatal depressive symptoms on breastfeeding. Simultaneously it was found to which extent attitudes were related to breastfeeding initiation and maintenance. Although previous studies have reported the strong predictor effect attitudes had on breastfeeding behaviour, none of them measured it with the range of variables we did. Coping mechanisms have a great potential to improve or diminish mood outcomes. As a related measure to maternal mood, coping was probably associated with improved breastfeeding behaviours. As a complemental concept to affect, it was expected that it would exert a significant influence on maternal mood and infant temperament as it did. Taken together, both variables were important elements in the identification of effects of our main variables in relation to breastfeeding and infant outcomes.

Chapter 11

Strengths and limitations

"Don't die by your weaknesses,
live through your strengths"
- Mark S. Kerr

The empirical studies described in this dissertation, offered a longitudinal perspective on how maternal mental health can have an impact on early and long-term breastfeeding practices as well as on infant's development. For this, different samples, various time points and measurements were applied. The first, a very large population study, assessed prenatal depressive symptoms, prenatal attitudes towards breastfeeding, and breastfeeding via self-report measures whilst the covariates were both self-reported and collected from participants' medical records. The second, comparatively much smaller, examined maternal mood, maternal coping styles, socio-demographic information, breastfeeding, and infant temperament also via self-reported instruments. Measurements were done longitudinally from mid-pregnancy (18 or 20 weeks) until six months postpartum and repeated at least three times for the main predictor variables of interest (prenatal depressive symptoms and breastfeeding), except for infant temperament. Two different datasets were used, which provided a more complete and comprehensive understanding of the research problem whilst allowing for generalization.

A further strength is the representative nature of the sample in both datasets. Although previous studies reporting conflicting findings on breastfeeding after exposure to prenatal depression were carried out with large samples, our extensive ALSPAC cohort helps to increase the validity of our results. The data were representative for the population of the United Kingdom in terms of ethnicity, education, age and all other socio-demographic and obstetric aspects included. Having so many co-variates in both studies contributed to their value in describing real associations with our main variables. Data were obtained in two different periods. The first cohort was collected in 1991-1992 in the Avon County in west England, whereas the second was recently recruited and followed up in London, England (2013-2014).

This research also has some limitations. In both studies, breastfeeding data were collected from birth until one month and then at six months postpartum rather than continuously until six months. Following the pattern of breastfeeding from one to six months would best inform about the weaning

and maintenance processes in light of prenatal and postnatal depressive symptoms. Yet, six months is the recommended period by the WHO (2002a) for exclusive breastfeeding, and we were able to investigate the duration of any breastfeeding given until six months. Future research would benefit from more regular breastfeeding measurements not only in the first six months, but also for the whole first year of life when assessing mental health outcomes. In addition, in our first study prenatal attitudes towards breastfeeding were assessed using a single questionnaire. It would be of interest in future research to understand more about what other factors were associated with this attitude.

A further limitation was the insufficient variation in maternal mood levels and maternal coping styles from pregnancy to postpartum in the second study. This did not allow us to analyse breastfeeding and infant temperament in relation to the longitudinal changes as we aimed. However, since our repeated mood measurements were significantly correlated between time points, analyses between the independent variables and the outcome measures could be carried out per time point (Weinfurt, 2000). Nevertheless, future research should focus on the consequences of maternal mood variation for different neurodevelopmental aspects of the infant.

Finally, the infant temperament assessment was limited to one time point. Thus, we were not able to analyse the persistence of the effects already presented at six months. However, it has been established that infant temperament has its foundations in the underlying neural networks and is comparable to personality (Rueda & Rothbart, 2009). Although altered over time by heredity and experience, infant temperament has been shown to remain relatively stable across the lifespan (Rothbart, Derryberry & Hershey, 2000). For instance, temperament measures collected in infancy were shown to predict those in 6-7 years old children, and those reported in preschool children predicted temperament at 18 years old (Evans & Rothbart, 2007). Therefore, although being measured only once, infant temperament at six months might reflect a similar pattern of future temperament and personality.

Chapter 12

Implications and conclusions

"In literature and in life we ultimately pursue,
not conclusions, but beginnings."
- Sam Tanenhaus

The findings of the present work provide not only new implications for research, but also for practice. The study of prenatal depression is of great significance for maternal physical and psychological wellbeing as well as for offspring's development. As has been demonstrated here, prenatal depressive symptoms affect breastfeeding initiation, and prenatal mood has a negative impact on infant's temperament. Beyond the scope investigated in the present dissertation, several lines of evidence have demonstrated the ways in which prenatal depression is linked with negative birth outcomes, postnatal depression, infant's risk for delays in growth and development. It has a potential effect to compromise cognitive, neuropsychological, social and emotional skills from infancy to adolescence (Feldman & Eidelman, 2009; Murray et al., 2011; Verbeek et al., 2012). Of particular importance was the finding that attitude towards breastfeeding is the greatest predictor of breastfeeding, which remained unaffected by depression levels. Breastfeeding rates are low worldwide. Therefore, knowledge on the effects of attitudes towards breastfeeding on infant feeding might be applied in breastfeeding promotion programmes, for example by specifically improving mothers' awareness about breast milk benefits. Breastfeeding interventions usually entail breast and emotional support as well as follow-up home visits or via telephone after birth (Renfrew et al., 2012). The present research suggests that these programmes might also promote positive attitudes towards breastfeeding by working with factors associated with it.

Given the profound disruptive influences of depression for both mother and infant, it is imperative that our study also highlights the importance of pregnancy intervention programmes for depressed women or women with depressive symptoms. This is not only for the sake of the woman herself, but also for her child. Recent studies have analysed the effectiveness of numerous interventions for management and reduction of prenatal depression. Integrated yoga groups (Gong et al., 2015) as well as psychoeducation (Spinelli, Endicott & Goetz, 2013), CBT programs (Kessler et al., 2009), and interpersonal therapy (Spinelli et al., 2013) have been shown to reduce depressive symptoms. Although these programs have a good rate of improvement, not all women will be

properly diagnosed or will have access to this sort of activity. However, it seems that some adverse effects of prenatal environment can be reversed by positive postnatal care (Bergman et al., 2010). The caregiving environment is an important factor in early life development. Maternal capacity to detect and respond to children's cues in a warm and affectionate manner is an essential characteristic in supporting the infant's emotion regulation (Swain et al., 2007). Maternal sensitivity is associated with infant lower levels of negative affect, higher levels of positive affect and greater levels of self-soothing behaviour (Conradt & Ablow, 2010). These are promising findings since prenatal depression cannot always be avoided during pregnancy.

Moreover, this work has shown that maternal coping styles are associated with the infant's temperament independent of maternal mood. This suggests that in addition to assessing and helping with symptoms of depression during pregnancy, it would be relevant to assess maternal coping styles, and possibly teach adequate coping strategies in antenatal classes.

In conclusion, this dissertation provides a novel perspective on the effects prenatal maternal depression exerts on breastfeeding behaviour and infant's temperament. Particularly, the studies here described offer new evidence that prenatal depressive symptoms are related to breastfeeding initiation, but not maintenance. In addition, it unfolds the role prenatal attitudes towards breastfeeding have in the determination of breastfeeding practices from one to six months. They also indicate that prenatal mood as early as at the 20th gestational week and maternal coping styles in mid-pregnancy are associated with infant temperament at six months. These findings contribute to a better understanding of the real effects of prenatal depression, which is crucial to develop effective intervention programmes for breastfeeding and for depression reduction. In spite of that, many questions are still unanswered and future studies should further advance and develop quality research in such an important area of life. After all, (almost) all begins before birth.

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