Sarah Myers

PhD in Anthropology

Maternal Investment and Postnatal Depression – An Evolutionary Approach

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Abstract

Postnatal depression is detrimental to maternal health and wellbeing, associated with poor developmental outcomes in children, and has prevalence estimates ranging from 13-60%; as such it is of significant public health concern and its origins are of interest from an evolutionary perspective. A growing movement within evolutionary research highlights the utility of evolutionary theory to elucidate the origins of health issues and indicate both novel approaches to treatment and prevention. A relatively longstanding, yet largely untested, existing evolutionary approach to postnatal depression proposes that it is a mechanism facilitating maternal investment decisions. More recently it has also been framed, somewhat complementarily, as the result of an evolutionary mismatch.

Using the responses to a retrospective survey study which collected the complete reproductive histories of women and was uniquely designed to capture their experiences of postnatal depression, the first data chapter of this thesis explores whether there is support for adaptationist hypotheses that postnatal depression exhibits good design as a mechanism guiding maternal reproductive trade-offs. The results, combined with critiques put forward here and by other authors, suggest an alternative approach to postnatal depression is warranted.

A limitation of both evolutionary and more traditional approaches to postnatal depression is that the commonly recognised risk factors for the condition fail to capture all the women who develop the condition. Recent developments in research into general depression, as opposed to postnatal depression, have highlighted the role of the immune system in symptom aetiology. This has led to a number of evolutionary researchers proposing that depression reflects an evolved inflammatory response to biological and social threat, with perceived social threat acting as an indicator of the likelihood of imminent biological threat. Inflammation then acts as the ultimate risk factor in the causal pathway to depression, and by extension postnatal depression, and suggests more attention needs to be paid to the social perceptions of women during pregnancy and early motherhood.

Data chapters 3-6 explore the social pressures surrounding women about motherhood, the role such pressures play in generating feelings of shame (an emotional marker of social threat causally linked to general depression development), and the ability of shame to predict postnatal depression. Particular attention is paid to pressures surrounding socially approved levels of maternal investment, namely in the form of bonding. Bonding is of interest due to the documented association between postnatal depression and poor bonding as well as the pressures placed on women in contemporary, developed populations, highlighted by sociologists and feminist scholars, as a result of the emphasis on the importance bonding for child development. The role of social isolation, another form of social threat linked to general depression, in postnatal depression risk is also assessed. In so doing, a new model for maternal emotional investments is developed based on embodied capital theory and the results of two further data sets are presented – the first is a longitudinal survey study tracking women across the perinatal period assessing their experience of social pressure, shame, and postnatal depression, and the second an experimental priming study designed to assess if social threat can be primed using popular and social media relating to mothering. Results derived from these studies are supportive of the perception of social threat being a largely unrecognised risk factor in postnatal depression and the thesis concludes with a discussion of the public health implications which stem from this novel insight.

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Chapter 1 – An Introduction to Postnatal Depression, Maternal Investment, and Life History Theory

Chapter outline

The thesis begins with a general overview of postnatal depression (PND)/postpartum depression (PPD)[1]. In the first section the clinical diagnostic criteria for PND are reviewed, before moving on to discuss the consequences of experiencing the condition. Following this, a brief literature review of the various psychosocial correlates of PND is presented and then the biological correlates. These correlates have led to two differing, though not mutually exclusive, evolutionary explanations for PND – an evolutionary mismatch approach and an adaptationist approach – which will then be introduced, along with life history theory which underpins the adaptationist perspectives and will also inform much of the evolutionary theory developed and tested throughout the following chapters. A discussion of maternal investment, attachment theory, and bonding theory then follows, leading to the posing of a variety of research questions to be tackled throughout the remainder of the thesis.

Postnatal depression – an introduction

PND is technically defined by the American Psychiatric Association's (APA) Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM-5)[2] as major depressive disorder which has an onset of within four weeks of giving birth (APA, 2013; APA 1994), the criteria for which can be seen in Table 1.1. The World Health Organization's (WHO) ICD-10 Classification of Mental and Behavioural Disorders criteria stretches the onset time of depression to six weeks but is otherwise broadly the same (WHO, 1992). However, onset of symptoms often present beyond these

[1] American authors use postpartum depression.
[2] The DSM-5 replaced the DSM-IV (APA, 1994) in May 2013; the criteria for major depressive disorders in respect to PND remained the same.

Major Depressive Disorder Diagnostic Criteria
A. Five (or more) of the following symptoms have been present during the same 2-week period and represent a change from previous functioning; at least one of the symptoms is either (1) depressed mood or (2) loss of interest or pleasure.
Note: Do not include symptoms that are clearly attributable to another medical condition.
1. Depressed mood most of the day, nearly every day, as indicated by either subjective report (e.g. feels sad, empty, hopeless) or observation made by others (e.g. appears tearful). (**Note**: In children and adolescents, can be irritable mood.)
2. Markedly diminished interest or pleasure in all, or almost all, activities most of the day, nearly every day (as indicated by either subjective account or observation).
3. Significant weight loss when not dieting or weight gain (e.g., a change of more than 5% of body weight in a month) or decrease or increase in appetite nearly every day. (Note: In children, consider failure to make expected weight gain.)
4. Insomnia or hypersomnia nearly every day.
5. Psychomotor agitation or retardation nearly every day (observable by others, not merely subjective feelings of restlessness or being slowed down).
6. Fatigue or loss of energy nearly every day.
7. Feelings of worthlessness or excessive or inappropriate guilt (which may be delusional) nearly every day (not merely self-reproach or guilt about being sick).
8. Diminished ability to think or concentrate, or indecisiveness, nearly every day (either by subjective account or as observed by others).
9. Recurrent thoughts of death (not just fear of dying), recurrent suicidal ideation without a specific plan, or a suicide attempt or a specific plan for committing suicide.
B. The symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.
C. The episode is not attributable to the physiological effects of a substance or to another medical condition.
Note: Criteria A-C represent a major depressive episode.
Note: Responses to a significant loss (e.g., bereavement, financial ruin, losses from a natural disaster, a serious medical illness or disability) may include the feelings of intense sadness, rumination about the loss, insomnia, poor appetite, and weight loss noted in Criterion A, which may resemble a depressive episode. Although such symptoms may be understandable or considered appropriate to the loss, the presence of a major depressive episode in addition to the normal response to a significant loss should also be carefully considered. This decision inevitably requires the exercise of clinical judgment based on the individuals history and the cultural norms for the expression of distress in the context of loss.
D. The occurrence of the major depressive episode is not better explained by schizoaffective disorder, schizophrenia, schizophreniform disorder, delusional disorder, or other specified and unspecified schizophrenia spectrum and other psychotic disorders.
E. There has never been a manic episode or a hypomanic episode.
Note: This exclusion does not apply if all of the manic-like or hypomanic-like episodes are substance-induced or are attributable to the physiological effects of another medical condition.

Table 1.1 Diagnostic criteria for major depressive disorder (APA, 2013: 160-161). The criterion symptoms must be present nearly every day, with the exception of suicidal ideation and weight change, and for a period of at least 2 weeks. Symptoms may be classified as mild, moderate or severe, as representing a single or recurrent episode, and with or without psychotic features.

cut-offs (Stowe, Hostetter, and Newport, 2005) and in practice it is diagnosed by doctors if depression occurs at any time in the first year (Halbreich and Karkun, 2006; Skalkidou *et al*, 2012). There are a number of screening tests used by health practitioners to identify women with potential symptoms (for a review see Boyd, Le, and Somberg, 2005), of which the Edinburgh Postnatal Depression Scale (EPDS) (Cox, Holden, and Sagovsky, 1987), a 10 item self-report questionnaire, is most widely used (Boyd, Le, and Somberg, 2005). It is generally reported that PND has a prevalence of 13% (O'Hara and Swain, 1996), although levels reported as a result of diagnostic screening put the figure much higher at 30-60% (Beck *et al*, 2011) and significant cultural variation is to be found (Halbreich and Karkun, 2006).

By 2020, depression is predicted to have become globally the second biggest general health problem (Murray and Lopez, 1997). The experience of depression at any time is devastating for an individual and their loved ones, and when experienced in the postnatal period has the potential to be particularly destructive. Indeed, suicide is currently the leading cause of maternal death in the UK, accounting for 10% of deaths between 1997 and 1999 (Oates, 2003). PND impedes a mother's ability to care herself and her baby and is associated with poor maternal-infant interaction, bonding, and attachment (Beck, 1995; Coyl, Roggman, and Newland, 2002; Moehler *et al*., 2006; Murray *et al*., 1996). Bonding is generally used to refer to the emotional connection a mother has to her infant (Kennell and McGrath, 2005); developing in the early postpartum it is thought to be, at least partly, a product of biological reactions to physical interaction between the mother and infant (Klaus and Kennell, 1976) (see below in this chapter for a more detailed discussion of bonding and attachment theory). Attachment is the later reciprocal relationship between mother and infant (Taylor, 2005), which emerges in the latter half of the infant's first year and is thought to be important in child development (Chisholm, 1996). PND, as a result of its supposed disruptive impact on bonding and subsequent attachment, is implicated in suboptimal child social, emotional, physical, and cognitive development (Beck, 1998; Cogill *et al*., 1986; Gelfand and Teti, 1990; Halligan *et al*., 2007; Murray and Cooper, 1997; Wright, Parkinson, and Drewett 2006), and it is often this reason that has driven research into the topic.

Once a woman has experienced PND she is more likely to do so again with subsequent births, with the risk approaching 50% (Weissman and Olfson, 1995), and she is also at greater risk of depression at other times due to depression's highly recurrent nature (Solomon *et al*., 2000). PND is also often of significant longevity, with one study finding 56% of mothers diagnosed with depression at 4 months still reporting symptoms 1 to 4 years later (McMahon, Trapolini, and Barnett, 2008). Despite its prevalence and severity, PND is still poorly understood and often goes undiagnosed and untreated, with estimates from the UK suggesting over 50% of cases are not picked up in routine clinical practice (Paulden, Palmer, and Hewitt, 2009); current screening is of debatable efficacy (Mitchell and Coyne, 2009) and numerous barriers prevent women from seeking help (Dennis and Chung-Lee, 2006). Routine screening in the UK is not currently recommended by the National Institute for Health and Care Excellence (NICE) (Musters, McDonald, and Jones, 2008) as is does not prove cost effective (Paulden, Palmer, and Hewitt, 2009). However, in January 2016 the then UK Prime Minister, David Cameron, pledged £290 million spending for maternal mental health with the aim of treating all women who need help by 2020 (Campbell, 2016), responding to findings that those who *are* detected do not currently receive adequate help (Thio *et al*., 2006). Shortly after this, the US Preventative Services Taskforce also recommended population wide screening for depression in pregnant and postpartum women (O'Connor *et al*., 2016). Screening is only part of the solution in dealing with PND; a recent article by Maes *et al*. bemoans the fact that "…Rational treatments aimed at causal factors of depression are not available yet" (2009: 27). In the UK, NICE recommends cognitive behavioural therapy, self-help strategies, non-directive counseling and interpersonal psychotherapy for women who are diagnosed with PND (NICE, 2007), and there is evidence to support the efficacy of such psychosocial interventions (Yozwiak, 2010). Although not officially recommended, antidepressants are also commonly prescribed, and their efficacy is supported (Boath, Bradley, and Henshaw, 2004). Yet, their use is often a source of stress, posing fears regarding breastfeeding, social stigma, and dependence. Some drugs are considered safer than others for breastfeeding mothers but the long term effects on infants who ingest them remain unknown (Musters, McDonald, and Jones, 2008). However, by not looking to address the causes of PND, this does little to prevent it in the first place, and also does little help to decrease the likelihood of a mother experiencing PND with subsequent births, thus fresh approaches are required.

In a recent review of the literature regarding PND risk factors, Yim *et al*. (2015) highlighted the bifurcated nature of approaches to the condition, with focus either on biological or psychosocial predictors, and decried this state of affairs in which “biopsychosocial processes and interactions are neglected, and integrated models remain underdeveloped and untested” (2015: 100). A brief review of this literature, divided as it is, will now be made before moving on to introducing current evolutionary perspectives on PND which, while noted by Yim *et al* (2015), are generally not considered by mental health researchers beyond the field of human evolutionary studies.

Postnatal depression – psychosocial correlates

A substantial literature on the psychosocial risk factors for PND exists, with a number of influential meta-analyses conducted by C.T. Beck being instrumental in forming the understanding researchers and physicians have of the factors which correlate with PND and place women at higher risk. Two widely cited meta-analyses of research conducted in the 1980s (Beck, 1996) and 1990s (Beck, 2001) identify thirteen PND predictors: 10 with moderate effects – prenatal depression, self-esteem, childcare stress, prenatal anxiety, life stress, social support, marital relationship, history of depression, infant temperament, and maternity blues (Beck, 1996; Beck, 2001), and 3 with small effects – marital status, socioeconomic status, and unwanted/unplanned pregnancy (Beck, 1996; Beck, 2001). A meta-synthesis of qualitative studies further identifies finding motherhood not to be what was expected and experiencing feelings of loss as major themes of qualitative studies on the subject (Beck, 2002).

Since the work of Beck, a range of larger scale, multivariate, and longitudinal studies have been conducted allowing for a more nuanced understanding of the psychosocial predictors of PND (Yim *et al*., 2015). In reviewing such work Yim *et al*. (2015) surmise the evidence regarding the association between stressful life events and PND to be mixed and indicative of the type and severity of events being important; for instance a South African study found that high mortality risk predicted PND while economic stress did not (Ramchandani *et al*., 2009). Chronic strains, such as employment demands and financial stress, and perceived stress consistently predict PND, as does parenting stress; however the directionality of this relationship still needs clarification (Yim *et al*., 2015). There is relatively strong evidence regarding the quality of relationships and PND, with abusive, conflictive, and unsupportive relationships conferring risk and high-quality and supportive relationships providing protection (Yim *et al*., 2015). A woman's mother and partner appear to be the most important players in the development of PND, while equivocal evidence is found in regard to other members of a woman's social network.

Postnatal depression – biological correlates

The biological correlates of PND are varied (Skalkidou *et al*., 2012). The biological hypotheses regarding the pathophysiology of the condition share much in common with those of depressive disorders at other life points; however as the hormonal changes and psychosocial events which characterise women who have just given birth mean they are a distinct group, direct comparisons between depressive events are complicated (Skalkidou *et al*., 2012). Research also suffers from the risks to the infant inherent in probing and experimenting on women during pregnancy and labour, thus much less is known of depression occurring postnatally than of other forms. Combine this with findings that PND is poorly diagnosed and goes widely untreated (Boath, Bradley, and Henshaw, 2004), and the situation looks bleak and in serious need of addressing from fresh perspectives. The following is an overview of what *is* currently known.

Hormones – reproductive

Estradiol has been mooted to play a causal role in PND, due to hypoestrogenism being associated with reduced well-being at other times in women's lives (Skalkidou *et al*., 2012). Levels of the hormone rapidly decrease after birth and high doses of the hormone have been found to improve depressive symptoms. However, studies suffer from a lack of replication and recently women with

PND have been found to actually have higher serum concentrations of estradiol than non-depressed mothers. Additionally, a small experimental pregnancy-simulation study indicates that differential sensitivity to, rather than levels of, estradiol and progesterone may characterise women with a history of PND (Bloch, Schmidt *et al*., 2000). Yim *et al*. conclude in their literature review "little evidence supports estrogen withdrawal theories, and biological vulnerability models remain largely untested" (2015: 107).

Progesterone levels, along with levels of its metabolite allopregnanolone, also rapidly fall after parturition, and lower allopregnanolone concentrations have been associated with postnatal blues (which are thought to be a risk factor for PND) (Skalkidou *et al*., 2012). Yet, findings regarding progesterone directly in relation to PND are equivocal, based on small studies, and lacking full investigation in terms of vulnerability moderators (Yim *et al*., 2015).

Prolactin has been shown to have anxiety relieving effects, thought to explain the protective effect breastfeeding has against stress (Torner and Neumann, 2002). A handful of studies have explored the hypothesis that levels of prolactin will be negatively related to PND (Yim *et al*., 2015), and while results have been mixed the larger of these studies finds the predicted association. Lower oxytocin release during breastfeeding has also been found in association with PND symptoms (Stuebe, Grewen, and Meltzer-Brody, 2013), one of a small number of studies which are suggestive of lower levels of oxytocin during pregnancy and post-birth being a risk factor for PND (Yim *et al*., 2015).

Hormones – stress

PND has been linked to hypo-activation of the hypothalamic-pituitary-adrenal (HPA) axis, and antenatal depression to its hyper-activation (Skalkidou *et al*., 2012). A number of studies have found women with PND to show a lower baseline of HPA responsiveness than controls, although other studies have failed to find an association (for a review see Skalkidou *et al*., 2012). Corticotropin-releasing hormone (CRH), produced by the hypothalamus, is generated in excess in the latter stages of pregnancy triggering a transient down-regulation of its production after birth.

Some research indicates that PND may result from increased CRH or increased levels of stress-induced cortisol during pregnancy. Oxytocin is released during labour and lactation and is thought to functionally offset the HPA axis; this may explain the relationship observed between failing to and ceasing to breastfeed and depression, although the direction of the association is far from clear. CRH levels during pregnancy may also only be related to PND in the early postnatal period and not later onset cases (Glynn and Sandman, 2014).

Serotonin

The serotonergic system has a widely supported role in the pathophysiology of depressive disorders and estradiol, progesterone, and cortisol have regulatory effects on the serotonin (5-HT) system (Skalkidou *et al*., 2012). Various research approaches support the general conclusion that women with PND possess lower accessible tryptophan levels, lower platelet serotonin levels and changed binding of platelet serotonin transport sites. In other depressed groups, genetic variation in the serotonin transporter gene 5HTT has been found to be linked to risk of depression. Brooks-Gunn (2010) has recently found that polymorphisms in this gene interact with socioeconomic status to effect PND risk; however the results of other investigations into its role are conflicting (Skalkidou *et al*., 2012).

Genetics

The genetic and epigenetic risk factors for PND in general are currently poorly understood (Skalkidou *et al*., 2012: Yim *et al*., 2015), but various lines of investigation have shown promise. A study of Australian twins has shown that it has a heritability of 38%, which is approximately the same as major depressive disorder (Treloar *et al*., 1999). The same study also indicated that the genetic correlation between PND and depression at other times was low, causing them to question their measure of PND. Engineer *et al*. (2013) found in a recent small study that variation in the genes for the glucocorticoid receptor (GR, NR3C1) and CRH receptor 1 (CRHR1) were associated with increased scores on the EPDS, suggesting that women with certain variants may react differently to psychobiological stressors. Experiments have shown that alterations in the GR gene cause a lack of maternal care in mice (Chourbaj *et al*., 2011). Variation in the brain-derived neurotrophic factor (BDNF) gene has also been linked to PND (Skalkidou *et al*., 2012). BDNF has been associated with major depressive disorder; it interacts with serotonin and helps regulate neurogenesis and synaptic plasticity. Levels are generally reduced in pregnancy and the postpartum period, and levels have been found to be lower still in depressed mothers (Skalkidou *et al*., 2012), yet Lommatzsch *et al*. (2006) found that levels alone could not predict depression. Figueria *et al*. (2010) failed to find an association between the Val66Met BDNF polymorphism and PND, but Comasco *et al*.'s (2011) investigation into the effects of the polymorphism found that seasonality modulated the risk posed by this particular variant, with those delivering in the autumn and winter being of greater susceptibility to depressive symptoms. Polymorphisms in the estrogen receptor and the oxytocin peptide may also have effects on PND risk (Yim *et al*., 2015). Epigenetic changes to DNA is an area which is beginning to expand understanding of the pathophysiology of major depression but is yet to be much applied to PND (Yim *et al*., 2015); one study which has been conducted implicates estrogen-mediated DNA methylation in PND aetiology, with the authors suggesting women with PND may have a heightened sensitivity to this form of epigenetic change (Guintivano *et al*., 2014).

Seasonality

A number of other studies have also looked at the role of seasonality in PND, with some finding an increased risk associated with giving birth in the autumn and winter in the Northern Hemisphere (Skalkidou *et al*., 2012). Seasonal affective disorder, another subset of major depressive disorder, is more common in women than men and is also linked to the hypoactivation of the HPA axis. Serotonin, cortisol, melatonin and tryptophan all follow a seasonal pattern and are thought to interact with sun light and vitamin D production to increase risk during the latter quarter of the year. Vitamin D has been linked to other mood disorders with mixed success; the one study that has so far addressed its relationship to PND found that depressed women had significantly lower levels of a vitamin D metabolite in their serum than controls.

The thyroid system

Thyroid disorders have been proposed as a risk factor, supported by the findings that overt dysfunction and also just the occurrence of thyroid antibodies during pregnancy increase the likelihood of PND (Skalkidou *et al*., 2012). However, treating them fails to reduce depressive symptoms. The relation between thyroid-stimulating hormone and PND has also so far proved inconclusive. Yim *et al*. (2015) suggest that thyroid markers should not be investigated in isolation and instead their interactions with other factors should be of focus.

Proteins and fatty acids

The protein leptin has recently received attention with regards to major depressive disorders (Skalkidou *et al*., 2012). Leptin plays a role in the control of food intake and energy expenditure, and rises during pregnancy, falls after birth, and then increases again through the first 6 months postpartum. Skalkidou *et al*. (2009) found that higher levels of leptin at the time of birth have a protective effect when PND was tested for at 5 days, 6 weeks and 6 months. The reasons underlying this association are currently unclear. Fatty acids have also been purported to play a role. Docosahexaenoic acid **(**DHA) has been found to increase during the first trimester and then fall throughout the rest of pregnancy and the postpartum period to below pre-pregnancy levels, decreasing more markedly in women who breastfeed (Otto, De Groot, and Hornstra, 2003). Increased symptoms of depression were found in women who took longer to raise their level of DHA back to pre-pregnancy levels, and while the increased risk to mothers who breastfed was suggested by the results of Otto *et al.'s* study the correlation was not statistically significant. DHA has anti-inflammatory effects (Kendall-Tackett, 2007), the import of which is reviewed below.

The immune system

Another role of the estradiol, progesterone, and cortisol increases during pregnancy is that of immunomodulation (Skalkidou *et al*., 2012). Because the foetus is perceived by the maternal immune system as a foreign body, alterations to immune function must occur in order for a pregnancy to remain viable. It is hypothesised that this is achieved via a downregulation of the part of the immune system mediated by antigen-specific T-cells, and a concomitant upregulation of the innate immune system and its generalised inflammatory response. Pro- and anti-inflammatory cytokines are released in reaction to injury, infection and, crucially, stress, and studies have found that pro-inflammatory cytokines are heightened during pregnancy and both kinds are increased during the postpartum period. Pro-inflammatory cytokine release triggers "a systematic inflammatory response characterized by fever, hypersomnia, activity reduction, fatigue, decreased appetite and, in humans, depressed mood" (Skalkidou *et al*., 2012: 668). Evidence, reviewed below, is growing to support a key role of this inflammatory response in the pathophysiology of major depressive disorders (Raison and Miller, 2013). It has been contended that in some women PND may denote a psycho-neuro-immunological disorder, due to an excessive inflammatory response combined with inadequate suppression of the HPA axis (Raison, Capuron, and Miller, 2006). It is interesting to note, however, that a study comparing depression in postpartum women and newly adoptive mothers found similar levels in each group, highlighting the likely importance of external stressors (Mott *et al*., 2011). Kendall-Tackett (2007) has highlighted the findings that many of the proposed risk factors for PND such as past or current psychological trauma, sleep disturbance, postpartum pain, and stress all trigger the release of pro-inflammatory cytokines, leading to the conclusion that "inflammation is not simply *a* risk factor; it is *the* risk factor that underlies all the others" (Kendall-Tackett, 2007: doi:10.1186/1746-4358-2-6). The pro-inflammatory cytokine IL-6 has been found at significantly higher concentrations in the serum of postnatally depressed women (Skalkidou *et al*., 2012). IL-6 is known to interact with the HPA axis, but peripartal and postpartum serum levels fail to predict later depression. Conversely, the pro-inflammatory cytokine IFN-γ has been found to be lower in women with PND, and levels of the anti-inflammatory IL-10 do not appear to vary between depressed women and controls. Yim *et al*. critique many of the studies exploring immune links and PND as small and employing unspecific depression screens, which may explain the inconsistent results and conclude that future work on inflammation and PND "may be one of the most exciting areas of empirical investigation" (2015: 111); this is a theme which will be returned to in Chapter 3.

Introducing evolutionary explanations of postnatal depression

Hahn-Holbrook and Haselton (2014) have recently put forward an evolutionary based 'mismatch hypothesis' for PND aetiology suggesting that PND is a 'disease of modern civilisation', which they view as complementary to adaptationist accounts which will be discussed shortly. They note that compared to ancestral diets, diets in industrialised populations are lacking in essential micronutrients and omega-3 essential fatty acids; pregnancy and lactation exacerbate this deficit. Supporting a role for dietary mismatch, Hibbeln (2002) showed that PND prevalence in a sample of countries correlated with estimates of seafood consumption, after excluding outlying Asian countries, and depression has been found to be effectively treated by taking omega-3 fatty acid supplements (Appleton, Rogers, and Ness, 2010). The literature on the association between lack of breastfeeding and PND is reviewed in support of the contention that infant feeding practices in contemporary developed societies also contribute to PND risk (Hahn-Holbrook and Haselton, 2014). Exercise has been found to act on various biological pathways implicated in depression (Woods, Vieira, and Keylock, 2009). Findings that contemporary hunter-gathers burn more calories a day than people in US, along with exercise having been shown to reduce rates of PND, are used to suggest that lower levels of physical activity during pregnancy and the postnatal period than were presumably ancestrally experienced may contribute to PND development (Hahn-Holbrook and Haselton, 2014). Various studies have found links between vitamin D deficiency and PND. Humans synthesise most of their vitamin D, which requires sun exposure; Hahn-Holbrook and Haselton contend "modern humans are increasingly sheltered from the sun" (2014: 397), the implication being that this is contributing to PND rates. Finally, Hahn-Holbrook and Haselton (2014) implicate shifts from living with multigenerational, extended families to Western patterns of nuclear families often considerably geographically distanced from other relatives in PND aetiology. They state that "mothers who emigrate from Mexico to the United States have lower rates of postpartum depression than White mothers" (Hahn-Holbrook and Haselton, 2014: 398); in support of this they cite a study by Campos *et al.* (2008) which found that while the Latina women are of lower SES and more likely to be unmarried they have more support from family and community.

However, Campos *et al*. (2008) do not actually make reference to PND; what their study found was that stress and anxiety during the second trimester of pregnancy was higher in White Americans. While other findings regarding the relationship between stress hormones during pregnancy and PND (Hahn-Holbrook *et al*., 2013) suggest that PND may indeed by higher in White Americans than Mexican immigrants, Hahn-Holbrook and Haselton do not provide evidence to support this.

Extrapolation aside, Hahn-Holbrook and Haselton's (2014) mismatch approach suffers on a number of grounds. A recent study by Brown, Rance, and Bennett (2016) suggests that the presumed relationship between breastfeeding and PND is simplistic. The reason for not breastfeeding was found to be key in predicting PND, with only women who gave up breastfeeding due to pain or physical difficulty at risk of PND, while those who gave up for other reasons were not at increased risk (Brown, Rance, and Bennett, 2016). A lack of extensive cross-cultural data on PND, in particular data from small-scale societies possessing characteristics more akin to ancestral environments means Hahn-Holbrook and Haselton's mismatch approach is untested. However, the little data that does exist does not fit well with a 'disease of modern civilisation' perspective. Depression has recently been described for the first time in a small-scale, pre-industrialised society, with Tsimane forager-horticulturalists of the Bolivian Amazon showing depressive symptoms in association with higher immune activation, and correlating with greater pathogen loads (Stieglitz *et al*., 2015). Preliminary analysis finds depression at a rate of 20% during the postnatal period of Tsimane women (Myers *et al*., 2016), which is problematic for a mismatch approach in that individuals live within an extensive kin network (Stieglitz *et al*., 2015), are physically active, and mothers generally intensively breastfeed infants (Veile *et al*., 2014).

The Tsimane depression data are supportive of the pathogen host defence theory for depression (Stieglitz *et al*., 2015), which has not been explicitly tested with regards to PND and will be the subject of Chapter 3. Alternative to a mismatch approach, but not mutually exclusive (Hahn-Holbrook and Haselton, 2014), evolutionary explanations of the PND have been put forward from an adaptationist perspective by a number of researchers (Crouch, 1999, 2002; Hagen, 1999, 2002; Thornhill and Furlow, 1998). While these adaptationist explanations vary in their detail (to be explored in depth in Chapter 2), they all propose PND as a means by which mothers mediate maternal investment decisions in their infants, and as such utilise the framework of life history theory. Life history theory is also the paradigm that will underpin the core theoretical explorations made in the course of this thesis and so, before going any further, it will be briefly introduced.

Life history theory in brief

At the foundation of the theory of evolution via natural selection is energy, with the evolution of life resulting from a process in which different forms compete to gather energy from the environment and turn that energy into copies of those forms (Hill and Kaplan, 1999); with those forms that harvest more energy and convert it more efficiently through time becoming more prevalent. This process produces complex time dependent problems of energy allocation in such activities as growth, maturation, reproduction and death, which are reliant on mortality risks and the ecology of energy production (Stearns, 1989). For each unit of energy attained, an organism is faced with a decision between investing it in somatic efforts, either growth or maintenance, thus increasing future rates of surplus energy production, or investing it in current reproduction. Life history theory is the study of the trade-offs between current and future reproduction, the selective pressures that affect them, and the timing of life events which they produce.

Parental investment theory (Trivers, 1974) is a key component of life history theory explaining the predicted trade-off between investment in current and future reproduction (Hill and Kaplan, 1999). Parental investment is defined as “any investment by the parent in an individual offspring that increases the offspring’s chance of surviving (and hence reproductive success) at the cost of the parent’s ability to invest in other offspring” (Trivers, 1972: 139). Parental investment theory follows on from Hamilton’s (1964) concept of inclusive fitness, under which individuals gain reproductive fitness from the reproductive success of genetic relations, and predicts that a mother should cease investing in an individual offspring when the benefits of the investment to her inclusive fitness are outweighed by the costs (Trivers, 1974). The costs may outweigh the benefits when the likelihood of the offspring surviving is in question or when there is a threat to the mother's fitness, and therefore her future reproductive success.

Two different, albeit conceptually similar, adaptationist explanations of PND have been proposed on the grounds of parental investment theory, by Hagen (1999, 2002) and Thornhill and Furlow (1998). A further, more sociologically driven perspective by Crouch (1999, 2002) does not explicitly use parental investment theory, but it shares much in common with the work of Hagen, Thornhill, and Furlow and will be discussed in conjunction. Adaptationist explanations of depression have been heavily critiqued (for example Nettle (2005)) and those regarding PND are also yet to be substantively empirically tested; doing so will form the basis of Chapter 2. These arguments share in common the notion that PND is involved in maternal investment trade-offs so, before discussing them in more detail, what constitutes maternal investment in the postnatal period will be considered.

Attachment theory

As noted, PND is implicated by the medical and developmental psychology literature as having a detrimental impact on child development due to its association with poor mother-infant attachment. The application of term attachment in reference to mother-child relations stems from the highly influential work of John Bowlby, who formulated attachment theory after being commissioned by the World Health Organization to investigate the emotional development of young World War II orphans (Chisholm, 1996). Influenced by the emerging fields of ethology and control systems theory, attachment theory was originally conceived to apply to an *infant's* attachment motivations, which Bowlby (1969) saw as being evolved to keep it in close proximity to its mother – the mother being an infant's primary source of safety. The work of Mary Ainsworth later expanded attachment to encompass the motivations of the mother; Ainsworth argued that the ability of the infant to attach lay in the behaviour of the mother, sparking the age of intensive mothering (Kanieski, 2010). Attachment may nowadays be defined as the reciprocal interaction between the mother and infant

(Taylor, 2005). It is widely accepted as a process that begins in the second half of an infant's first year, when expression of anxiety at separation from its mother is usually first shown (Chisholm, 1996), and is mediated by the *seeking* and *panic* (or *grief*) basic emotion command systems (Zellner *et al*., 2011).

Disruptions to the mother-infant relationship during the latter half of the infant's first year are widely linked to differences in infant attachment style, and Chisholm (1996) has used a life history approach to suggest that factors which cause such disruptions represent conditions of environmental risk and uncertainty to which variances in attachment security may represent facultative adaptations. A similar argument has been utilised in the proposition that Reactive Attachment Disorder, a clinical diagnosis given to children displaying distinctly disturbed and developmentally inappropriate social reactions, is an adaptive strategy in insecure social environments (Balbernie, 2010).

Bonding theory

The notion of bonding has its roots in attachment theory. Bonding was originally suggested by Klaus and Kennell in the 1970s as being the first stage of attachment, and was presented as an innate psychobiological path occurring in a "sensitive period in the first *minutes* and hours of life during which it is *necessary* that the mother and father have close contact with the neonate for later development to be optimal" (Klaus and Kennell, 1976: 14 in Scheper-Hughes, 1985: 307, emphasis added). Klaus and Kennell argued that many of the maternity practices carried out under the auspices of Western medicine, such as separating the infant from the mother, inhibited this bonding process and were thus detrimental to future attachment (Scheper-Hughes, 1985). Their publication of *Maternal-Infant Bonding* (1976) came in the wake of widespread criticism of the medical management of childbirth and a demand for more 'natural' approaches from many quarters, and seemingly provided scientific justification for a program of acceptably altered hospital procedures (Crouch, 2002). The medical profession embraced the 'bonding principle' and, within two years of the book's publication, the American Medical Association was advising its hospitals to review their policies in the light of the work. Another advantage of the idea of bonding, from a social perspective, was that, due to the liberation movement 1970s women had become "freed" from the shackles of the nursery and kitchen and attachment theory's requirements of lengthy, dedicated mothering were becoming potentially oppressive. Bonding theory "lifted that burden by compressing the essence of attachment into the 'sensitive period.' This seemed to offer a prospect of rapidly acquiring insurance against longer-term problems with the mother-child relationship to which Bowlby and his followers had pointed" (Crouch, 2002: 367).

Current usage of the term 'bonding' would appear to be somewhat of a semantic minefield – a brief review of the academic literature shows that authors may use it interchangeably with attachment, with or without definition, to refer to purely physiological occurrences, emotional occurrences, or a combination of the two, taking place over varying timeframes, and popular notions confuse the picture further. This is not, however, to suggest that there are no measurable behaviours or consequences associated with bonding; rather that these are too often lost or misinterpreted due to ill-defined terminology. The following is a brief overview of the use of bonding in biological and psychological research, after which the case will be made for a new set of terms to aid future research on the subjects currently falling under the umbrella of 'bonding'.

Physiological bonding responses

There is growing evidence for a suite of postpartum physiological processes in humans, on the part of both the mother and infant, which support the biological element of Klaus and Kennell's psychobiological path. Skin-to-skin contact between mother and infant after birth results in greater retention of body heat (Bystrova *et al*., 2003; Christensson *et al*., 1992) and better metabolic function in infants (Christensson *et al*., 1992). Infants exhibit 'prefeeding behaviour' when given early exposure to their mothers, crawling and pushing with their legs to locate the nipple (Varendi, Porter, and Winberg, 1994), which also triggers uterine contractions in the mother, reducing vaginal blood loss. Research suggests that intimate bodily contact after birth also helps to prolong lactation, and a mother's digestive system may be helped to adapt to the increased demands of lactation by infant sucking (Uvnäs-Moberg, Winberg, and Lebenthal, 1989). Although the mechanisms are not fully understood, it has been found that immediate postnatal touching, sucking, or licking of the areola has an impact on maternal attentiveness; women experiencing this leave their babies alone for less time during the first four days after birth, talk to their babies more whilst breastfeeding, and have lowered serum levels of gastrin whilst feeding, which indicates lower stress levels (Winberg, 2005). As of yet, researchers have been unable to pin point the precise maternal and infant regulators and their targets in humans, although oxytocin is assumed to be key (Feldman *et al*., 2007; Winberg, 2005).

Psychological bonding responses

The psychological element of Klaus and Kennell's original thesis has proved to be more problematic and controversial. Both academics and the media enthusiastically embraced the concept of bonding as an emotional process, beyond the mere physical; for example, a standard 1980s medical textbook cites bonding as an "intimate psychological unity between mother and infant" (Hull *et al*., 1980: 250 in Crouch, 2002: 365). Rapid mother-infant bonding also came to be treated as fact by the media, and subsequent studies have demonstrated that many women believe immediate bonding is essential for good mothering (Crouch, 2002). Over time, physiological bonding has become synonymous with emotional bonding, through the rather unscientific process of, as Kennell himself puts it, "general consensus" (Kennell and McGrath, 2005: 775), and it is this psychological or emotional bonding which is normally being referred to when bonding is discussed and measured in the psychological literature.

Despite largely unaltered popular understandings, scientific research has moved on from regarding psychological bonding as a strictly immediate process (Crouch, 2002); however it is still an area of much debate (Taylor *et al*., 2005). Definitions of bonding are noticeably loose; for instance it is "how the mother feels towards her infant" (Taylor *et al*., 2005: 46), the "development of positive feelings about their newborns" (Pascoe, 1989), "the emotional tie from parent to infant" (Kennell and McGrath, 2005: 775), or "the mother's affectional tie with the child and the unique place he/she holds in her representational world" (Figueiredo *et al*., 2009: 539), with 'bonding failure' referring to "an extreme and persistent lack of emotional connection between a mother and her infant" (Sluckin, 1998: 11). Nonetheless, bonding has been subject to much quantitative study with the aim of delineating the 'normal' timeframe for its occurrence. At the present time the results of such studies are varied at best: a literature review by Figueiredo *et al*. (2009) reports that a number of studies found that most mothers show emotional affection on first contact with their infant, while others indicate 30-50% do not. For example, a study of 54 primiparous mothers by Robson and Moss (1970) found just as many women who felt bonded at birth as women who felt bonded only after several months, and a later study, also by Robson, recording the emotional reactions of 193 women holding their infant for the first time, reported that the predominant feeling of 40% of those who were primiparae and 25% who were multiparae had been one of indifference (Robson and Kumar, 1980). Pascoe (1989) found that of a sample of 100 new mothers, 39% reported their first positive feeling during pregnancy, 42% during birthing or the first day, and 19% on the second or third day. While Taylor *et al*. (2005) found that there was a progressive development of bonding over the first 12 weeks. Increasing attention is also being paid to the relationship a mother has with her foetus prior to giving birth, commonly referred to in the medical and psychological literature as 'maternal-foetal attachment' (Salisbury *et al*., 2003), with studies finding a broad array of onset timings. Finally, a number of factors have been reported as delaying bonding, such as maternal unemployment (Figueiredo *et al*., 2009), being unmarried (Figueiredo *et al*., 2009), having low educational level (Figueiredo *et al*., 2009), previous or current obstetrical complications (Figueiredo *et al*., 2009; Pascoe, 1989; Robson and Kumar, 1980), mental health issues including depressive symptoms (Figueiredo *et al*., 2009; Pascoe, 1989; Taylor *et al*., 2005), infant sickness (Figueiredo *et al*., 2009), infant sex (Figueiredo *et al*., 2009), unplanned pregnancy (Pascoe, 1989), breastfeeding (Pascoe, 1989), unrealistic expectations and perceptions of the infant temperament (Pearce and Ayers, 2005), and "disappointment with the 'bonding' experience" (Pascoe, 1989: 452). Risk factors for low maternal foetal attachment lack extensive exploration but show overlap with those influencing bonding in the postnatal period (Salisbury *et al*., 2003).

Emotional bonding as an investment

What comes out of this research is a picture of a highly contingent emotional relationship which has no set path or timeframe. It is notable that many of the factors found to delay 'bonding', listed above, are also the psychosocial risk factors for PND on which adaptationist accounts of PND have been predicated due to their being indicative of poor infant condition or maternal circumstances (Hagen, 1999, 2002; Thornhill and Furlow, 1998), pointing to the utility of a life history approach to 'bonding'. Critics, such as medical anthropologist Nancy Scheper-Hughes (1985) and feminist historian Élisabeth Badinter (1981), suggest that attempts to give psychological or emotional bonding a normal or optimal timeframe arguably reflects a Western-centric, misguided, modern, medical agenda. Indeed a number of authors have highlighted the problematic nature of bonding (see Crouch, 2002 for a review), with Herbert, Sluckin, and Sluckin (1982), for instance, calling for discontinuation of its use on the grounds that "the usage of the term 'bonding' is often misleading, because of a tendency to reify and simplify attachment phenomena [and]… the negative and pessimistic implications of using this concept in social work and clinical practice" (1982: 205).

It would certainly seem that bonding is a term best avoided without the use of adequate qualifiers, appearing, as it does, to encompass at least two separate events – one physical and one emotional. Whilst the physical may bolster the emotional, it is not sufficient to ensure the emotional (Scheper-Hughes, 1985), nor is it necessarily required at all – while emotional relationships may suffer when infants are separated from their mothers after birth due to ill health (Feldman *et al*., 1999) this is by no means always the case (Mann, 1992). Some authors have sought to conceptualise emotional bonding as being a dual process, breaking it down into two further parts. The first part consisting of the mother's worries and activities regarding the safety and well-being of the infant, and a second part concerning her affectional tie to the infant (Figueiredo *et al*., 2009) and there is evidence suggesting this dual process is what occurs. Mann (1992) found that whilst mothers of extremely low birth weight twins, with within-pair variation in health, displayed similar levels of caring behaviour towards the sick twin relative to healthy twin, they displayed significantly more affectionate behaviour towards the healthy twin. This latter behaviour Mann terms 'psychosocial investment' and conceives of it being comprised of "holding, soothing…stimulation…mutual gazing, mutual play… affection… vocalizations…brief arousing events…and proportion of time that the mother and infant were in contact" (Mann, 1992: 379).

Neuroscientific approaches to emotion

An approach to emotional bonding which takes it to be composed to two parts, one concerned with emotions relating to infant safety and the other concerned with affection, is plausible given a contemporary neuroscientific framework of emotions. The field of affective neuroscience is generating support for the existence of seven 'subcortical emotion systems' in the human brain (Davies and Panksepp, 2011); these systems have been conserved across mammals and are comprised of *seeking*, *lust*, *rage*, maternal *care*, *fear*, separation-distress *panic/grief*, and physical *play*[3]. These seven core emotions may be understood as emotional endophenotypes; "*basic* emotional tendencies which are sufficiently strongly linked to specific functional neural circuits [and which]…may provide psychologically relevant sets of target variables to be studied" (Panksepp, 2006: 775). The emotion of maternal *care* perhaps accounts for the first part of dual emotional bonding. Affective neuroscience holds 'love', on the other hand, to be a more complex higher-level emotion, with components drawn from numerous social-emotional endophenotypes (Panksepp, 2006), suggesting the second part of dual emotional bonding is a somewhat distinct and more complex phenomena from the first.

The seven subcortical emotion systems are thought to be an important foundation of personality (Davies and Panksepp, 2011). Personality is widely assessed using the Five Factor Model (Digman, 1990), which regards personality as comprising five dimensions, often labelled Agreeableness, Conscientiousness, Extraversion or Surgency, Emotional Stability, and Intellect or Openness to

[3] In the neuroscience and psychology literature these emotion systems are denoted using capitalisation, for instance SEEKING. The capitalisations are used due to the need for a specialised terminology to refer to the pure emotion (devoid of cognitive content) primary-processes of the brain that they reflect, and which together compose forms of affective consciousness (Davies and Panksepp, 2011). However the capitalisation may be jarring for the reader and so they have been italicised.

Experience. Personality, measured in this manner, has been found to be associated with various social behaviours of potential import to reproductive success (Alvergne, Jokela, and Lummaa, 2010). For instance, Extraversion has been positively correlated with number of sexual partners but is also associated with health costs (Nettle, 2005), longevity is associated with low neuroticism (high Emotional Stability and low anxiety), high neuroticism or emotionality reduces female fertility in the West (Jokela *et al*., 2009), whilst in high fertility populations it increases offspring quantity and reduces their quality, and pursuing health behaviours correlates with Conscientiousness (Alvergne, Jokela, and Lummaa, 2010). Davis and Panksepp devised the Affective Neuroscience Personality Scales (ANPS) as a way of measuring the affective underpinnings of the Five Factor Model and have gathered data to support a strong relationship between the two measures (Davies and Panksepp, 2011). They contend that “individual differences in such higher affective, as well as lower, primary-process aversive affective brain systems (*rage*, *fear*, and *sadness*) along with the positive affect systems of *play*, *caring*, and *seeking* are foundational for personality expression as well as the emergence of mental anguish and pathology. Individuals with different levels of responsiveness in these primary brain systems not only react differently to the same stimuli, they will experience these stimuli differently and develop different conditioned response tendencies and ongoing personal preferences.” (Davies and Panksepp, 2011: 1954 – italics switched from capitals in original).

The emotional personality of mothers, as measured by the ANPS (Davies and Panksepp, 2011), seems likely to play a role in emotional bonding behaviour, and this will be explored in Chapter 4. However, as previously noted, use of the term ‘bonding’ is fraught with difficulties, so there is arguably a need for a new terminology to put an end to confusion and enable research to progress unimpeded. The field of evolutionary biology and specifically that of life history theory may provide a more productive framework with which to view the maternal behaviours and emotions currently covered by the umbrella of bonding. Life history theory is the study of the trade-offs between investments in current and future reproduction, the selective pressures that affect investment trade-offs, and the timing of life events which such investments produce, with the currency of investments being energy and time (Hill and Kaplan, 1999). Both the products of ‘physiological bonding’, such as lactation and infant body temperature regulation, and ‘emotional bonding’, such as caring for and developing an emotional relationship with an infant, are tangible and equate to investments of time and energy; thus referring to such behaviours as ‘maternal investment’ may be more productive than discussing them in terms of ‘bonding’. In the same way as ‘bonding’ has been viewed as a dual process (Figueiredo *et al*., 2009), maternal investment might then be divided into ‘physical investment’ and ‘emotional investment’. Physical investment would then refer to physical acts by the mother contributing to the somatic health of her infant, acts such as feeding, changing, carrying, responding to crying, safety vigilance – analogous to Mann’s (1992) caring behaviour. Emotional investment, on the other hand, denotes affectionate behaviour contributing to psychological, emotional development, acts such as caressing, soothing, play, stimulation, engaging in prolonged eye contact, use of motherese – analogous to Mann’s (1992) psychosocial investment.

Improving the accuracy and usability of terminology surrounding ‘bonding’ is important not only from a theoretical perspective; as will be outlined in Chapter 3, the ‘bonding’ relationships mothers have with infants are central to the cultural construction of motherhood in contemporary, industrialised, low fertility populations where parenting culture emphasizes the importance of high investment parenting. It is thus important that the scientific literature informing popular notions regarding maternal psychology and the impact of maternal emotions on infant development be clear and leave as little room for misinterpretation or misrepresentation as possible, a point which will be returned to in the final chapter.

Postnatal depression and mother-infant relations – a case of reverse causality?

The poor bonding and attachment often documented between a mother with PND and her infant is assumed to be the product of her depression; indeed the US Preventative Services Task Force recently proposed plans to target PND so as a to improve bonding and attachment and, hence, child outcomes (USPSTF, 2016). However, if this is the wrong way round, and low maternal emotional investment precedes PND in some women, with depression being a by-product in women made to feel bad about their lack of bonding and attachment, borne of a life history trade-off, then interventions targeting the effect rather than the cause may have little impact on altering relations and improving conditions for the infant.

The idea that the direction of effect between PND and bonding/attachment might be misconstrued has not received much attention, possibly because in their original and highly influential incarnations bonding and attachment were thought to be the evolved, automatic pattern of behaviour (Bowlby, 1969; Klaus *et al*., 1970) and so it was detrimental events such as illness that caused them to go awry. To my knowledge, in the psychological literature only Moehler *et al*. (2006) have briefly mooted but not tested the notion that PND may follow rather than precede poor bonding/attachment, and they point out that studies have not been designed to detect whether it might be the case. However, supportive results come from of a study by Pearce and Ayers (2005) indicating the relationship between PND and poor bonding is simultaneous rather than causal. When the French feminist writer and social historian Elisabeth Badinter suggested in 1980 that mother love was not an instinct but contingent on the environment there was outrage (Du Plessix Gray, 1981), but subsequent work from evolutionary theorists on infanticide has bolstered the validity of her argument (Daly and Wilson, 1984; Hrdy, 1992). Environmental impacts on attachment relationships have also since received more critical evolutionary attention with work by eminent researchers such as Belsky (1997a) and Chisholm (1996) amongst others. Such works indicate that bonding and attachment are not automatic pathways for mothers and that their absence may in fact be ‘natural.’ That this is very much not the received wisdom in the West (Marshall, 1991) opens up the possibility that misperceptions about the bonding process may be negatively impacting those women who do not experience feelings they anticipated to towards their infant, causing them to become depressed. Indeed mismatches between expectation and experience have repeatedly been found to correlate with PND (Beck, 2002).

Research questions

There are increasing calls from within the field of evolutionary studies for medics and public health researchers to embrace the explanatory power of evolutionary theory (Stearns, 2012); however, for this to become a reality it is crucial that the evolutionary explanations of medical issues put forward are tested, lest their utility be found wanting and evolutionary theory dismissed wholesale. Adaptationist perspectives on PND, despite being proposed over a decade ago, have yet to be thoroughly empirically examined, and thus the first research question to be addressed in this thesis is as follows:

> *Are there identifiable adaptive benefits to PND or is it too costly to show good design as a signal/aid to maternal investment? If so this would suggest the possibility it is instead a by-product of some other evolutionary process should be explored instead.*

This question is addressed in Chapter 2 by means of a specially designed retrospective questionnaire study which gathered the complete reproductive histories of a cohort of postmenopausal women and, uniquely, collected data on their experiences of PND.

The adaptationist and mismatch evolutionary explanations of PND introduced above suffer from an inability to explain the presence of PND in women who are without the commonly recognised risk factors for PND (Myers, Burger, Johns, 2016); an issue stemming from the fact these evolutionary explanations are *based* on such risk factors. Nor can they easily account for why a mismatch between expectation and experience is associated with PND. This suggests a fresh perspective is required, one which is both capable of causally linking together currently recognised risk factors and explaining instances of PND in women who do not appear to be at risk based on current understandings. Taking as a starting point the possibility that low maternal emotional investment, or ‘emotional bonding’, precedes PND in some women, and employing a multidisciplinary approach drawing on life history theory, human social genomics, and sociological and feminist perspectives of motherhood, a model will developed across Chapters 3 to 6 with the purpose of comprehensively explaining the occurrence of PND and, in Chapter 7, proposing novel preventative measures. In doing so, the following major research questions will be addressed:

Does social evaluative threat predict PND?

This question is addressed in Chapter 3 using a specifically designed longitudinal questionnaire study following women from pregnancy through into the postpartum, assessing their perceptions of social evaluative threat both prior to and after giving birth and their experience of PND.

Does the social construction of motherhood in Western, educated, industrialised, rich, democratic (WEIRD) (Henrich, Heine, and Norenzayan, 2010) settings act as a source of social stress for mothers, thereby playing a causal role in PND?

This question is addressed in Chapter 3 via use of the aforementioned longitudinal questionnaire following mothers across the perinatal period and in Chapter 5 using a priming study designed to assess the impact of exposing young women to messages regarding motherhood drawn from WEIRD popular and social media.

Can maternal emotions be understood as forms of embodied capital investment in offspring?

In Chapter 4 a diverse body of literature is presented to support the case that the emotional relationships mothers have with their infants can be viably considered a form of embodied capital. Following this, the aforementioned longitudinal questionnaire following mothers across the perinatal period is also used, having taken various measures of the emotional relationship mothers had with their infants.

If the former question can be said to be the case, what influences trade-offs in relation to maternal emotional investment?

Again the longitudinal questionnaire is employed, in Chapter 4, to explore the factors influencing the development of the emotional relationships mothers have with their infants.

If the social construction of motherhood is a source of social evaluative threat, can it be experimentally induced?

The aforementioned priming study is used in Chapter 5 to assess the capacity of popular and social media messages surrounding motherhood to induce social evaluative threat.

Does the experience of social stress in relation to emotional investment explain PND in women lacking commonly recognised risks for PND?

The longitudinal questionnaire tracking women through the perinatal period is employed for a final time in Chapter 6 and the measures of social stress, first explored in Chapter 3, are used to predict PND experience whilst controlling for risk factors.

Chapter 2 – Postnatal Depression – Testing Current Adaptationist Paradigms

Chapter outline

There is great scope in looking to mental health issues, and medical issues more generally, to gain insight into human behavioural evolution and vice versa. For instance, schizophrenia and bipolar disorder have been linked to the evolution of human creativity (Horrobin, 2001; Nettle, 2001), Reactive Attachment Disorder has been proposed to be an adaptive strategy in children lacking secure social environments (Balbernie, 2010), and there are a multitude of evolutionary hypotheses regarding aetiology and functions of depression (Nettle, 2004). The burgeoning field of evolutionary medicine is showing that "a more explicit evolutionary approach to medicine may provide relatively easy solutions to some major public health problems" (Poiani, 2011: 10). For instance, signal detection theory has been utilised to illuminate anxiety attacks (Nesse, 2011), various authors have made headway in applying life history theory to understand teenage pregnancy (for example Burton, 1990; Johns, Dickens, and Clegg, 2011) and explain the observed correlation between it and absent fathers (Chisholm *et al*., 2005), and the insurance hypothesis, which postulates it is adaptive to store fat in response to food insecurity, provides insights into obesity (Nettle, Andrews, and Bateson, 2016). Indeed, "the time has arrived for wide public understanding of the importance and relevance of evolutionary biology in everyday lives" (Bull and Wichman, 2001: 212).

This chapter will begin with an overview of current adaptationist evolutionary explanations of PND (Crouch, 1999, 2002; Hagen, 1999, 2002; Thornhill and Furlow, 1998) introduced in the previous chapter. While widely recognized, see below, these arguments presently lack substantive empirical testing and, once outlined, the remainder of this chapter will be devoted to presenting the results of a study designed to address this.

Adaptationist perspectives – postnatal depression as a signal to withdraw investment

Hagen (1999, 2002) proposes that PND is an adaptation that functions as a signal to mothers that they "are suffering or have suffered a fitness cost, which motivates them to reduce or eliminate investment in offspring under certain circumstances" (1999: 325). In support of this contention Hagen (1999) cites the findings that PND correlates with problems relating to: infants, including issues during pregnancy and delivery; marital issues; and a lack of social support for the mother. It is also suggested that the depression acts as a bargaining tool (Hagen, 2002; Hagen and Rosenström, 2016) persuading others to invest in the infant instead, on the basis that severe social costs are attached to neglecting or killing an infant (Hagen, 2002).

Thornhill and Furlow's (1998) explanation for PND is conceptually very similar to that of Hagen's, suggesting that the psychological pain experienced in PND is an "evolutionary psychological adaptation for discriminative maternal solicitude, encouraging mothers to cease investment in newborn offspring under circumstances in which the offspring would have had low reproductive value in ancestral environments" (1998: 341). The psychic pain hypothesis is put forward, under which psychological pain is held as evolutionarily analogous to physical pain, "designed to demand immediate attention" (Thornhill and Furlow, 1998: 342), hence social events which radically reduce fitness proximately cause depression. Whilst focusing on PND, they treat postpartum psychosis[4] as being part of the same spectrum and as having the same evolutionary underpinnings, resulting as it does in a distancing of the mother from the infant and overtly visible signs of distress.

Thornhill and Furlow (1998) cite an earlier conference paper given by Hagen and note their approval of his suggestion that depressive symptoms like weeping and irritability evoke social support. Findings that tearfulness is immunosuppressive in adult women are put forward to suggest that this element of PND may represent a Zahavian honest signal of need (Thornhill and Furlow, 1998; Zahavi, 1975). However, recent findings regarding the upregulation of the innate immune

[4] Postpartum psychosis or puerperal psychosis is a rare psychotic disorder, occurring in 1-2/1000 women within 4 weeks of birth, the DSM-IV and 5 classify it as a severe form of depression, but there is growing evidence that it represents an overt presentation of bipolar disorder (Sit *et al*., 2006).

system during depression (which will be discussed later in this chapter) presumably counteract any suppression occurring during crying. They are less hesitant than Hagen when discussing cross cultural data on PND; they note cultures with a history of Western colonialism have a similar PND to Western cultures themselves which they suggest it a result of the disruptive influence of colonial powers on traditional practices and, following the work of Stern and Krukman (1983), argue that in non-Western societies that remain traditional PND seems rare as a result of protective postnatal rituals (Thornhill and Furlow, 1998). Kumar (1994), however, has argued against this position, contending that cultural stereotyping by social and medical anthropologists may mean it has just been obscured.

Hagen later incorporates the psychic pain hypothesis into his arguments (Hagen and Clarke Barrett, 2007), proposing "…Negative maternal emotions directed towards pregnancy or a new baby might reflect an evolved psychology designed to reduce investment in offspring under costly conditions" (2007: 27). Hagen and Clarke Barrett (2007) document perinatal sadness, a form of psychic pain, among the Shuar, Ecuadorian hunter-horticulturalists, in support of the psychic pain hypothesis; 21 women were asked if they were sad during pregnancy or after birth and if they wanted their child, and those women who reported being sad or not wanting their child were asked to explain why. 62% of women reported being sad during pregnancy, 33% reported being sad postnatally, and 35% reported not wanting their child; women were more likely to be sad during pregnancy if they did not want their child (p = 0.052), but they were not more likely to be sad during the postpartum (p = 0.340). Women who reported being sad or not wanting their child gave reasons which were indicative of their lack of resources in line with parental investment theory, however no data was collected regarding comparability of resources available to the women who were not sad or did want their child. While data was not collected to test the hypothesis that "sadness will motivate mothers to take action that, at least in ancestral environments, would have increased biological fitness" (Hagen and Clarke Barrett, 2007: 36), this is suggested as an explanation as to why women who were sad during pregnancy did not remain so after birth. These results are used as support for a psychic pain explanation of PND; although it is noted that the study assessed sadness and "not necessarily depression" (Hagen and Clarke Barrett, 2007: 28), it is argued that there might be a substantial overlap between postpartum sadness and PND, on the grounds that sadness is an important symptom of PND.

Adaptationist perspectives – postnatal depression as an aid to maternal responsiveness

Crouch (1999, 2002) shares commonalities with the previous two approaches and draws from Thornhill and Furlow (1998), citing them in her central premise that the psychological pain experienced by mothers is an adaptive answer to the demands and challenges of the postpartum period, signalling to others that the mother is in need of support (Crouch, 1999). She initially questions the diagnosis of PND, and instead broadens her focus to postnatal stress and depression "to denote the multifaceted and variable pattern of emotional and functional disturbances during the postpartum" (Crouch, 1999: 166), although later deals more directly with PND (Crouch, 2002). Her approach is grounded in Evolutionary Psychology, contending that the behaviour developed in the environment of evolutionary adaptiveness (EEA), during which time social structures and cultural practices are supposed to have existed to protect mothers and ensure someone was there to respond to her signals of distress. However, nowadays in the West a sociocultural environment exists "that is largely emancipated from established traditions and within which 'rational' judgments and action are (at least ostensibly) favored, postnatal distress responses can appear to be inappropriate and disproportionate and are therefore seen to represent symptoms of an illness" (Crouch, 1999: 170), whilst the process of diagnosis both delays help and prolongs the distress signal, and so escalates negative affect.

Crouch relies heavily on the work of Barr (1990) who observed the care-taking practices of the !Kung and proposed that constant mother-infant contact enables continuous feeding, thus explaining the finding that their infants cry for shorter periods of time than infants in the West. This work is used to argue that women's emotions have evolved to desire constant contact and feeding, but when they find themselves in a sociocultural environment in which constant caretaking is not possible or approved of, a situation arises in which "the maternal disposition (with its emotional underpinnings) is at variance with the social environment" (Crouch, 1999: 173). This is where Crouch differs from Hagen and Thornhill and Furlow in that she sees psychological pain not as a signal to withdraw investment, but as an "aid to maternal responsiveness" (Crouch, 1999: 177). Under Crouch's hypothesis, feeling psychological pain at her inability to adequately respond to her infant would signal for and solicit help from others in the EEA, restoring her responsiveness capacities. However in the West, confronted with an infant who cries a lot and a thwarted 'continuous responsiveness' tendency, a mother will concentrate on her infant's crying and feeding, which may "result in obsessive worry, depression, anxiety, debility, sleep disturbances and the like all of which signal that 'there is something wrong' and thus cry out for immediate help and support, whether it is obtainable or not" (Crouch, 1999: 173). In support of this she cites her own finding, and very little else, that distressed mothers are concerned by their infant's feeding and crying (Crouch and Manderson, 1993), and she is critical of popular literature and 'expert' advice for compounding concerns. She expands on this latter point in her later work, critiquing the impact of bonding theory and links it to PND (Crouch, 2002). Crouch views bonding as a facet of maternal responsiveness, and problems with bonding and PND as interrelated manifestations of challenged mother-infant relations resulting from inappropriate social triggers.

Work which will be detailed in Chapter 4 attests to the level of concern Western mothers display over their infants (Leckman *et al.*, 1999), however, the problem Crouch fails to address in this analysis is why all women in the West are not stressed and depressed. Or, if all Western mothers are stressed and depressed, why are some more so than others? Presumably, under her line of reasoning, the answer is variance in social support, but as Crouch (1999) makes little reference to the literature on the risk factors of PND she fails to make the association, although she later pays cursory notice to this risk factor (Crouch, 2002). Without reviewing the biological changes during the perinatal period or noting any links to genetic variance, she does suggest that "given the inevitable variability associated with the human genetic make-up…adaptive social practices in relation to childbearing cannot cancel, in every individual case, reproduction's potential for noxious effects" (Crouch, 1999: 169). As she goes on to argue such adaptive social practices have been eroded in the contemporary West anyway, again the question remains why do some women become clinically stressed and depressed and others do not? Growing evidence also supports the notion that humans evolved as cooperative breeders (Hrdy, 1999, 2009), and that whilst constant infant-caretaker contact may be the norm amongst extant hunter-gatherers and other small scale societies, the caretaker is not necessarily the mother. Although taking her start from Thornhill and Furlow (1998), and discussing briefly the idea of parent offspring conflict (Trivers, 1974), Crouch (1999, 2002) makes no mention of the concept of life history trade-offs or that maternal responsiveness should be costly to a mother. In fact she does not discuss explicitly, or arguably implicitly, reproductive fitness either. So while she makes some valid and interesting points, as an evolutionary hypothesis her work is somewhat insubstantial.

Unifying issues and critiques

A psychic pain hypothesis, whether PND is viewed as a mechanism signalling to women that they should reduce maternal investment when the costs outweigh the benefits (Hagen, 1999; Hagen and Clarke Barrett, 2007; Thornhill and Furlow, 1998), as a bargaining tool to gain resources (Hagen, 2002; Hagen and Rosenström, 2016), as an aid to maternal responsiveness (Crouch, 1999), or a combination of the three, views PND as adaptive. Grounded in the framework of Evolutionary Psychology, in which "…Adaptive behaviors, such as investing or disinvesting in offspring, must be produced by evolved psychological mechanisms (Tooby and Cosmides 1990b)" (Hagen and Clarke Barrett, 2007: 27), PND is seen as having evolved in the EEA and being fixed in the population. The hypothesis that PND provides benefits in terms of future reproductive opportunities is relatively untestable if the mechanism is fixed because all women should have the adaptation; however Nettle (2004) has called into question the viability of this stance on a number of grounds. Firstly, the idea that psychic pain is fixed in the population is problematized due to findings that major depressive disorders display heritability (Nettle, 2004); an Australian twin study found PND to have a heritability of 38% (Treloar *et al*, 1999). The stressors that precipitate depression are also arguably things that happen to most people at some point in their lives and yet most people do not become depressed, thus it is reasonable to contend the entire population is an adequate control group (Nettle, 2004).

All three hypotheses suffer from the fact that depression is a highly costly signal. Depression presents major costs to morbidity and mortality. It causes prolonged inflammation increasing the risks of cardiovascular disease, type 2 diabetes, arthritis and certain cancers (for example see Kiecolt-Glaser and Glaser, 2002; Mykletun *et al*., 2009), and heightens suicide risk (Blair-West *et al*., 1999; Oates, 2003). Only one study appears to have directly investigated the impact of general depression on female fertility. Compared to a control group, depressed/anxious women had significantly fewer pregnancies overall (2.0 vs. 2.8), and fewer pregnancies that culminated in live births (1.0 vs. 2.1) (Essock and McGuire, 1989). The physical effects of PND may render women less able to conceive in the future; women with depression have lower plasma levels of estradiol during the follicular-phase and higher levels of luteinising hormone (Young *et al*., 2000). PND also becomes chronic in 38% of sufferers (Vliegen, Casalin, and Luyten, 2014), and women with a lifetime history of depression are at greater risk of an earlier menopause (Harlow *et al*., 2003). It may also cause women to be less attractive to mates. PND is associated with increases in marital problems (Burke, 2003) and depression, more generally, has been found to to reduce social attractiveness (Coyne, 1976), increase the rate of failure for social relationships (Bouchard, Lussier, and Sabourin, 1999; Kelly and Conley, 1987; Reich, 2003), and reduce economic prospects (Ettner, Frank, and Kessler, 1997; Stewart *et al*., 2003). Finally it is possible that women will actively avoid childbearing to prevent a repeat experience of PND; people avoid experiences they anticipate to be detrimental to their wellbeing (Newman, 2008). Whilst sexual selection predicts that signals involved in mate choice will evolve to be honest and costly (Zahavi, 1975), it seems unlikely that a signal to one’s self should evolve to be costly, especially when the signal is to inform you of the paucity of your own situation. It is more parsimonious to suggest a mechanism of *perception > cost-benefit analysis > reaction,* than *perception > cost-benefit analysis > costly/honest signal >*

reaction. Studies by Bereczkei (2001) and Mann (1992) have reported varying levels of maternal investment dependent on infant viability without associated depression, thus suggesting it is not necessitated as a signal. The possibility then exists that depression is too costly to have developed as a signal to warn an individual of their already impoverished situation, and those mothers experiencing too high a fitness cost will simply not develop strong feelings of bonding and then attachment, thus minimising their investment costs – the costs of PND will be the subject of the analysis presented shortly in this chapter and maternal emotions will be the focus of Chapters 3 and 4. If Thornhill and Furlow (1998) are correct in supposing the need for a costly, honest signal to solicit help, all three hypotheses must still deal with the fact that depression is characterised by active social avoidance (Raison and Miller, 2013) and postnatally depressed women often refuse help from others (Mauthner, 1999), and Hagen and Thorhill and Furlow must deal with findings that depression is commonly caused by social isolation and rejection (Slavich *et al*., 2009), such that there may not be anyone to signal to and bargain with.

The issue of reproductive success is problematic for all. Crouch is explicit in contending that PND outside of the EEA is maladaptive so it should not be associated with reproductive fitness now, but she fails to suggest how depression now differs from depression then, thus why depression wasn't costly in our evolutionary past. Hagen and Thornhill and Furlow seem to suggest the behaviour is still adaptive, rather than having become maladaptive in contemporary environments, so the costs of depression should not outweigh the benefits (although for a more recent clarification of their position supporting a maladaptive perspective on PND see Hagen and Thornhill (2017)). In either circumstance, given the physical and potential social costs of depression, the benefits to reproductive success must be high; in discussing depression in general, Nettle notes while it is permissible for some individuals to suffer costs from depression "[evolutionary] theory also requires that a sizable group does well, to keep the adaptation in the population, and it is this group which is very hard to locate" (2004: 97). In their defence, Hagen, Thornhill, Furlow, and Crouch state that their ideas are largely speculative and they make little attempt to subject them to quantitative investigation. However, despite such lack of testing this adaptationist perspective appears to be accepted as *the* evolutionary explanation for PND, as suggested by its description in Yim *et al*.'s (2015) review of PND research, and between Hagen's two theoretical papers (1999, 2002) and Thornhill and Furlow's paper (1998) they have 378 citations [5]. The empirical data that has been brought to bear has solely focused on predicted patterns of incidence: as noted Hagen and Clark Barrett (2007) have assessed the correlation between sadness and not wanting a child in the Shuar; evidence to support the prediction that as women age and have fewer reproductive opportunities they should be more likely to invest in infants, and thus less likely to have PND, has been found in contemporary US (Hagen, 2002) and Brazilian samples (Bottino *et al*., 2012), and; Beaulieu and Bugental (2008) found that PND correlated with risky infants as indicated by premature birth. However, no studies have sought to assess the effects of PND in terms of outcomes in relation to measures of reproductive success.

Researchers from evolutionarily informed disciplines are increasingly calling for evolutionary theory to be absorbed and applied within medical and public health domains; for evolution's explanatory power to be fully appreciated it is crucial that the theories espoused have been rigorously tested. Thus, it is high time that the current adaptationist approach receive targeted empirical analysis. Proponents of evolutionary psychology may state the case for favouring evidence of good design over markers of current biological fitness on the grounds that psychological adaptations evolved in the EEA should no longer be expected to be adaptive in contemporary settings (for example see Hagen and Thornhill (2017)); however, this stance is thought to be sufficiently untenable in relation to depression, due to the critiques of this position made by Nettle (2004). Thus substantive empirical testing is deemed possible and necessary; addressing this gap in the literature will be the focus of the remainder of this chapter.

[5] Based on Google Scholar citation statistics as of July 2016.

Research question

> *Are there identifiable adaptive benefits to PND or is it too costly to show good design as a signal/aid to maternal investment? If so this would suggest the possibility PND is instead a by-product of some other evolutionary process should be explored.*

Life history theory predicts parents will make trade-offs in the allocation of energy between offspring quality and quantity so as to maximise their inclusive fitness in the environmental circumstances in which they find themselves (Stearns, 1989). Humans have been found to make quality-quantity offspring trade-offs in a number of societies (Borgerhoff Mulder, 2000; Gibson and Lawson, 2011; Huber, Bookstein, and Fieder, 2010; Meij *et al*., 2009); levels of extrinsic mortality risk negatively correlate with parental investment (Quinlan, 2007), child survival declines as sibling numbers increase (Lawson, Alvergne, Gibson, 2012; Meij *et al*., 2009), and maternal capital negatively predicts fertility (Lawson, Alvergne, Gibson, 2012). If the condition of PND is part of an adaptive suite of responses to the parental investment trade-off between current and future reproduction, activated in reaction to environmental risk as proposed by Hagen (1999, 2002) and Thornhill and Furlow (1998) then, utilising life history theory, a range of hypotheses (for a brief overview see Table 2.1) regarding the incidence of PND and its impact on fertility and mother-offspring relations, and by extension offspring quality, can be generated from these arguments, as follows.

Hypotheses

-Relationships (R)

A great deal of attention has been paid to the effects of PND on infant development, with mother-offspring relationship quality held to be the mediating factor between PND and deficits in infant cognitive, social, emotional, and physical development. Research on the impacts of PND has extended to the adolescent period, finding it to be linked to an increased incidence of teenage

Hypothesis	Dependent variable	Independent variable(s)	Statistical approach
Relationships			
Ri. Mothers who experienced PND will have lower quality relationships with the children with whom the depression was associated throughout their lives	**Ri.** Mother-offspring relationship quality	**Ri.i.** *PND incidence* **Ri.ii-iii.** *PND severity*, infant birth weight, infant health issues, breastfeeding, age at birth, tendency towards DAS, current depression, social pressure, SES, level of support from family, friends, offspring's father and own mother, the occurrence of birth complications and the emotional experience of birth, and offspring's current age	**Ri.i.** Mann-Whitney U test **Ri.ii.** Linear regression **Ri.iii.** Multi-level linear modelling
Rii. Mothers who experienced PND will have lower quality relationships with their grandchildren from children whose births were associated with depression	**Rii.i.** Impact of mother-offspring relationship on mother-grandchild relationship **Rii.ii.** Mother-grandchild emotional closeness	**Rii.** *PND incidence*	**Rii.** Pearson chi-square
Fertility			
Fi. PND positively affects completed fertility	**Fi.** Completed fertility	**Fi.** *PND incidence*	**Fi.** Mann-Whitney U test
Fii. The number of bouts of PND positively correlates with percentage of women continuing childbearing at each parity level	**Fii.** Parity progression	**Fii.** *PND history*	**Fii.** Pearson chi-square
Fiii.i. PND increases the likelihood of parity progression **Fiii.ii.** PND will show an additive negative effect on the likelihood of progression from higher parities when assessing the effect of increasing number of bouts **Fiii.iii.** PND will show an additive negative effect on the likelihood of progression from higher parities when assessing the effect of a bout beyond the parity at which is occurred	**Fiii.** Parity progression	**Fiii.i.** *PND severity* (for full modelling details see Myers, Burger, and Johns, 2016) **Fiii.ii.** *PND history* (for full modelling details see Myers, Burger, and Johns, 2016) **Fiii.iii.** *PND severity* at earlier births (for full modelling details see Myers, Burger, and Johns, 2016)	**Fiii.i** Binary logistic regression and moderation analysis **Fiii.ii-iii.** Binary logistic regression

Table 2.1 Hypotheses tested in Chapter 2 and the measures and methods used to test them. Measures in *italics* denote the variable of interest. Abbreviations: postnatal depression (PND), depression anxiety stress (DAS), socioeconomic status (SES), interbirth interval (IBI).

Hypothesis	Dependent variable	Independent variable(s)	Statistical approach
Fiv.i. Among women in poor circumstances at their first birth, circumstances improving in general between parities 1 and 2 will increase the likelihood of progressing to parity 3 **Fiv.ii.** Women who have poor circumstances at their first birth, but whose circumstances improved at their second birth, will be more likely to have a third birth if they had PND at their first birth then if they did not have PND	**Fiv.** Parity progression	**Fiv.** *PND incidence*, age at birth, and mother's year of birth (samples determined by maternal circumstance)	**Fiv.** Binary logistic regression
Fv. Interbirth intervals (IBI) will be shorter following PND	**Fv.** IBI	**Fv.** *PND incidence*, age at birth, mother's year of birth, SES, the duration of breastfeeding, tendency towards DAS, the emotional experience of birth, occurrence of birth complications, infant birth weight, infant health issues, and the level of support from friends, family, own mother, and offspring's father	**Fv.i.** Multilevel Cox regression **Fv.ii.** Multilevel linear modelling
Fvi. Mothers who experienced PND will have more grandchildren	**Fvi.** Number of grandchildren from a given offspring	**Fvi.i.** *PND incidence* (sample determined by infant sex) **Fvi.ii.** *PND incidence*, SES during childhood, offspring's birth weight, offspring's health issues in the first year, breastfeeding, mother-offspring relationship quality, level of paternal support in offspring's first year, year of offspring's birth, and mother's completed fertility (sample determined by infant sex)	**Fvi.i.** Mann-Whitney U test **Fvi.ii.** Linear regression
Incidence			
Ii. The incidence of PND will negatively correlate with age	**Ii.** PND severity	**Ii.** *Age at birth* (categorised as ≤35 or >35 years)	**Ii.** Independent samples T-test
Iii. The incidence of PND will positively correlate with increasing parity	**Iii.** PND severity	**Iii.** *Parity*, general tendency towards DAS, SES, level of support from family, friends, offspring's father and own mother, age at birth, infant birth weight, infant health issues, the occurrence of birth complications, and emotional experience of birth	**Iii.i.** Linear regression **Iii.ii.** Multilevel linear modelling
Iiii. PND will be more likely in association with multiple births than single births	**Iiii.** PND incidence	**Iiii.** *Birth type*	**Iiii.** Fisher's exact test
Iiv. PND will be more likely in association with male births than female births	**Iiv.** PND incidence	**Iiv.** *Infant sex*, general tendency towards DAS, occurrence of birth complications, SES, level of support from family, friends, offspring's father and own mother, age at birth, and mother's year of birth	**Iiv.** Generalised estimating equations

Table 2.1 (continued) Hypotheses tested in Chapter 2 and the measures and methods used to test them. Measures in *italics* denote the variable of interest. Abbreviations: postnatal depression (PND), depression anxiety stress (DAS), socioeconomic status (SES), interbirth interval (IBI).

anxiety disorders (Halligan *et al*., 2007), and PND has also been linked to increased rates of marital discord and depression in partners (Burke, 2007). However, little is known about the impact of PND on the longer-term mother-offspring relationships and the intergenerational effects this may have. Such effects are important to understand from an evolutionary perspective because relationship quality is likely to be a key mediating factor in maternal and grandmaternal investment (Barnett *et al*., 2010; Michalski and Shackelford, 2005).

In terms of Hagen (1999, 2002) and Thornhill and Furlow's (1998) adaptationist approach to PND in which PND is a mechanism signalling to a mother to withdraw investment, reduced mother-offspring relationship quality is a predictable outcome of low investment. However, if PND also functions to solicit extra resources from kin (Crouch, 1999; Hagen, 2002; Hagen and Rosenström, 2016), thereby restoring maternal responsiveness (Crouch, 1999), then the effects on mother-offspring relations might be expected to be neutral, if not beneficial. Given the aforementioned literature documenting the deficits to infant development associated with PND, the former seems the more likely and the following hypotheses are framed in this light, while the latter will be returned to in the discussion. The adaptationist perspective makes no predictions regarding the intergenerational effects of PND on grandmother-grandchild relations; the hypothesis dealing with this relationship is based instead on Barnett, Robins, and Janata's (2010) and Michalski and Shackelford's (2005) work.

Ri) Mothers who experienced PND will have lower quality relationships with the children with whom the depression was associated throughout their lives

If PND is a proxy for a low investment strategy in offspring, or if PND itself reduces offspring quality, then it is likely to correlate with low offspring investment across the offspring's life course, manifesting in lower mother-offspring relationship quality.

Rii) *Mothers who experienced PND will have lower quality relationships with their grandchildren from children whose births were associated with depression*

Grandparents make investments that influence their children's reproductive trade-offs even in modern, developed settings (Coall and Hertwig, 2011; Tanskanen *et al*., 2013; Emmott and Mace, 2015). Relationships with children mediate grandparent-grandchild relations (Michalski and Shackleford, 2005), positively correlating with grandparental involvement (Barnett *et al*., 2010). If PND negatively affects mother-offspring relationship quality, it is also likely to negatively affect grandmaternal investment via reduced grandmother-grandchild relationship quality.

-Fertility (F)

PND, operationally[6] defined as a depressive episode occurring within 12 months after a birth (Halbreich and Karkun, 2006; Skalkidou *et al*., 2012; Yim *et al*., 2015), presents a puzzling phenomenon for evolutionary anthropologists because it leads to suboptimal social, emotional, physical, and cognitive development in children (Beck, 1998; Cogill *et al*., 1986; Gelfand and Teti, 1990; Halligan *et al*., 2007; Murray and Cooper, 1997; Wright, Parkinson, and Drewett, 2006). These deficits arise from the negative affect PND has been found to have on the quality of mother-infant interaction, bonding, and attachment (Beck, 1995; Coyl, Roggman, and Newland, 2002; Moehler *et al*., 2006; Murray *et al*., 1996). Because it involves investment in children, emotional stress, and condition of the mother, PND should be of great interest for researchers interested in parental investment or quality-quantity offspring trade-offs. Yet, since the original adaptationist theoretical work by Hagen (1999, 2002), Thornhill and Furlow (1998), and Crouch (1999), PND has received very little empirical study as to its benefit for reproductive success by evolutionary researchers, leaving open questions as to why this emotional state evolved and whether it could be adaptive. The following hypotheses stem from the implication of Hagen *et al*.'s adaptationist perspective that the reproductive success of women with PND should benefit from resources either saved or gained, and that this may manifest in increased fertility.

Fi) PND positively affects completed fertility

[6] PND is technically defined as major depressive disorder which has an onset of within four weeks of giving birth (APA, 2013). However, onset of symptoms attributed to it often present beyond these cut-offs (Stowe *et al*., 2005) and in practise it is diagnosed if depression occurs at any time in the first year (Halbreich and Karkun, 2006; Skalkidou *et al*., 2012).

Completed fertility provides a basic fitness-relevant fertility measure and an appropriate target for quantification of the effect of PND under the theoretical paradigm of human behavioural ecology (Betzig, 1998). The reverse of this hypothesis, that PND negatively affects completed fertility was tested in Myers, Burger, and Johns (2016) and, as such, only a summary of these results will be presented here while full details of the analysis can be found in the paper which forms Appendix A.

Fii) The number of bouts of PND positively correlates with percentage of women continuing childbearing at each parity level

The previous hypothesis treated PND episodes as singular events. It has been shown that, for instance, number of existing sons has an additive effect on the percentage of women continuing to bear children at a given parity (Chaudhuri, 2012), so the possibility the PND has an additive effect was explored with respect to *PND history*.

Fiii) PND increases the likelihood of parity progression

A quantity over quality trade-off resulting in higher completed fertility is achieved via higher rates of parity progression, therefore based on an adaptationist perspective the hypothesis that *Fiii.i*) *PND increases the likelihood of progression from the parity at which it is experienced* can be posed. Adaptive explanations for PND based on it being an aid to maternal decision making predict that PND will have a positive effect on the fitness of women in poor circumstances in particular. This may be reflected in increased fertility resulting from an increased likelihood of parity progression when PND is experienced in association with poor circumstances. This hypothesis was the subject of analysis published in Myers, Burger, and Johns (2016), and as such only a summary of these results will be presented here while full details of the analysis can be found in the paper which forms Appendix A. In Myers, Burger, and Johns (2016) we also presented two further alternative hypotheses on the basis of the medical literature reviewed Chapter 2 indicating cumulative physical costs of PND: *Fiii.ii*) *PND will show an additive negative effect on the likelihood of progression from higher parities when assessing the effect of increasing number of bouts*, and; *Fiii.iii*) *PND will show an additive negative effect on the likelihood of progression from* *higher parities when assessing the effect of a bout beyond the parity at which is occurred*. We also compared models resulting from the testing of these three hypotheses to test the prediction that models accounting for PND having an accumulative effect will be stronger than models which do not take this into account; again full details of the analysis can be found in the paper which forms Appendix A.

Fiv) Women with poor circumstances and PND at parity 1, whose circumstances improved at parity 2, will be more likely to progress to parity 3 then women with poor circumstances at parity 1 whose circumstances improved but who did not have PND

Current adaptationist explanations of PND propose that the display of distress exhibited by women with PND is a mechanism by which women elicit extra resources from kin (Hagen, 1999, 2002; Hagen and Rosenström, 2016; Thornhill and Furlow, 1998), thus offsetting the costs of childrearing. It is well documented that poor circumstances, which reduce a woman's ability to invest in offspring (Hagen, 1999, 2002; Thornhill and Furlow, 1998), predict PND (Beck, 1996, 2001). If women in poor circumstances have PND, then they should save resources from their reduced investment and gain resources via social subsidy which can then be used to have more offspring if their circumstances improve. Women in poor circumstances who do not have PND, on the other hand, will not benefit from resources saved or gained, and will thus be less likely to have more offspring if their circumstances improve. This hypothesis can be broken down into two parts: *Fiv.i*) *among women in poor circumstances at their first birth, circumstances improving in general between parities 1 and 2 will increase the likelihood of progressing to parity 3*, and; *Fiv.ii*) *women who have poor circumstances at their first birth, but whose circumstances improved at their second birth, will be more likely to have a third birth if they had PND at their first birth then if they did not have PND.*

Fv) Interbirth intervals will be shorter following PND

The likelihood of parity progression is influenced by two sets of, not necessarily mutually exclusive, factors; those which cause a woman to permanently cease reproducing, and those which increase the period to a subsequent birth, both of which lead to reduced completed fertility. An adaptationist perspective in which PND facilitates a low investment strategy would be expected to reduce interbirth intervals (IBIs), mirroring the pattern found by Bereczkei, Hofer, and Ivan (2000) in relation to low birth weight infants. Conversely, PND may increase IBIs as a result of temporary subfertility from the hormonal disruption depression can cause, or alternatively, but not mutually exclusively, women may consciously delay childbearing while they recover from depression.

Fvi) Mothers who experienced PND will have more grandchildren

This prediction is derived both directly from the hypothesis that mothers who experience PND will have more children so *ipso facto* have more grandchildren, and indirectly from the hypothesis that PND reduces offspring quality (see below) thereby encouraging fast life history strategies favouring quantity over quality trade-offs in these offspring.

The sample size of women whose children are *all* aged 40 or over, and thus likely to be approaching stopping producing grandchildren, is small (N=35) and does not enable analysis of grandchild numbers with adequate controls. Instead, analysis is conducted on individual offspring aged 40 or over, and the implications for completed grandchildren numbers inferred. Where offspring are female it can reasonably be assumed that they have completed their childbearing, however male offspring fertility is not necessarily complete.

Mothers are known to make different levels of investment depending upon the sex of the child (Sear and Mace, 2008), investments which are predicted to be partly contingent on the mother's own condition and resources, and hence her ability to raise an offspring of high reproductive value (Trivers and Willard, 1973). PND has been found to have more detrimental effects on the development of males (Carter *et al*., 2001; Grace, Evindar, Stewart, 2003), thus any impact of PND on the number of grandchildren may vary by sex of the child, and so the effect of parental (parent of the grandchild) sex was also investigated. The following factors potentially influencing offspring quality, and hence their fertility and/or life history strategies, were also controlled for: SES during childhood (Duncan *et al*., 1998); abnormal birth weight and health issues during infancy; whether infants were breastfed; paternal support during infancy; mother-offspring relationship quality, which may reflect the level of grandmaternal support received; mother's completed fertility, which has been found to influence social norms surrounding desired fertility level (Testa and Grilli, 2006; Shenk *et al*., 2013), and; year of offspring's birth – accounting for both fertility (particularly in males) not being completed, thus fertility may be positively correlated with age, and background trends in population level fertility.

-Incidence (I)

A number of predictions can be made regarding the incidence of PND when viewed from current adaptationist perspectives (Crouch, 1999; Hagen, 1999 and 2002; Thornhill and Furlow, 1998). Such perspectives are predicated on the correlations of PND with various factors indicating poor maternal or infant circumstance (Hagen, 1999; Thornhill and Furlow, 1998), these relationships are not controversial and attempts to replicate them here would seem a little redundant; rather the focus will be on patterns implied by an adaptationist stance which have not been extensively explored previously.

Ii) The incidence of PND will negatively correlate with age

Hagen (2002) hypothesises that as women age and have fewer reproductive opportunities they should be more likely to invest in infants and thus less likely to have PND, which was supported by a small US sample in which 9 women over the age of 35, with one existing child, were found to have lower levels of PND symptoms than 68 women aged 35 and under. Bottino *et al*. (2012) found similar results in a larger Brazilian sample. The following analysis mirrors Hagen's (2002) methodology with a larger sample (women with one existing child: N $\leq$ 35 = 212, > 35 = 40; no existing children: N $\leq$ 35 = 270, > 35 = 31).

Iii) The incidence of PND will positively correlate with increasing parity

Increasing numbers of children will increase the strain on a mother's resources, thereby reducing her ability to invest. Thus somewhat counter to the previous hypothesis, because parity positively correlates with age, it may be predicted that the incidence of PND will increase with parity.

Iiii) PND will be more likely in association with multiple births than single births

If PND is a mechanism to signal to a mother to withdraw investment due to her inadequate resources, then the birth of multiple offspring, with the extra costs this entails in terms of both energetic resources and care requirements, is more likely to lead to PND then singleton births.

Iiv) PND will be more likely in association with male births than female births

Trivers and Willard (1973) showed that natural selection may favour parental capacity to adjust parental investment differentially by sex based on the ability of the parent to invest, where a son in good condition is predicted to out-reproduce his sister of comparable condition, while a daughter will have higher reproductive success than a son if both are in poor condition. Parental investment theory predicts that a mother should cease investing in an individual offspring when the benefits of the investment to her inclusive fitness are outweighed by the costs (Trivers, 1974). Mothers in poor condition or in risky environments, and so unable to make the requisite investments to raise a high quality offspring, will be more likely to gain grandoffspring from a daughter than a son. The same pattern is predicted when sons are born in poor health compared to when daughters are born in poor health. Therefore, it follows that the costs of investing in a son as opposed to a daughter will be higher, and the reproductive benefits lower, under such circumstances, leading to a mother being more likely to withdraw her investment. Following Hagen (1999, 2002) and Thornhill and Furlow's (1998) argument that that PND is an adaptive signal to a mother that she is experiencing a fitness cost by investing in a particular offspring and thus she should reduce or eliminate investment, PND should conform to the predictions of the TW hypothesis, that is be more likely to occur in association with the births of male offspring when the condition of the mother, the environment, or of the offspring are less than ideal.

Materials and methods

-Data collection

Very little in the way of existing data was previously available with which to test such hypotheses, so the data presented here are drawn from a survey specifically designed for this purpose (see Appendix B for details of the design process and the actual survey). The complete reproductive histories of post-menopausal women were collected by retrospective survey. Respondents reported details about every birth they had experienced, separately and in chronological order, and were assessed on a number of demographic and psychological measures, including three different measures of PND and a measure of relationship quality. Participants were recruited via advertising in newsletters and social media channels of UK-wide branches of the Women's Institute (a voluntary organisation providing social and educational opportunities for its 212,000 members, 93% of whom are aged 45 and over (The WI, 2014)), the alumni networks of two UK universities, and social media aimed at older women. The survey was conducted online using the SurveyGizmo platform and, to minimise inaccurate reporting due to the sensitive nature of information requested, participants remained anonymous with the exception of their IP address, which was collected to control for multiple responses from the same address. 306 valid responses were received.

-Psychological measures

Postnatal Depression – measures

Women were asked to self-report their diagnostic history of PND, giving a categorical measure of *PND incidence based on actual diagnosis* at each birth. It was anticipated that this sample size would be small, on the grounds that PND is chronically under diagnosed (Paulden, Palmer, and Hewitt, 2009), so two retrospective screening measures for PND, the Bromley Postnatal Depression Scale (BPDS) (Stein and van den Akker, 1992) and a modified version of the Edinburgh Postnatal Depression Scale (EPDS) (Cox, Holden, and Sagovsky, 1987) were also completed for each birth a woman reported. The sample size of women receiving diagnosis was too small (N=41) to use in the regression analyses, but it is used in the analyses of completed fertility to avoid potential critique for relying purely on retrospective screening measures.

The BPDS consists of a statement regarding depressive symptoms and a question regarding whether such symptoms were experienced; if the answer is affirmative the symptom duration is recorded, with anything over a month indicating PND. This element of the scale was used to determine a categorical measure of *PND incidence* at a given parity and also to create a categorical measure of cumulative *PND experience* or depression history, i.e. the number of PND events prior to a given parity, used in the regression models. The BPDS is specifically designed to assess PND symptoms retrospectively (Stein and van den Akker, 1992) and has been used in previously published studies assessing similar durations of recall (McLaren *et* al., 2007; Séjourné *et al*., 2011), yet it provides no scope for assessing severity of symptoms. For this reason a modified version of the EPDS is used.

The 30 point EPDS is the most widely used screen for PND (Boyd, Le, and Somberg, 2005). Questions were presented in the past tense and participants were requested to reflect back on the first year after each birth. To the best of our knowledge this is the first application of this form of the EPDS retrospectively over a long recall duration, but Payne *et al*. (2010) used it to assess depressive symptoms over a retrospective period of 5 years (Payne *et al*., 2010). An alternatively modified EPDS has also recently been used as part of the Netherlands Study of Depression and Anxiety (NESDA) to assess lifetime PND prevalence (Meltzer-Brody *et al*., 2013). An EPDS score for each birth was calculated and was used as a continuous measure of *PND severity* at a given birth. A categorical measure of *PND incidence* after each birth was also determined by using a cut-off score of 12 following Payne *et al*. (2010); this is a higher cut-off value than that suggested by Cox, Holden, and Sagovsky (1987) and was deemed appropriate due to findings that the accuracy of recall in retrospective reporting of depression increases with severity of symptoms (Wells and Horwood, 2004). Finally this measure of incidence was used to determine a measure of cumulative *PND history* or *number of bouts* of PND.

Postnatal depression – use of measures

Exploratory analysis showed that AICc scores, which provide a relative measure of how much information is lost by a model (Burnham, Anderson, and Huyvaert, 2011), were lower in regression models predicting parity progression, IBI, and relationship quality, when PND measures derived from the EPDS were used compared to measures from the BPDS or actual diagnostic history (see Appendix C for details). As such, the EPDS was used in all the following regression analyses, while the BPDS and actual diagnosis were additionally used in more basic analyses to reinforce findings.

PND was actually diagnosed in 54 births. 94 births met the BPDS criteria for PND, and 153 births met the EPDS criteria. When predicting PND itself, to maximise sample size and the chances that PND is what is actually being measured, a combined measure is used in which PND is deemed to have occurred if an actual diagnosis was received or a birth met the criteria for PND on *both* the EPDS and BPDS screening measures (N = 88).

General Depression

Current depression at the time of survey completion may adversely affect the recall of past events so the Beck Depression Index-Short Form (BDI-SF) (Beck and Steer, 1993) controlled for respondent's current emotional state. The following cut-offs were used based on Stukenberg, Dura, and Kiecolt-Glaser's (1990) validation of the scale in an elderly non-clinical community: mild depression ≥ 5, moderate depression ≥ 8, and severe depression ≥ 16.

To control for any negative affective tendencies which may have influenced fertility in our respondents (Jokela *et al*., 2009) we used the short version of the Depression Anxiety Stress Scales (DASS) (Lovibond and Lovibond, 1995a), using trait wording (Lovibond, 1998). The DASS is designed to be compared to normative population data (Crawford and Henry, 2003; Psychology Foundation of Australia, 2013) and is split into separate sections for each emotional state, each giving a score out of 63. The depression score was used as a continuous variable indicating *depressive tendency* throughout the life course and the aggregated score to indicate *general* *tendency towards depression, anxiety, and stress (DAS)*. Clinical cut-offs also exist classifying respondents into ranges of ‘normal’, ‘mild’, ‘moderate’, ‘severe’, and ‘extremely severe’ (Lovibond and Lovidond, 1995b), and an aggregated score for the full scale was used to classify respondents.

-Birth characteristics

Emotional experience of birth

Birth trauma is an increasingly recognised issue (Beck et al., 2011), impacting on maternal mental health and likely to influence willingness to undergo future pregnancies (Gottvall and Waldenström, 2002). Respondents were asked whether the emotional experience of each of their births was ‘positive’, ‘negative’, or ‘mixed’.

Occurrence of birth complications

Respondents reported whether during birth they experienced no complications, minor complications, and major complications, as complications are likely to reduce the likelihood of parity progression (Smith et al., 2006; Priddis et al., 2013) and increase interbirth intervals (Murphy, Stirrat, and Heron, 2002) (but see Evers et al., 2014).

Birth type

Respondents reported whether a given birth was a single or multiple (twins, triplets etc.) birth event.

-Infant related issues

Infant sex

Respondents reported the sex of offspring at each birth event.

Infant birth weight

Low infant birth weight has been found to be associated with decreased interbirth intervals and increased completed fertility in humans (Bereczkei, Hofer, and Ivan, 2000; Bereczkei, 2001). Participants were asked whether their offspring's birth weight was 'low', 'normal', or 'high'; these measures were subsequently collapsed into categories of 'normal' and 'not normal' for the analysis as the sample size of low and high were small and high birth weight infants are also at increased risk of future morbidity (Danielzik *et al*., 2004; Harder *et al*., 2007; Ørskuo *et al*., 2003).

Infant health issues

Poor infant health has been found to be associated with decreased interbirth intervals and increased completed fertility in humans (Bereczkei, Hofer, and Ivan, 2000; Bereczkei, 2001). Participants were asked whether their offspring had any serious health issues in their first year post-birth.

Breastfeeding

Participants were also asked to report if they breastfed each of their offspring. Whilst breastfeeding has a suppressing effect on ovulation this effect lasts under a year in an average, well-nourished woman (Grey *et al*., 1990; Lewis *et al*., 1991) and so was unlikely to inhibit further reproduction in the respondents. However, breastfeeding has been linked to enhanced infant bonding and attachment (Britton, Britton, and Gronwaldt, 2006; Else-Quest, Shibley Hyde, and Clark, 1982), so it may play a role in enhancing women's experience of motherhood and increasing the likelihood of parity progression.

-Relationship quality

Mother-offspring relationship quality

Mother-offspring relationship quality was determined by the Positive Affect Index (PAI) (Bengtson and Schrader, 1982) which measures subjective relationship solidarity. The index is made of two parts assessing a mother's feelings *towards* her offspring and her perception of her offspring's feelings *about* her. Subjective solidarity is measured along five dimensions of affect; 1) understanding, 2) fairness, 3) trust, 4) respect, and 5) affection. Degree of solidarity was rated on a

Likert scale of 1 (not well) to 5 (extremely well) following Birditt, Rott, and Fingerman (2009); the index then provides three continuous measures, a score out of 25 for feelings *towards*, a score out of 25 for perceptions *about*, and a combined measure of overall relationship quality scored out of 50.

Grandmother-grandchild relationship quality

Those participants who reported that they had grandchildren from one or more of their children were asked to rate how emotionally close they felt with each grandchild and also whether they felt the relationship they have with their child positively or negatively impacts their relationship with their grandchild/grandchildren on Likert scales of 1 (*very close*) to 5 (*not at all close*).

-Social environment

Social support

Given that kin network influences female fertility decision making in contemporary Western populations (Matthews and Sear, 2013; Tanskanen *et al*., 2013), that peer support may prevent PND (Dennis *et al*., 2009), and that social isolation is linked to depression (Slavich *et al*., 2010a), the following measures were assessed: a respondent's perceived level of support during the first year after each birth from (1) the offspring's *father*, (2) her *family*, and (3) her *friends*, (4) whether her own mother was alive at the time of her first giving birth, and if so, (5) the perceived level of support available to her specifically from her *mother*. Level of support was initially rated on a scale of 1 (*very low*) to 5 (*very high*) or for maternal support 0 (*none* – when the mother wasn't alive at first birth) to 5 (*very high*). This scale was condensed to 0/1 (*none*/*low*) to 3 (*high*) for the purposes of the binary logistic regression/multilevel analyses to reduce the standard errors resulting from small sample size. The initial scale was used in the creation of an *average support across all offspring* variable and an *overall social support* variable, for which scores were then aggregated and assigned to either the lowest, middle, or highest third, used in the testing of hypothesis *Iiii*.

Social pressure

Respondents were also asked if they experienced *social pressure* to be a ‘good mother’, with ‘yes’ or ‘no’ response options as perception of social threat is associated with stress and depression (Slavich et al., 2010a; Slavich et al., 2010b), thus social pressure surrounding mothering is likely to increase negative affect and may alter desires surrounding fertility.

-Demographics

Age

Respondents reported their dates of birth and those of their offspring, from which the mother’s age at survey completion (current age), mother’s *age at birth*, mother’s *year of birth*, and *current offspring* age at the time of survey completion were calculated. Mother’s year of birth was used in the analysis to control for any confounding effects of the respondents being born during a period of fertility decline (Frejka and Calot, 2001).

Socioeconomic status (SES)

Retrospective *SES* during respondents’ childbearing years was determined by the Social Class Based on Occupation method (CeLSIUS, 2007), with participants asked to classify the occupation of the household member who made the majority contribution to finances. SES was categorised as either high (professional), medium (managerial and technical), or low (skilled non-manual, skilled manual, partly-skilled, and unskilled).

Maternal circumstances

A continuous measure of a mother’s circumstance at a given parity was also created, reflecting the number of “poorest” categories a mother was rated in for a range of the above variables. A score of 1 was assigned if the mother fell into the following categories: minor or major *birth complications*, not *breastfeeding*, negative *emotional experience of birth*, abnormal *infant birth weight*, *infant health issues*, low *SES*, low *support from family*, *friends*, the offspring’s *father*, and low or no *support from their mother* (*social pressure* was excluded due to the poorest category choice being debateable). The scores were summed and used as a continuous numerical variable with a possible range of 0-10.

-Sample characteristics

Respondents were born between 1930 and 1967, and their average age was 59.1 years (SD 7.5). The majority of respondents (82.3%) were married throughout their childbearing years, of high to medium

SES (‘professional’ 68.0%, ‘managerial and technical’ 20.6%), with the women’s husband/partner contributing the majority to household finances (77.1%). The majority did their childrearing in the UK (73.9%), followed by North America (15.6%), the rest of Europe (4.8%), Australia and New Zealand (2.6%), and the rest of the world (3.1%). On average, respondents gave birth to 2.28 infants (range 1–6). An actual diagnosis of PND, at at least one birth, was received by 41 women (13.4%), while 73 women (23.9%) met the criteria for PND according to the BPDS at least once, and 108 women (35.9%) met the cut-off for PND according to the EPDS at least once. For the percentage of the sample that continued childbearing at each parity and the distributions of each measure of PND across parities see Table 2.2.

Measure	Parity 1	Parity 2	Parity 3	Parity 4	Parity 5	Parity 6
Entire sample	100.0	83.7	31.0	7.5	1.0	0.3
Giving birth	83.7	37.1	24.2	13.0	33.3	0.0
BPDS	15.5	17.0 (9.5)	3.2 (0.0)	13.6 (9.5)	0.0 (na)	0.0 (na)
EPDS	26.2	23.0 (11.2)	14.0 (7.5)	22.7 (18.8)	33.3 (0.0)	0.0 (na)
Actual diagnosis	9.2	9.1 (4.8)	3.2 (2.5)	0.0 (na)	0.0 (na)	0.0 (na)

Table 2.2. Percentage distributions of women in the sample reaching each parity, giving birth at each parity, and of PND by parity – the figures in () reflect the percentage of women experiencing PND for the first time at a given parity. Entire sample at parity 1 N = 306.

-Statistical approach

Ri) Mothers who experienced PND will have lower quality relationships with the children with whom the depression was associated throughout their lives

Ri.i First, to assess the impact of experiencing PND on *mother-offspring relationship quality* Mann-Whitney U tests were performed on relationship quality (PAI score) split by *PND incidence* at offspring birth.

Ri.ii Next, to assess whether PND impacts *mother-offspring relationship quality* once other factors known to influence relationship quality are accounted for, linear regression was performed regressing *PND severity* against *mother-offspring relationship quality* whilst also controlling for the following factors: *infant birth weight*, *infant health issues, breastfeeding*, *age at birth, tendency towards DAS*, *current depression, social pressure*, *SES*, *level of support from family*, *friends*, offspring's *father* and own *mother*, the *occurrence of birth complications* and the *emotional experience of birth,* and *offspring's current age*. Variance inflation factors and tolerance statistics indicated no multicollinearity. Bootstrapping with a bias corrected and accelerated confidence interval was performed to counter potential heteroscedasticity indicated by the plotting of standardised residuals against predicted values (Field, 2013).

Ri.iii Finally, to further explore the effect of *PND severity* on *mother-offspring relationship quality*, multilevel modelling was used to account for correlations within the data reported by individuals. First, a *PND only model* was created. Second, a *Full model* was created controlling for all of the variables in the previous linear regression. Finally, a *selected model* was created by removing all variables from the *full model* with a non-significant effect ($p < 0.1$); this process was repeated until only significant predictors remained. A random intercept and slope was fitted, restricted maximum likelihood estimation was employed, and each model was subjected to bootstrapping with a bias corrected and accelerated confidence interval to counter the potential heteroscedasticity found in the previous linear regressions.

Rii) *Mothers who experienced PND will have lower quality relationships with their grandchildren from children whose births were associated with depression*

Rii.i Pearson chi-square tests were performed on the distributions of the nature of the impact the mother-offspring relationship has on grandmother-grandchild relations, split by whether the birth of the grandchild's parent was associated with PND.

Rii.i Pearson chi-square tests were performed on the distributions of reported relationship quality with grandchildren, split by whether the birth of the grandchildren's parent was associated with PND.

Fi) PND positively affects completed fertility

For details see Myers, Burger, and Johns (2016), also available in Appendix A.

Fii) The number of bouts of PND positively correlates with percentage of women continuing childbearing at each parity level

At a given parity, respondents were grouped by the number of *PND bouts* they had experienced prior to that parity and Pearson chi-square tests were performed on the percentage distributions of respondents who continued childbearing at each parity level by *PND history*.

Fiii) PND increases the likelihood of parity progression

For details see Myers, Burger, and Johns (2016), also available in Appendix A.

Fiv) Women with poor circumstances and PND at parity 1, whose circumstances improved at parity 2, will be more likely to progress to parity 3 then women with poor circumstances at parity 1 whose circumstances improved but who did not have PND

Fiv.i Women were first selected on the basis of their having a maternal circumstances score ≥ 2 at parity 1, indicating two or more poor category ratings (N = 154). A binary logistic regression model was then run with parity progression from parity 2 acting as the dependent variable, and whether maternal circumstances stayed the same/deteriorated or improved between parities 1 and 2 acting as a categorical predictor, while controlling for the demographic factors *age at second birth* and *year of mother's birth*.

Fiv.ii Next, from this sample women were further selected on the basis of their having a positive score when their maternal circumstances score at parity 2 was subtracted from their score at parity 1, indicating their circumstances improved (N = 83). A binary logistic regression model was then run with parity progression from parity 2 acting as the dependent variable, and PND incidence (EPDS) at parity 1acting as the predictor, while also controlling for the demographic factors age at second birth and year of mother's birth.

Fv) Interbirth intervals will be shorter following PND

Fv.i Cox regressions

Cox regressions were used to assess the proportional hazard of having a birth over time. Bereczkei, Hofer, and Ivan (2000) employ censoring to the right using cut-off of 120 months to indicate when a subsequent birth was deemed not to have occurred in their analysis of the effect of low birth weight on IBIs. Following this, *censored IBIs* were created in which missing values for those who did not have another birth were replaced by 7300 days (approximately 240 months, reflecting the longer IBIs in this sample). Yet this entails a broad interpretation of IBI in which mothers are always deemed to be in between births and results may be biased by factors causing women to cease entirely rather than delay reproducing. Thus *actual IBIs*, those ended by a birth event, were also analysed.

Multilevel Cox regressions were performed, with IBIs stratified by *birth order*. Whether or not PND occurred (*PND incidence*) at the birth at the beginning of the IBI was the variable of interest, and this was assessed alone (*PND only model*) and after controlling for the effects of demographic factors and other measures known to influence IBI (*Full model*): mother's *age at birth*, her *year of birth*, *SES*, the *duration of breastfeeding*, mother's *general tendency towards DAS*, the *emotional experience of birth*, *occurrence of birth complications*, *infant birth weight* and *health issues*, and the *level of support available from friends*, *family*, *mother*, and infant's *father*. While there were theoretical reasons to enter all of the covariates at once into the analysis, the results from the *full model* found the influence on IBI of numerous variables to be non-significant. Therefore, a *selected model* was created by removing all non-significant predictor variables (p <0.1) from the *full model*, with this process repeated until only significant predictors remained.

Fv.ii Multilevel analysis

To further explore the effect of PND on actual IBIs, multilevel linear regression models were used to account for correlations within the data reported by individuals. Due to issues potentially caused by a lack of normality in the previous IBIs (not an issue with Cox regressions but problematic for linear regressions) a further set were created in which the actual IBIs were subjected to a log transformation using base 10 (Field, 2013). Categorical variables with more than one category were split into binary dummy variables.

The same modelling approach was taken as used in the above Cox regressions, with the addition of *number of existing children* entered as a variable. This variable was added because parity strongly influenced IBI in the Cox regression models, and parity is a rough proxy of number of existing children a woman has. The data was hierarchically nested by individual woman and parity level. A mixed effects model was tested; however the addition of a random intercept caused the model not to converge and so the final models reported reflect population averaged or marginal models using restricted maximum likelihood estimation (SPSS, 2005).

Estimated marginal means for IBIs were computed, and differences assessed using univariate tests and the Sidak multiple tests adjustment when calculating significance (SPSS, 2005).

Fvi) Mothers who experienced PND will have more grandchildren

Fvi.i Mann-Whitney U tests were used to assess the difference in offspring fertility, measured as *number of grandchildren from a given offspring*, dependent on whether their birth was associated with PND. Offspring fertility was assessed both irrespective of sex and split by sex.

Fvi.ii To control for other factors which may influence offspring fertility, linear regression was performed on the same set of offspring, split by sex, with *number of grandchildren from a given offspring* as the dependent variable. *PND incidence* (EPDS) is first assessed alone (*PND only model*), then after the following variables are all controlled for (*Full model*) and after controlling for those retained via backwards entry (*Selected model*): *SES* during childhood, offspring's *birth weight*, offspring's *health issues in the first year*, *breastfeeding*, *mother-offspring relationship quality*, *level of paternal support* in offspring's first year, *year of offspring's birth*, and *mother's completed fertility*. Bias corrected accelerated bootstrapping was performed to improve robusticity (Field, 2013).

Ii) The incidence of PND will negatively correlate with age

Independent samples T-tests were performed to assess the impact of age (categorised as either ≤ 35 or > 35 years at giving birth) on PND symptom severity (EPDS score) at both parities 1 and 2.

Iii) The incidence of PND will positively correlate with increasing parity

Iii.i Linear regression was performed, with *PND severity* as the dependent variable whilst controlling for *parity* (1-4 only due to small sample size at 5-6) and other factors thought to potentially increase the risk of PND: *general tendency towards DAS*, *SES*, *level of support from family, friends,* offspring's *father* and own *mother*, *age at birth*, *infant birth weight*, *infant health issues*, the *occurrence of birth* complications, and *emotional experience of birth*. Bias corrected accelerated bootstrapping was performed to counter slight heteroscedasticity (Field, 2013).

Iii.ii To assess the relationship between PND likelihood as parity increases *within* women, as well as *between* women, a hierarchical multilevel generalised estimating equation (GEE) model was employed. A binary logistic model structure was used with *PND incidence* (actual diagnosis or *both* BPDS and EPDS) acting as the binary dependent variable, and the data was hierarchically nested by individual women using an independent correlation matrix structure to control for non-independent individual effects. The effect of increasing *parity* was assessed after controlling for *general tendency towards DAS*, *SES*, *level of support from family*, *friends*, offspring's *father* and own *mother*, *age at birth*, *infant birth weight*, *infant health issues*, the *occurrence of birth complications*, and *emotional experience of birth*.

Iiii) PND will be more likely in association with multiple births than single births

Birth events were categorised as either single or multiple, depending on how many infants were born, and Fisher's exact tests performed to test for differences in the percentage distribution of PND.

Iiv) PND will be more likely in association with male births than female births

The relationship between infant sex and PND was first assessed with a logistic regression model in which PND incidence acted as the dependent variable and infant sex as the predictor. Second, a hierarchical multilevel generalised estimating equation (GEE) model, which allowed for multilevel analysis of a binary dependent variable, was employed. PND incidence again acted as the dependent variable in a binary logistic model structure. The data was hierarchically nested by individual woman and the birth order of each of her birth events using an M-dependent correlation matrix structure to control for non-independent individual effects. Third, interaction effects between infant sex and factors which effect maternal investment decisions (Table 2.3) were added, first individually and then as a cumulative measure of maternal circumstance, after controlling for demographic factors (*mother's age at birth* and *year of birth*). Variables were centred before the interaction terms were created. The GEE has no standard absolute goodness-of-fit measure: results are reported in the form of coefficients, from which odds ratios are also calculated.

Further analysis

While the results from the previous analysis indicated the risk of PND was higher with male infants, there were no interactions between maternal circumstances and infant sex, leaving open the question as to the reason for this sex difference and so further analysis was required.

To assess the differential effects of PND risk factors by sex the sample of births was split into two groups depending on whether the resulting infant was male or female. A multilevel GEE model

Variable	Hypothesised Level of Investment Costs if Male
Maternal investment decision factor intrinsic to the mother/PND risk factor	
Emotional condition – general tendency towards depression, anxiety, and stress (DAS) symptoms	DASS score positively correlated with the costs of male infants
Maternal investment decision factor intrinsic to the infant	
Occurrence of birth complications	*High* – 'complications' *Low* – 'no complications'
Maternal investment decision factor extrinsic to the mother and infant/PND risk factor	
SES during childbearing years	*High* – 1 'professional' *Intermediate* – 2 'managerial and technical' *Low* – 3 'skilled non-manual – unskilled'
Social support – level of perceived support during pregnancy and offspring infancy received from her own mother was recorded on a Likert scale of 0 (*none*) to 5 (very *high*). Levels of perceived support from family, friends, and offspring father during the first year of life of each offspring were recorded on a scale of 1 (*very low*) to 5 (*very high*). These scores were then aggregated and assigned to the lowest ('low'), middle ('medium'), or highest ('high') third.	*High* – 'low' *Intermediate* – 'medium' *Low* – 'high'
Maternal investment decision factors/PND risk factors combined	
Maternal circumstance – a continuous measure of a mother's circumstance at a given birth, reflecting the number of high cost categories she was rated in. Scores were summed and assigned as follows: DASS – mild – extremely severe = 1, normal = 0; occurrence of birth complications – complications = 1, no complications = 0; SES – 3 = 2, 2 = 1, 1 = 0; Social support – low = 2, medium = 1, high = 0.	Score positively correlated with the costs of male infants

Table 2.3 Factors effecting maternal investment decisions used in assessing PND in relation to the Trivers-Willard hypothesis.

was then run on each group, in which PND incidence acted as the binary dependent variable, PND risk factors and birth complications acted as predictor variables, and demographic factors acted as controls. Differences between the resulting odds ratios from each group were then tested for. Continuous variables were centred and standardized to allow the odds ratios to be interpreted as effect sizes having removed the units and standardised the variance.

Results

Ri) Mothers who experienced PND will have lower quality relationships with the children with whom the depression was associated throughout their lives

Ri.i Mother-offspring relationship quality was lower when the offspring's birth was associated with PND (Table 2.4).

Ri.ii Linear regression analysis showed this relationship remained after controlling for other factors that influence relationship quality (Table 2.5); as PND severity increased mother-offspring relationship quality decreased.

Ri.iii Multilevel analysis showed this relationship remained after controlling for individual effects (Table 2.6); a woman's PND severity was negatively correlated with relationship quality when comparing between her births as well as across all births.

Rii) *Mothers who experienced PND will have lower quality relationships with their grandchildren from children whose births were associated with depression*

Rii.i The relationship a mother has with her offspring was less likely to have a positive impact on her relationship with her grandchildren from that offspring if the offspring's birth was associated with PND as measure by the BPDS and EPDS (Table 2.7): BPDS Fisher's exact test = 5.601, p = 0.053; EPDS Fisher's exact test = 5.846, p = 0.044; actual diagnosis Fisher's exact test = 0.235, p = 1.000.

PND Experience		PND Measure					
		BPDS		EPDS		Actual Diagnosis	
		Mean PAI score (SE) (*95% CI*)	**Mann-Whitney *p***	**Mean PAI score (SE) (*95% CI*)**	**Mann-Whitney *p***	**Mean PAI score (SE) (*95% CI*)**	**Mann-Whitney *p***
PND at birth	No	43.124 (0.226) (*42.685 – 43.575*)	**.003**	43.340 (0.240) (*42.867 – 43.812*)	**.000**	42.971 (0.224) (*42.530 – 43.411*)	**.021**
	Yes	40.989 (0.660) (*39.678 – 42.301*)		41.143 (0.469) (*40.215 – 42.070*)		41.173 (0.829) (*39.508 – 42.383*)	

Table 2.4 Mean PAI score dependent on PND experience (SE) (*95% CI*) and Mann-Whitney *p* (one-tailed) values for tests on the difference in PAI score dependent on experience.

Variable	**Unstandardised coefficients**	**Standardised coefficients**	**Bootstrap**		
	b	**β**	**SE**	***p***	**BCa 95% CI**
PND severity	**-0.182**	**-0.199**	**0.047**	**0.001**	**-0.275 – -0.092**
Age at birth	0.016	0.015	0.055	0.765	-0.089 – 0.121
Breastfeeding – no vs yes (ref)	-0.649	-0.037	0.745	0.387	-2.142 – 0.957
Current age of offspring	0.017	0.029	0.026	0.531	-0.033 – 0.065
Current depression – yes vs no (ref)	0.070	0.010	0.324	0.842	-0.599 – 0.646
Emotional experience of birth – mixed vs positive (ref)	0.102	0.008	0.511	0.844	-0.945 – 1.245
Emotional experience of birth – negative vs positive (ref)	1.721	0.079	0.976	**0.081**	-0.217 – 3.714
Infant birth weight – no vs yes (ref)	0.030	0.002	0.520	0.946	-1.058 – 1.178
Infant health issues – yes vs no (ref)	-1.041	-0.053	0.748	0.156	-2.518 – 0.422
General tendency towards DAS	-0.067	-0.176	0.016	**0.001**	-0.099 – -0.035
Occurrence of birth complications – minor complications vs no complications (ref)	1.386	0.119	0.458	**0.004**	0.516 – 2.243
Occurrence of birth complications – major complications vs no complications (ref)	1.516	0.078	0.734	**0.037**	0.117 – 2.772
SES – medium vs high (ref)	0.295	0.022	0.533	0.574	-0.772 – 1.486
SES – low vs high (ref)	1.885	0.101	0.845	**0.030**	0.242 – 3.617
Support from family – medium vs high (ref)	-0.495	-0.039	0.590	0.410	-1.622 – 0.594
Support from family – low vs high (ref)	-0.132	-0.011	0.797	0.877	-1.726 – 1.416
Support from father – medium vs high (ref)	-1.056	-0.081	0.542	**0.047**	-2.107 – 0.057
Support from father – low vs high (ref)	-0.098	-0.006	0.716	0.884	-1.596 – 1.350
Support from friends – medium vs high (ref)	-0.895	-0.078	0.485	**0.076**	-1.870 – 0.077
Support from friends – low vs high (ref)	-1.314	-0.097	0.691	**0.054**	-2.682 – 0.130
Support from mother – medium vs high (ref)	-1.198	-0.084	0.665	**0.063**	-2.682 – 0.130
Support from mother – low vs high (ref)	-1.152	-0.098	0.677	**0.098**	-2.466 – 0.172
Support from mother – none vs high (ref)	2.055	0.109	0.690	**0.003**	0.720 – 3.408
Constant	48.153		2.615	**0.001**	42.851 – 53.403

Table 2.5 Results of linear regression showing the effect of increasing PND severity (EPDS) on mother-child relationship (PAI), controlling for other factors. Bias corrected and accelerated bootstrap (BCa) based on 1000 samples. Adjusted R^2 0.160.

Variable		Estimate	Bootstrap				
						BCa 95% CI	
			Bias	SE	*p*	Lower	Upper
PND only model							
PND severity		**-0.165**	**0.017**	**0.046**	**0.001**	**-0.278**	**-0.005**
Intercept		44.180	-0.121	0.388	**0.001**	43.588	44.545
Full model							
PND severity		**-0.119**	**0.002**	**0.062**	**0.025**	**-0.244**	**0.010**
Age at birth (years)		0.041	0.028	0.056	0.452	-0.0876	0.248
Current age of offspring		0.016	0.003	0.025	0.430	-0.036	0.072
SES	High	0.061	-0.302	0.476	0.909	-0.592	0.122
	Medium	-	-	-	-	-	-
SES	High	-1.912	-0.424	0.747	**0.005**	-2.941	-1.731
	Low	-	-	-	-	-	-
General tendency towards DAS		-0.064	-0.005	0.018	**0.001**	-0.092	-0.047
Current depression	No	0.141	-0.147	0.584	0.755	-0.877	0.847
	Yes	-	-	-	-	-	-
Support from family	High	0.120	-0.355	0.759	0.894	-0.968	0.464
	Medium	-	-	-	-	-	-
Support from family	High	-0.247	-0.546	0.950	0.811	-1.457	-0.131
	Low	-	-	-	-	-	-
Support from father	High	0.898	-0.194	0.644	0.177	-0.194	1.554
	Medium	-	-	-	-	-	-
Support from father	High	0.036	-0.326	0.965	0.967	-1.546	0.961
	Low	-	-	-	-	-	-
Support from friends	High	0.914	-0.022	0.589	0.130	-0.240	1.994
	Medium	-	-	-	-	-	-
Support from friends	High	1.600	0.254	0.910	**0.083**	-0.519	4.059
	Low	-	-	-	-	-	-
Support from own mother	High	1.353	0.264	0.616	**0.010**	-0.172	3.431
	Medium	-	-	-	-	-	-
Support from own mother	High	1.277	0.374	0.731	**0.058**	-0.840	4.266
	Low	-	-	-	-	-	-
Support from own mother	High	-1.658	0.055	0.607	**0.001**	-2.950	-0.310
	None	-	-	-	-	-	-
Infant birth weight	Normal	0.152	-0.029	0.513	0.767	-0.782	1.036
	Abnormal	-	-	-	-	-	-
Infant health issues	No	0.346	-0.457	0.764	0.708	-0.725	0.505
	Yes	-	-	-	-	-	-
Breastfeeding	Yes	1.025	0.173	1.026	0.283	-0.918	3.579
	No	-	-	-	-	-	-

Table 2.6 Results of multilevel regression showing the effect of PND severity on mother-offspring relationship quality both between women and across a woman’s offspring, after controlling for other factors. Bias corrected and accelerated (BCa) bootstrap based on 1000 samples.

Variable			Bootstrap				
						BCa 95% CI	
		Estimate	Bias	SE	*p*	Lower	Upper
Full model continued							
Emotional experience of birth	Positive	-0.380	-0.273	0.574	0.563	-1.233	-0.069
	Mixed	-	-	-	-	-	-
Emotional experience of birth	Positive	-0.938	0.209	1.172	0.428	-3.402	2.127
	Negative	-	-	-	-	-	-
Occurrence of birth	None	-0.998	0.390	0.810	0.259	-3.361	1.594
	Minor	-	-	-	-	-	-
Occurrence of birth	None	-0.858	0.181	0.479	0.119	-2.017	0.695
	Major	-	-	-	-	-	-
Intercept		43.462	0.107	3.257	**0.001**	36.548	50.010
Selected model							
PND severity		**-0.077**	**0.006**	**0.055**	**0.089**	**-0.195**	**0.050**
General tendency towards DAS		-0.069	-0.000	0.017	**0.001**	-0.102	-0.039
Support from friends	High	0.862	-0.167	0.531	0.116	0.050	1.388
	Medium	-	-	-	-	-	-
Support from friends	High	1.478	0.124	0.802	**0.061**	-0.318	3.629
	Low	-	-	-	-	-	-
Support from own mother	High	1.533	0.055	0.510	**0.001**	0.552	2.637
	Medium	-	-	-	-	-	-
Support from own mother	High	1.139	0.016	0.483	**0.002**	0.116	2.200
	Low	-	-	-	-	-	-
Support from own mother	High	-1.412	-0.137	0.488	**0.001**	-2.208	-0.903
	None	-	-	-	-	-	-
Intercept		42.587	0.034	1.086	**0.001**	40.371	44.709

Table 2.6 (continued) Results of multilevel regression showing the effect of PND severity on mother-offspring relationship quality both between women and across a woman's offspring, after controlling for other factors. Bias corrected and accelerated (BCa) bootstrap based on 1000 samples.

Rii.ii Relationships with grandchildren were of lower emotional closeness when the birth of the grandchild's parent was associated with PND as measured by the BPDS and EPDS (Table 2.7): BPDS Pearson χ^2 (2, 197) = 12.381, p = 0.002; EPDS Pearson χ^2 (2, 197) = 5.590, p = 0.061; actual diagnosis Fisher's exact test = 1.441, p = 0.476.

PND measure	PND status	Emotional closeness with grandchildren (observed/expected)			Impact of mother-child relations on grandmother-grandchild relations (observed/expected)		
		Very close – close	Moderately close	Quite close – not at all	Very positive – positive	No impact	Negative – very negative
BPDS	No PND	120 / 115.1	27 / 25.5	15 / 21.4	138/134.0	21/23.0	3/4.9
	PND	20 / 24.9	4 / 5.5	11 / 4.6	25/29.0	7/5.0	3/1.1
EPDS	No PND	111/105.9	23/23.4	15/19.7	127/123.3	20/21.2	2/4.5
	PND	29/34.1	8/7.6	11/6.3	36/39.7	8/6.8	4/1.5
Actual diagnosis	No PND	128/126.5	28/28	22/23.5	147/147.3	25/25.3	6/5.4
	PND	12/13.5	3/3	4/2.5	16/15.7	3/2.7	0/0.6

Table 2.7 The distributions of relationship emotional closeness ratings split by PND experience.

Fi) PND positively affects completed fertility (results reproduced from Myers, Burger, and Johns (2016))

Respondents who experienced PND at least once did not have higher completed fertility than those who did not (Table 2.8). However, when PND experience at different parity levels (P1-P3) was assessed in isolation, respondents who experienced PND at their first birth had lower completed fertility compared to those who did not have PND after their first birth according to all measures of PND (BPDS p = 0.002; EPDS p = 0.004; actual diagnosis p = 0.017); those with PND at their second birth (measured by the EPDS p = 0.008) also had lower completed fertility, and; those with PND at their third birth (measured by the EPDS p = 0.053) had completed fertility which was lower at a likelihood marginally above significance.

PND Experience		**PND Measure**					
		BPDS		**EPDS**		**Actual Diagnosis**	
		Mean Offspring No. (SE) (*95% CI*)	**Mann-Whitney *p***	**Mean Offspring No. (SE) (*95% CI*)**	**Mann-Whitney *p***	**Mean Offspring No. (SE) (*95% CI*)**	**Mann-Whitney *p***
PND at least once	No	2.313 (.058) (*2.200 – 2.427*)	.104	2.280 (.062) (*2.158 – 2.401*)	.397	2.291 (.053) (*2.186 – 2.395*)	.297
	Yes	2.178 (.090) (*2.003 – 2.354*)		2.269 (.081) (*2.109 – 2.428*)		2.220 (.124) (*1.970 – 2.469*)	
PND at first birth	No	2.332 (.055) (*2.224 – 2.440*)	**.002**	2.347 (.058) (*2.232 – 2.462*)	**.004**	2.302 (.052) (*2.199 – 2.404*)	**.017**
	Yes	1.936 (.083) (*1.770 – 2.103*)		2.076 (.086) (*1.905 – 2.247*)		1.964 (.120) (*1.717 – 2.211*)	
PND at second birth	No	2.541 (.051) (*2.450 – 2.642*)	**.075**	2.567 (.054) (*2.461 – 2.673*)	**.008**	2.524 (.048) (*2.429 – 2.619*)	.164
	Yes	2.372 (.100) (*2.170 – 2.574*)		2.328 (.083) (*2.161 – 2.494*)		2.391 (.151) (*2.079 – 2.704*)	
PND at third birth	No	3.300 (.060) (*3.181 – 3.419*)	.596*	3.338 (.066) (*3.205 – 3.470*)	**.053**	3.311 (.061) (*3.191 – 3.431*)	.404*
	Yes	3.333 (.333) (*1.900 – 4.768*)		3.077 (.077) (*2.909 – 3.245*)		3.000 (na) (*na*)	

Table 2.8 Mean number offspring born dependent on PND experience (SE) (*95% CI*) and Mann-Whitney *p* (one-tailed) values for tests on the difference in completed fertility dependent on experience. *Exact test used due to small sample size. Table reproduced from Myers, Burger, and Johns (2016).

Fii) The number of bouts of PND positively correlates with percentage of women continuing childbearing at each parity level

As the number of previous bouts of PND increased there was a general trend for the percentage distributions of women continuing childbearing to decrease (Table 2.9); this trend was significant at parity 2 when measured by the EPDS (p = 0.032).

Parity/no. of PND bouts	BPDS - % continued childbearing (95% CI)	Pearson chi-square/Fisher's exact test *p*	EPDS - % continued childbearing (95% CI)	Pearson chi-square/Fisher's exact test *p*	Actual diagnosis - % continued childbearing (95% CI)	Pearson chi-square/Fisher's exact test *p*
Parity 1						
0	84.4 (80.0, 88.8)	χ^2 (1, N=296) = 1.913, *p* = 0.167	84.8 (80.7, 88.9)	χ^2 (1, N=294) = 1.270, *p* = 0.260	83.6 (79.2, 88.0)	Fisher's exact *p* = 0.792
1	76.1 (63.8, 88.4)		79.2 (74.6, 83.8)		82.1 (67.9, 96.3)	
Parity 2						
0	38.3 (31.4, 45.2)	χ^2 (2, N=246) = 4.027, *p* = 0.134	**39.6** (33.5, 45.7)	χ^2 (2, N=245) = 6.911, ***p* = 0.032**	37.3 (31.5, 43.1)	Fisher's exact = 4.306, *p* = 0.127
1	25.6 (11.9, 39.3)		**33.3** (27.4, 39.2)		38.1 (17.3, 58.9)	
2	21.1 (2.8, 39.4)		**16.7** (12.0, 21.4)		8.3 (-7.3, 23.9)	
Parity 3						
0	26.4 (16.2, 36.6)	Fisher's exact = 3.018, *p* = 0.429	24.6 (15.5, 33.7)	Fisher's exact = 1.003, *p* = 0.911	25.0 (15.3, 34.7)	Fisher's exact = 0.375, *p* = 1.000
1	0		23.5 (14.5, 32.5)		22.2 (-5.0, 49.4)	
2	20.0 (-15.1, 55.1)		0		0	
3	0		25.0 (15.8, 34.2)		na	
Parity 4						
0	11.1 (-3.4, 25.6)	Fisher's exact = 1.679, *p* = 1.000	7.7 (-4.0, 19.4)	Fisher's exact = 2.677, *p* = 0.589	10.5 (-3.28, 24.28)	Fisher's exact *p* = 1.000
1	0		20.0 (2.5, 37.5)		0	
2	na		0		na	
3	0		na		na	
4	na		0		na	
Parity 5						
0	50.0 (-19.3, 119.3)	na	100	Fisher's exact *p* = 1.000	50.0 (-19.3, 119.3)	na
1	na		na		na	
2	na		0		na	
3	na		na		na	
4	na		na		na	
5	na		na		na	

Table 2.9 Percentage of women who continued childbearing at a given parity dependent on PND history and the results of Pearson chi-square or Fisher's exact tests testing the hypothesis that PND reduces the percentage continuing.

Fiii) PND increases the likelihood of parity progression (results reproduced from Myers, Burger, and Johns (2016))

Fiii.i The direction of the effect of increasing *PND severity* at a given parity on progression from that parity was not consistent across levels (Table 2.10, Figure 2.1). The point estimate for the effect of increasing EPDS score at parity one was non-significant for each model but always negative. At parity two there was a significant negative effect in models with EPDS on its own and after controlling for demographic factors; the effect remained negative yet lost significance once

Model	Variable of interest		Parity 1				Parity 2				Parity 3			
			OR	AICc	R^2_{CS}	R^2_N	OR	AICc	R^2_{CS}	R^2_N	OR	AICc	R^2_{CS}	R^2_N
Hypothesis 2														
1 PND only	PND severity at birth *n*		0.963	256.691	0.007	0.012	**0.952****	316.376	0.021	0.029	0.967	97.510	0.005	0.008
2 Base	PND severity at birth *n*		0.976	233.031	0.110	0.189	**0.937****	303.230	0.104	0.143	0.947	97.487	0.102	0.155
3 Full	PND severity at birth *n*		1.000	250.032	0.177	0.305	**0.947***	324.978	0.174	0.237	1.066	128.112	0.316	0.479
4 Selected	PND severity at birth *n*		0.984	222.176	0.166	0.287	0.966	299.595	0.156	0.214	1.075	91.467	0.230	0.348
Hypothesis 3a														
1 PND only	PND history	Bouts x1	-	-	-	-	0.774	315.389	0.033	0.045	-	-	-	-
		Bouts x2	-	-	-	-	**0.290****				-	-	-	-
2 Base	PND history	Bouts x1	-	-	-	-	0.700	303.203	0.112	0.153	-	-	-	-
		Bouts x2	-	-	-	-	**0.240****				-	-	-	-
3 Full	PND history	Bouts x1	-	-	-	-	0.786	324.314	0.185	0.252	-	-	-	-
		Bouts x2	-	-	-	-	**0.256****				-	-	-	-
4 Selected	PND history	Bouts x1	-	-	-	-	0.791	297.538	0.148	0.203	-	-	-	-
		Bouts x2	-	-	-	-	**0.236****				-	-	-	-
Hypothesis 3b														
1 PND only	PND severity birth 1		-	-	-	-	**0.929****	312.404	0.037	0.051	0.999	97.952	0.000	0.000
2 Base	PND severity birth 1		-	-	-	-	**0.922****	300.635	0.114	0.156	0.995	98.264	0.094	0.143
3 Full	PND severity birth 1		-	-	-	-	**0.907****	321.328	0.195	0.266	0.965	135.991	0.317	0.481
4 Selected	PND severity birth 1		-	-	-	-	**0.915****	292.806	0.172	0.235	0.996	91.585	0.251	0.380
1 PND only	PND severity birth 2		-	-	-	-	-	-	-	-	0.978	97.648	0.003	0.005
2 Base	PND severity birth 2		-	-	-	-	-	-	-	-	0.979	98.070	0.096	0.146
3 Full	PND severity birth 2		-	-	-	-	-	-	-	-	1.029	135.991	0.317	0.481
4 Selected	PND severity birth 2		-	-	-	-	-	-	-	-	0.961	91.162	0.210	0.318

Table 2.10 Odds ratios (OR) for the effect of PND on parity progression across models testing *hypotheses 2-3b* (which equate to hypotheses *Fiii.i-iii* respectively). The PND only model contains only the PND measure listed under variable of interest, the Base model contains the additional variables age at birth, mother's year of birth and SES, the Full model contains all the additional variables listed in Table 1 of Myers, Burger, and Johns (2016), and the Selected model contains the variables retained after forward selection on the full set of variables after forcing the retention of PND and the Base model variables (see Appendix A for details). PND severity ORs reflect unstandardised results (for effect sizes see supplementary material). Akaike's information criterion with bias correction (AICc) shows the relative information loss across models at each parity, and Cox and Snell's (R^2_{CS}) and Nagelkerke's (R^2_N) pseudo R^2's estimate the variance captured by the models. ***p < .001, **p < .05, *p < .1. Reproduced from Myers, Burger, and Johns (2016).

more factors were controlled for. At parity three the negative effect found when EPDS was entered on its own and after controlling for demographic factors shifted to a positive effect once more factors were controlled for, although all results were non-significant. The full regression results for each model can be found in the supplementary material of Myers, Burger, and Johns (2016). AICc comparison shows the *selected model* to lose the least information at each parity level (Table 2.10).

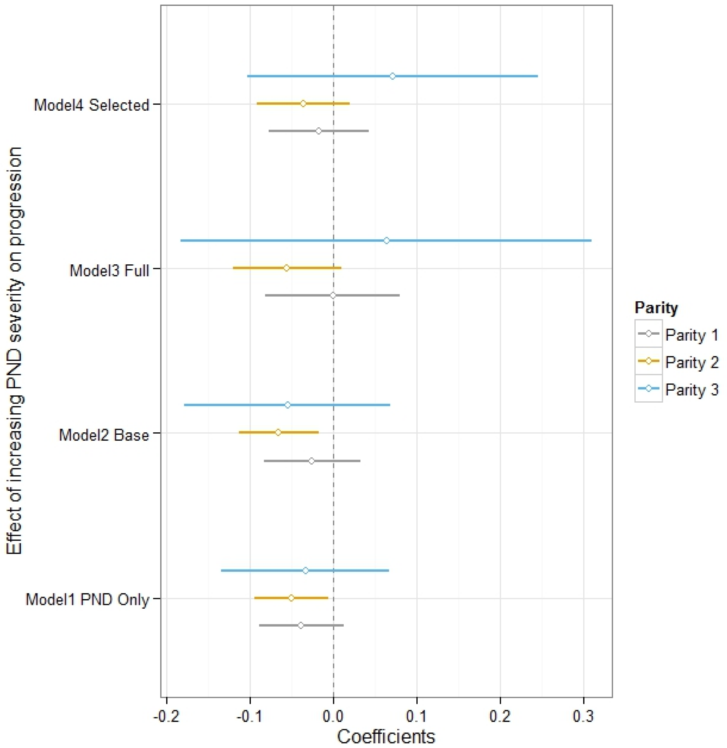

Figure 2.1 Coefficient plot of the effect of increasing PND severity at each parity on progression from that parity, across all models. Reproduced from Myers, Burger, and Johns (2016).

Moderation analysis found only two significant interactions ($p < 0.05$) in 60 possible interactions assessed (for full results of the moderation analysis see Myers, Burger, and Johns (2016) supplementary material). The significant interactions were between *PND severity* and having *support from the infant's father* (*low* vs. *high*) and *PND severity* and the respondent's *emotional experience of birth* (*mixed* vs. *positive*) at parity 2. Further, there was no significant interaction between the combined *maternal circumstances* variable and *PND severity*. The interaction between

PND severity and *father support* was significant ($p = 0.047$); separating women by level of support found that when women received *high support* the effect of increasing *PND severity* on parity progression had an odds ratio of 0.898 ($p = 0.000$), and when women received *low support* it was 1.063 ($p = 0.321$) (see Myers, Burger, and Johns (2016) supplementary material for full details). The interaction between *PND severity* and *emotional experience of birth* was significant ($p = 0.005$); in women with a *positive emotional experience* the effect of increasing *PND severity* had an odds ratio of 0.901 ($p = 0.001$), and when they had *mixed emotions* the odds ratio was 1.070 ($p = 0.204$).

Fiii.ii Increasing number of bouts, *PND history*, decreased the likelihood of progressing from parity 2 (Table 2.10); this was significant across all models. The full results for each regression model can be found in the supplementary material of Myers, Burger, and Johns (2016). AICc comparison shows the *selected model* to lose the least information (Table 2.10).

Fiii.iii Increasing *PND severity* at the first birth was associated with decreasing likelihood of progressing from parity 2 (Table 2.10, Figure 2.2); this effect was significant across all models. Increasing *PND severity at the first birth* was also associated with decreasing likelihood of progressing from parity 3 (Table 2.10); however this effect never reached significance. Increasing *PND severity at the second birth* was associated with decreasing likelihood of progressing from parity 3 in all but the *full model* (Table 2.10); again significance was not reached in any models. The full results for each regression model can be found in the supplementary material of Myers, Burger, and Johns (2016). AICc comparison shows the *selected model* to lose the least information at each parity level (Table 2.10).

Model comparison reproduced from Myers, Burger, and Johns (2016)

The effect of PND is found to be significant in various models at parity 2 across *hypotheses Fiii.i-iii*. Comparing the AICc's of the strongest model (the *selected models*) generated under each hypothesis at parity 2 shows the model containing *PND severity at birth one* (*hypothesis Fiii.iii*) to lose the least information (Table 2.10), followed by *PND history* (*hypothesis Fiii.ii*); AICc weights

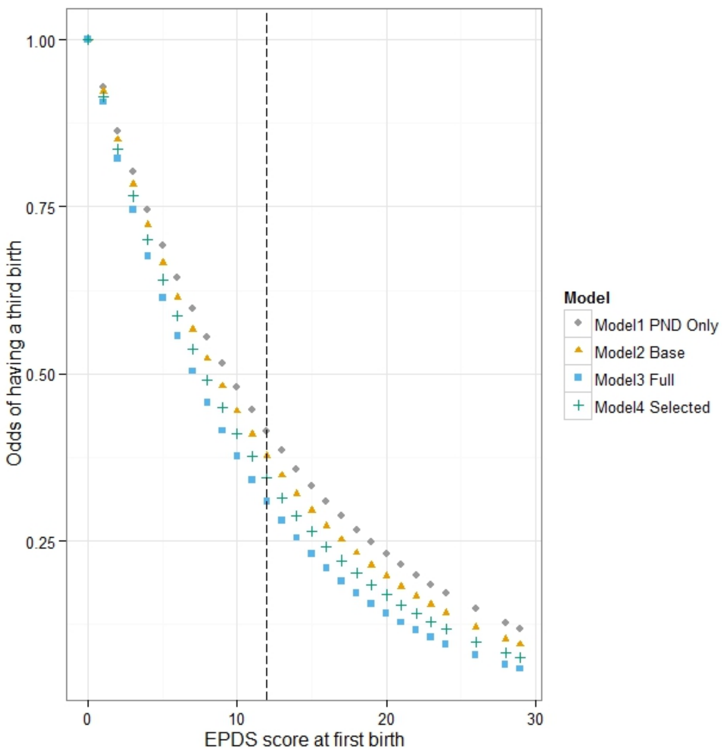

Figure 2.2 Odds of a third birth at parity 2 dependent on PND severity (EPDS score) at first birth across all models. The dashed vertical line indicates the cut-off for PND. Reproduced from Myers, Burger, and Johns (2016).

find there to be a probability of 0.863 that the *hypothesis Fiii.iii* model is the strongest (see Appendix A for full calculations). When only *PND severity at first birth* was entered at parity 2 it had an odds ratio of 0.929, falling to 0.915 after controlling for *age at birth*, *year of mother's birth*, *SES*, *occurrence of birth complications*, *breastfeeding*, and *support from friends* in the *selected model*. The negative effect of *PND severity at birth one* on progression from parity 2 is of a similar effect size to *age at birth*, and within the range of *minor birth complications* (Figure 2.3). Having *a bout of PND at both first and second birth* has the second largest effect size on progression from parity two, smaller yet within the range of *major birth complications* (Figure 2.3). The full list of effect sizes for all variables in each regression model can be found in the supplementary material of Myers, Burger, and Johns (2016).

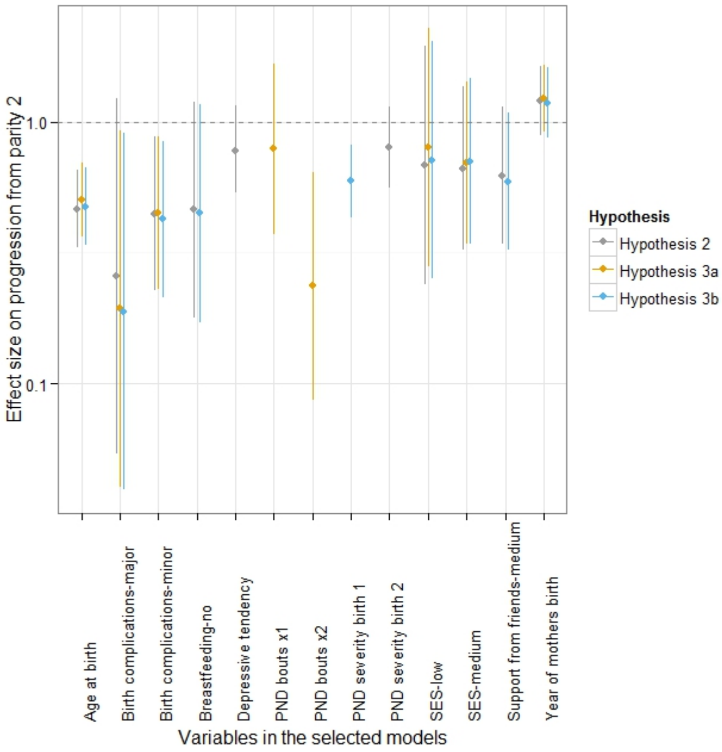

Figure 2.3 Odds ratio plot of standardised variables showing the relative effect sizes of the impact of variables in the selected models across *hypotheses 2-3b* (which equate to hypotheses *Fiii.i-iii* respectively) on progression from parity 2. Reproduced from Myers, Burger, and Johns (2016).

Fiv) *Women with poor circumstances and PND at parity 1, whose circumstances improved at parity 2, will be more likely to progress to parity 3 then women with poor circumstances at parity 1 whose circumstances improved but who did not have PND*

Fiv.i There was a trend for women whose circumstances improved between her first and second births to have increased odds of having a third birth (OR 2.010, p = 0.057) (Table 2.11).

Fiv.ii PND in association with a woman’s first birth reduced the odds of her having a third birth by 70% (OR 0.304, p = 0.029) (Table 2.11).

Variable		b	SE	Wald	df	p	Odds ratio	95% CI for odds ratio	
								Lower	Upper
Does circumstance improvement increase parity progression									
Did maternal circumstances improve?	**Yes**	**0.698**	**0.367**	**3.614**	**1**	**0.057**	**2.010**	**0.979**	**4.129**
	No (ref)	-	-	-	-	-	-	-	-
Age at birth (years)		-0.131	0.039	11.296	1	**0.001**	0.877	0.813	0.947
Year of mother's birth		0.011	0.023	0.236	1	0.627	1.011	0.967	1.057
Constant		-18.503	44.183	0.175	1	0.675	0.000	-	-
Does PND increase parity progression									
PND	**Yes**	**-1.190**	**0.546**	**4.752**	**1**	**0.029**	**0.304**	**0.104**	**0.887**
	No (ref)	-	-	-	-	-	-	-	-
Age at birth (years)		-0.164	0.057	8.374	1	**0.004**	0.849	0.760	0.949
Year of mother's birth		0.050	0.032	2.458	1	0.117	1.051	0.988	1.118
Constant		-91.885	61.519	2.231	1	0.135	0.000	-	-

Table 2.11 Results of binary logistic regression models assessing *Fiv.i* does improvement in maternal circumstance increase the likelihood of parity progression, and *Fiv.ii* does PND increase the likelihood of parity progression in women whose circumstances improve. Pseudo R^2: *Fiv.i* Cox and Snell 0.090, Nagelkerke 0.123; *Fiv.ii* Cox and Snell 0.154, Nagelkerke 0.207.

Fv) Interbirth intervals will be shorter following PND

Fv.i Cox regressions

PND reduced the proportional hazard of having a subsequent birth, increasing both censored and actual IBIs when controlling for factors which influence IBI and fertility (Table 2.12, Figure 2.4a-c). The *selected* models were the strongest, with AICc comparison showing them to lose the least information (Table 2.12); the proportional hazard of a subsequent birth decreased by a hazard ratio of 0.710 (p = 0.008) when censored IBIs were assessed, and by 0.761 (p = 0.042) when actual IBIs were assessed.

Fv.ii Multilevel modelling

PND was found to increase subsequent IBIs when controlling for individual effects in the *selected model* (p = 0.028) and in the *full model* at a level approaching significance (p = 0.083) (Table 2.13). The *selected model* found the estimated marginal mean IBI to be 141 days longer when the birth at the start of the interval was associated with PND (Table 2.14).

Variable		Censored IBIs							Actual IBIs						
						95% CI for HR							95% CI for HR		
		b	**SE**	***p***	**HR**	**Lower**	**Upper**	**Model AICc**	***b***	**SE**	***p***	**HR**	**Lower**	**Upper**	**Model AICc**
PND only model															
PND	**Yes**	**-0.356**	**0.128**	**0.005**	**0.701**	**0.545**	**0.900**	3642.494	**-0.214**	**0.130**	**0.101**	**0.808**	**0.626**	**1.043**	2980.869
	No (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
Full model															
PND	**Yes**	**-0.287**	**0.155**	**0.064**	**0.751**	**0.554**	**1.017**	3624.994	**-0.311**	**0.166**	**0.060**	**0.733**	**0.530**	**1.014**	3001.702
	No (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
Age at birth (years)		-0.065	0.012	0.000	0.937	0.916	0.959		0.037	0.015	0.011	1.038	1.009	1.069	
Year of mother's birth		0.001	0.008	0.929	1.001	0.986	1.016		0.007	0.008	0.401	1.007	0.991	1.023	
SES	1 (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
	2	0.119	0.137	0.384	1.127	0.861	1.473		0.121	0.140	0.389	1.129	0.857	1.486	
	3	-0.481	0.200	0.016	0.618	0.418	0.915		0.125	0.212	0.556	1.133	0.748	1.717	
Breastfeeding duration (months)	0 (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
	<3	0.395	0.237	0.096	1.484	0.932	2.362		-0.182	0.248	0.463	0.833	0.513	1.355	
	3-6	0.575	0.228	0.012	1.777	1.136	2.780		-0.371	0.243	0.127	0.690	0.429	1.110	
	6-9	0.536	0.226	0.018	1.710	1.098	2.662		-0.226	0.236	0.338	0.798	0.503	1.266	
	9-12	0.859	0.226	0.000	2.361	1.515	3.680		-0.001	0.237	0.998	0.999	0.628	1.591	
	>12	0.278	0.263	0.289	1.321	0.789	2.210		-0.589	0.280	0.035	0.555	0.321	0.960	
Emotional experience of birth	Positive (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
	Mixed	0.094	0.135	0.488	1.098	0.843	1.431		-0.083	0.141	0.553	0.920	0.698	1.212	
	Negative	-0.088	0.249	0.724	0.916	0.562	1.492		-0.373	0.258	0.147	0.689	0.416	1.141	
Support from family	High (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
	Medium	0.109	0.169	0.520	1.115	0.800	1.553		0.328	0.176	.062	1.388	0.983	1.959	
	Low	0.010	0.208	0.962	1.010	0.672	1.517		0.131	0.212	.535	1.140	0.753	1.727	

Table 2.12 Results of multilevel Cox regressions predicting the proportional hazard of a subsequent birth dependent of the experience of PND at the previous birth. HR = hazard ratio.

Variable		Censored IBIs							Actual IBIs						
						95% CI for HR		Model					95% CI for HR		Model
		b	**SE**	***p***	**HR**	**Lower**	**Upper**	**AICc**	***b***	**SE**	***p***	**HR**	**Lower**	**Upper**	**AICc**
Full model continued															
Support from the father	High (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
	Medium	-0.179	0.138	0.195	0.836	0.638	1.096		0.285	0.144	0.048	1.329	1.002	1.763	
	Low	0.248	0.172	0.151	1.281	0.914	1.796		0.412	0.186	0.027	1.510	1.049	2.172	
Support from friends	High (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
	Medium	-0.043	0.138	0.758	0.958	0.731	1.256		0.155	0.144	0.281	1.168	0.881	1.548	
	Low	0.055	0.163	0.738	1.056	0.767	1.453		0.174	0.173	0.313	1.190	0.849	1.669	
Support from own mother	High (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
	Medium	0.014	0.171	0.935	1.014	0.725	1.419		0.024	0.181	0.895	1.024	0.718	1.461	
	Low	0.040	0.187	0.829	1.041	0.721	1.503		-0.108	0.190	0.568	0.897	0.619	1.302	
	None	-0.306	0.217	0.159	0.737	0.482	1.127		0.072	0.227	0.751	1.075	0.689	1.675	
Occurrence of birth complications	None (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
	Minor	-0.033	0.213	0.876	0.967	0.637	1.468		-0.087	0.228	0.704	0.917	0.587	1.433	
	Major	-0.300	0.125	0.017	0.741	0.580	0.948		-0.073	0.130	0.575	0.930	0.720	1.200	
Infant birth weight	Normal (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
	Abnormal	-0.019	0.136	0.889	0.981	0.752	1.281		0.204	0.139	0.141	1.227	0.934	1.611	
Infant health issues	No (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
	Yes	0.144	0.209	0.489	1.155	0.767	1.739		0.252	0.213	0.235	1.287	.848	1.952	
Tendency towards DAS		-0.003	0.004	0.446	0.997	0.989	1.005		0.001	0.005	0.904	1.001	.992	1.010	

Table 2.12 (continued) Results of multilevel Cox regressions predicting the proportional hazard of a subsequent birth dependent of the experience of PND at the previous birth. HR = hazard ratio.

Variable		Censored IBIs							Actual IBIs						
						95% CI for HR							95% CI for HR		
		b	**SE**	***p***	**HR**	**Lower**	**Upper**	**Model AICc**	***b***	**SE**	***p***	**HR**	**Lower**	**Upper**	**Model AICc**
Selected model															
PND	**Yes**	**-.342**	**.129**	**.008**	**.710**	**.551**	**.915**	3604.401	**-.273**	**.134**	**.042**	**.761**	**.585**	**.991**	2976.862
	No (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
Age at birth (years)		-.070	.011	**.000**	.932	.912	.953		.028	.013	**.028**	1.028	1.003	1.054	
SES	1 (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
	2	.147	.132	.263	1.159	.895	1.500		-	-	-	-	-	-	
	3	-.431	.184	**.020**	.650	.453	.933		-	-	-	-	-	-	
Breastfeeding duration (months)	0 (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
	<3	.324	.220	.141	1.382	.898	2.127		-	-	-	-	-	-	
	3-6	.513	.211	**.015**	1.670	1.105	2.524		-	-	-	-	-	-	
	6-9	.523	.201	**.009**	1.687	1.136	2.503		-	-	-	-	-	-	
	9-12	.767	.203	**.000**	2.153	1.446	3.204		-	-	-	-	-	-	
	>12	.287	.246	.242	1.333	.823	2.158		-	-	-	-	-	-	
Support from the father	High (ref)	-	-	-	-	-	-		-	-	-	-	-	-	
	Medium	-	-	-	-	-	-		.283	.131	**.031**	1.327	1.027	1.715	
	Low	-	-	-	-	-	-		.363	.163	**.026**	1.438	1.045	1.977	

Table 2.12 (continued) Results of multilevel Cox regressions predicting the proportional hazard of a subsequent birth dependent of the experience of PND at the previous birth. HR = hazard ratio.

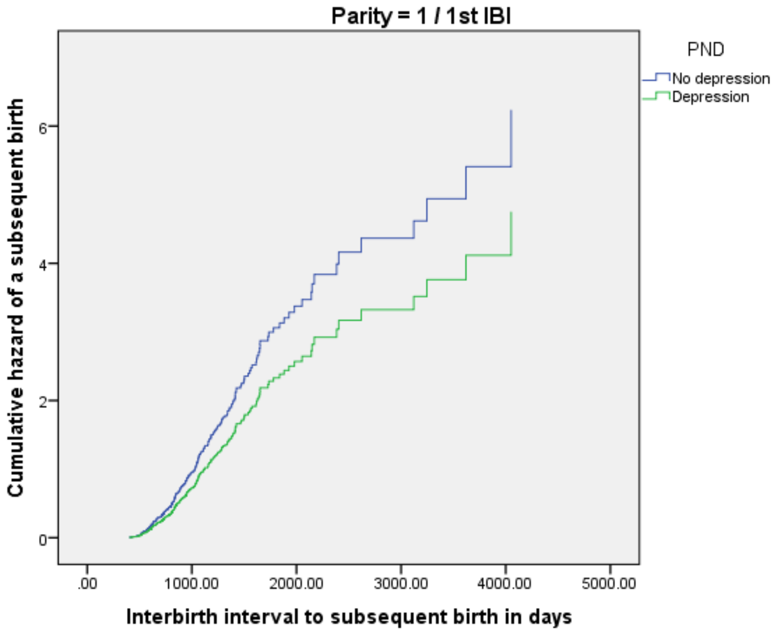

Figure 2.4a Graph derived from the *selected* Cox regression model showing the cumulative proportional hazard of women having a second birth dependent on PND experience at their first birth, based on actual IBIs.

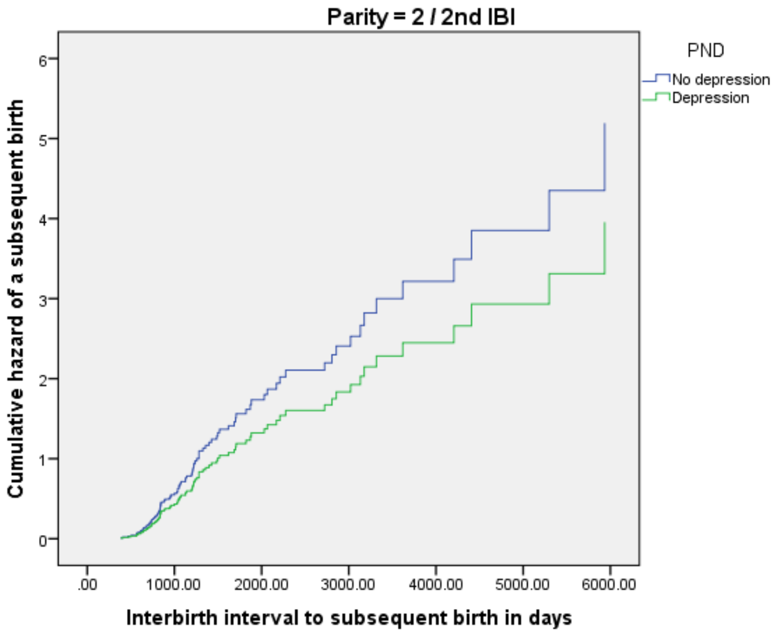

Figure 2.4b Graph derived from the *selected* Cox regression model showing the cumulative proportional hazard of women having a third birth dependent on PND experience at their second birth, based on actual IBIs.

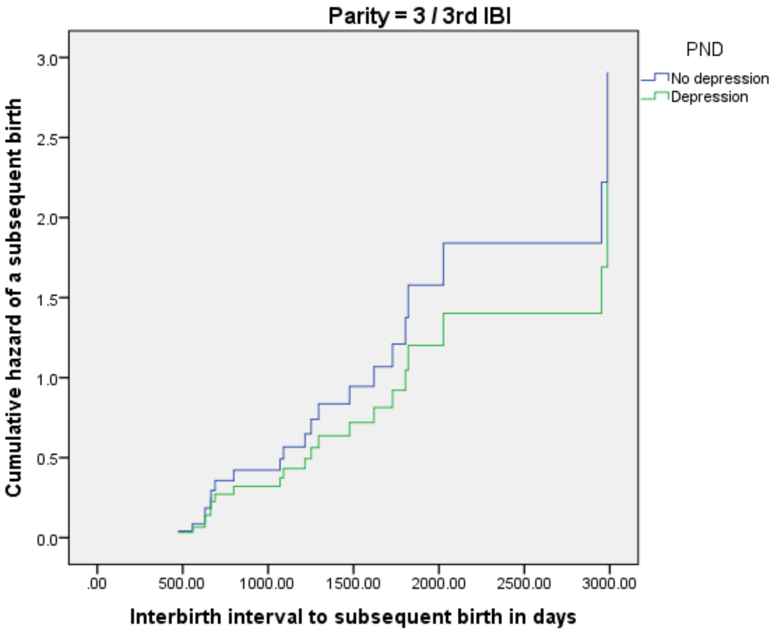

Figure 2.4c Graph derived from the *selected* Cox regression model showing the cumulative proportional hazard of women having a fourth birth dependent on PND experience at their third birth, based on actual IBIs.

Variable		Estimate	SE	df	t	*p*	95% CI	
							Lower	Upper
PND only model								
PND	**No**	**-0.033**	**0.025**	**309.899**	**-1.286**	**0.199**	**-0.082**	**0.017**
	Yes	-	-	-	-	-	-	-
Intercept		3.019	0.022	296.832	135.504	**0.000**	2.975	3.063
Full model								
PND	**No**	**-0.056**	**0.032**	**292.094**	**-1.737**	**0.083**	**-0.120**	**0.007**
	Yes	-	-	-	-	-	-	-
Age at birth (years)		-0.005	0.003	306.725	-1.768	**0.078**	-0.010	0.001
Year of mother's birth		-0.001	0.002	319.841	-0.425	0.671	-0.004	0.002
Number of existing children		0.079	0.022	46.999	3.659	**0.001**	0.036	0.123
SES professional vs managerial and technical	1	-0.025	0.027	312.141	-0.927	0.355	-0.079	0.028
	2	-	-	-	-	-	-	-
SES professional vs skilled non-manual - unskilled	1	0.005	0.040	301.851	0.117	0.907	-0.074	0.083
	3	-	-	-	-	-	-	-
Breastfeeding duration		0.008	0.008	302.184	0.994	0.321	-0.008	0.024
Emotional experience of birth positive vs mixed	Positive	-0.001	0.026	293.638	-0.031	0.975	-0.052	0.051
	Mixed	-	-	-	-	-	-	-
Emotional experience of birth positive vs negative	Positive	0.060	0.049	290.826	1.231	0.219	-0.036	0.155
	Negative	-	-	-	-	-	-	-
Support from family high vs medium	High	-0.032	0.033	320.496	-0.965	0.335	-0.096	0.033
	Medium	-	-	-	-	-	-	-
Support from family high vs low	High	-0.014	0.041	309.511	-0.341	0.734	-0.095	0.067
	Low	-	-	-	-	-	-	-
Support from the father high vs medium	High	-0.049	0.028	318.970	-1.728	**0.085**	-0.105	0.007
	Medium	-	-	-	-	-	-	-

Table 2.13 Results of multilevel population averaged models assessing the effect of PND incidence (EPDS) on IBI after controlling for various measures.

Variable		Estimate	SE	df	t	*p*	95% CI	
							Lower	Upper
Full model continued								
Support from the father high vs low	High	-0.076	0.035	316.500	-2.191	**0.029**	-0.145	-0.008
	Low	-	-	-	-	-	-	-
Support from friends high vs medium	High	-0.019	0.027	316.451	-0.713	0.476	-0.073	0.034
	Medium	-	-	-	-	-	-	-
Support from friends high vs low	High	-0.036	0.035	309.909	-1.018	0.310	-0.104	0.033
	Low	-	-	-	-	-	-	-
Support from own mother high vs medium	High	0.006	0.035	309.893	0.183	0.855	-0.063	0.076
	Medium	-	-	-	-	-	-	-
Support from own mother high vs low	High	0.001	0.037	314.894	0.030	0.976	-0.071	0.073
	Low	-	-	-	-	-	-	-
Support from own mother high vs none	High	-0.027	0.045	304.342	-0.602	0.548	-0.114	0.061
	None	-	-	-	-	-	-	-
Birth complications none vs minor	None	0.018	0.041	268.441	0.436	0.663	-0.063	0.098
	Minor	-	-	-	-	-	-	-
Birth complications none vs major	None	0.007	0.025	304.305	0.277	0.782	-0.042	0.056
	Major	-	-	-	-	-	-	-
Infant birth weight	Normal	0.041	0.026	303.012	1.585	0.114	-0.010	0.092
	Abnormal	-	-	-	-	-	-	-
Infant health issues	No	0.029	0.041	321.513	0.715	0.475	-0.051	0.109
	Yes	-	-	-	-	-	-	-
Tendency towards DAS		0.000	0.001	286.245	0.143	0.886	-0.002	0.002
Intercept		4.332	2.978	320.107	1.455	0.147	-1.526	10.191

Table 2.13 (continued) Results of multilevel population averaged models assessing the effect of PND incidence (EPDS) on IBI after controlling for various measures.

Variable		Estimate	SE	df	t	*p*	95% CI	
							Lower Bound	Upper Bound
Selected model								
PND	**No**	**-0.057**	**0.026**	**302.365**	**-2.212**	**0.028**	**-0.108**	**-0.006**
	Yes	-	-	-	-	-	-	-
Age at birth (years)		-0.003	0.002	327.325	-1.410	0.159	-0.008	0.001
Number of existing children		0.083	0.020	68.924	4.056	**0.000**	0.042	0.123
Support from the father high vs medium	High	-0.055	0.026	345.259	-2.097	**0.037**	-0.107	-0.003
	Medium	-	-	-	-	-	-	-
Support from the father high vs low	High	-0.079	0.032	348.165	-2.452	**0.015**	-0.142	-0.016
	Low	-	-	-	-	-	-	-
Intercept		3.096	0.069	325.513	45.142	**0.000**	2.961	3.231

Table 2.13 (continued) Results of multilevel population averaged models assessing the effect of PND incidence (EPDS) on IBI after controlling for various measures.

(I) PND	(J) PND	Mean Difference (I-J)	SE	df	*p*	95% CI for Difference Lower	95% CI for Difference Upper	Estimated marginal mean IBI (days)
No PND	PND	-0.057	0.026	302.365	**0.028**	-0.108	-0.006	986.27949
PND	No PND	0.057	0.026	302.365	**0.028**	0.006	0.108	1127.1975

Table 2.14 Differences in IBI estimated marginal means split by PND incidence (*selected model*) using the Sidak adjustment for multiple comparisons.

PND measure	Mean no. offspring born to offspring aged 40 years or over (95% CI)								
	All offspring			Female offspring			Male offspring		
	No PND	**PND**	**Mann-Whitney *p***	**No PND**	**PND**	**Mann-Whitney *p***	**No PND**	**PND**	**Mann-Whitney *p***
BPDS	1.670 (1.440 – 1.901)	2.177 (1.541 – 2.812)	**0.087**	1.791 (1.487 – 2.097)	1.667 (0.725 – 2.608)	0.828	1.535 (1.177 – 1.893)	2.750 (1.885 – 3.615)	**0.009**
EPDS	1.682 (1.454 – 1.911)	2.191 (1.604 – 2.777)	**0.059**	1.826 (1.544 – 2.108)	1.700 (0.631 – 2.769)	0.814	1.513 (1.135 – 1.891)	2.636 (2.015 – 3.257)	**0.004**
Actual diagnosis	1.743 (1.516 – 1.969)	1.857 (0.868 – 2.846)	0.736	1.796 (1.504 – 2.089)	1.333 (-1.535 – 4.202)	0.465	1.681 (1.318 – 2.044)	2.250 (0.727 – 3.774)	0.294

Table 2.15 Mean number of grandchildren born to offspring aged 40 years or over dependent on whether their birth was associated with PND and results of Mann-Whitney U tests assessing the difference.

Variables	**Male offspring fertility**					**Variable**	**Female offspring fertility**				
	b	**SE**	***β***	***p***	**95% CI for *b***		***b***	**SE**	***β***	***p***	**95% CI for *b***
PND only model						***PND only***					
PND – yes vs. no (ref)	**1.124**	**0.383**	**0.390**	**0.005**	**0.354 – 1.893**	**PND – yes vs. no (ref)**	**-0.126**	**0.370**	**-0.046**	**0.735**	**-0.868 – 0.616**
Constant	1.513	0.179		**0.000**	1.152 – 1.874	Constant	1.826	0.156		**0.000**	1.513 – 2.140
Full model						***Full model***					
PND – yes vs. no (ref)	**0.775**	**0.446**	**0.257**	**0.114**	**-0.191 – 1.701**	**PND – yes vs. no (ref)**	**-0.489**	**0.445**	**-0.184**	**0.278**	**-1.386 – 0.409**
Abnormal birth weight	0.667	0.401	0.258	0.105	-0.105 – 1.481	Abnormal birth weight	0.076	0.388	0.030	0.846	-0.706 – 0.858
Infant health issues	-0.107	0.548	-0.031	0.874	-1.220 – 1.007	Infant health issues	0.226	0.581	0.063	0.699	-0.946 – 1.398
Not breastfeeding	-0.164	0.366	-0.066	0.657	-0.907 – 0.579	Not breastfeeding	-0.073	0.349	-0.034	0.835	-0.778 – 0.632
Increasing relationship quality	-0.084	0.036	-0.373	**0.027**	-0.157 – -0.010	Increasing relationship quality	-0.008	0.028	-0.048	0.778	-0.063 – 0.048
SES – medium vs high (ref)	0.227	0.545	0.070	0.679	-0.880 – 1.334	SES – medium vs high (ref)	-0.226	0.442	-0.082	0.611	-1.118 – 0.665
SES – low vs high (ref)	-0.406	0.475	-0.132	0.400	-1.372 – 0.561	SES – low vs high (ref)	0.349	0.555	0.106	0.533	-0.770 – 1.467
Paternal support – medium vs high (ref)	-0.442	0.426	-0.181	0.307	-1.307 – 0.423	Paternal support – medium vs high (ref)	0.222	0.392	0.103	0.574	-0.568 – 1.013
Paternal support – low vs high (ref)	-0.212	0.524	-0.065	0.688	-1.278 – 0.853	Paternal support – low vs high (ref)	0.634	0.480	0.263	0.194	-0.334 – 1.062
Year of offspring's birth	-0.013	0.046	-0.049	0.775	-0.106 – 0.080	Year of offspring's birth	0.036	0.045	0.140	0.420	-0.054 – 0.127
Increasing completed fertility of mother	-0.127	0.288	-0.090	0.663	-0.713 – 0.459	Increasing completed fertility of mother	0.195	0.275	0.125	0.483	-0.360 – 0.750
Constant	30.787	90.646		0.736	-153.429 – 215.002	Constant	-70.108	88.572		0.433	-248.731 – 108.514
Selected model						***Selected model***					
PND – yes vs. no (ref)	**0.795**	**0.390**	**0.271**	**0.048**	**0.008 – 1.581**	Paternal support – low vs high (ref)	0.694	0.328	0.275	**0.059**	0.038 – 1.350
Abnormal birth weight	0.746	0.341	0.288	**0.034**	0.057 – 1.435	Constant	1.845	0.142		**0.000**	1.561 – 2.219
Increasing relationship quality	-0.074	0.030	-0.328	**0.018**	-0.134 – -0.013						
Constant	3.693	1.326		**0.008**	1.018 – 6.369						

Table 2.16 Results of linear regression modelling of the fertility of offspring aged 40 years or over, split by sex. Adjusted R^2's: PND only model – male 0.135, female -0.016; Full model – male 0.152, female -0.065; Selected model – male 0.229, female 0.048.

Fvi) Mothers who experienced PND will have more grandchildren

Fvi.i There was a trend for fertility of offspring aged 40 years and over to be higher when their birth was associated with PND (Table 2.15); analysis of differences between the sexes showed that this effect was driven by increased fertility among males whose mothers had PND after their birth.

Fvi.ii This effect remained after controlling for other factors known to influence fertility (Table 2.16); *selected models* found male fertility to be increased by PND after their birth, non-normal birth weight, and poorer relationship quality with their mothers, whilst female fertility was not predicted by PND and only low paternal support in their first year (i.e. their father was less involved) was retained, predicting higher fertility.

Ii) The incidence of PND will negatively correlate with age

Women over the age of 35 at the time of their first birth had higher PND symptom severity (mean EPDS score = 10.193) than women aged 35 and under (mean EPDS score = 8.526), but the difference was not significant ($p = 0.134$). There was no difference ($p = 0.898$) between the PND symptom severity of women over the age of 35 at their second birth and women aged 35 and under (mean EPDS score = 7.825 vs. 7.684).

Iii) The incidence of PND will positively correlate with increasing parity

Iii.i Linear regressions showed a trend towards PND severity decreasing as parity increased; however, this effect approached but did not reach significance (BCa $p = 0.137$) (Table 2.17).

Iii.ii Multilevel modelling showed no relationship between a woman's parity level and her likelihood of PND (Table 2.18).

Iiii) PND will be more likely in association with multiple births than single births

While the percentage distributions of PND for all but the actual diagnosis measure were higher for multiple births than singleton births (Table 2.19) the difference was not significant; BPDS p =

Variable		**Bootstrap**				
					BCa 95% CI	
	b	**Bias**	**SE**	***p***	**Lower**	**Upper**
Parity	**-0.411**	**0.006**	**0.266**	**0.137**	**-0.972**	**0.149**
Age in years at birth	0.083	-0.002	0.045	**0.066**	-0.004	0.165
Emotional experience of birth – mixed vs positive (ref)	2.993	0.013	0.441	**0.001**	2.072	3.847
Emotional experience of birth – negative vs positive (ref)	6.018	-0.047	1.078	**0.001**	3.988	8.036
Infant birth weight – no vs yes (ref)	-0.824	0.022	0.424	**0.047**	-1.700	0.109
Infant health issues – yes vs no (ref)	0.969	-0.032	0.788	0.221	-0.571	2.431
General tendency towards DAS	0.170	0.000	0.013	**0.001**	0.144	0.196
Occurrence of birth complications – minor complications vs no complications (ref)	0.423	0.029	0.398	0.289	-0.386	1.245
Occurrence of birth complications – major complications vs no complications (ref)	-0.900	0.035	0.824	0.275	-2.574	0.862
SES – medium vs high (ref)	0.900	-0.026	0.430	**0.041**	0.103	1.705
SES – low vs high (ref)	2.414	-0.014	0.841	**0.004**	0.840	4.101
Support from family – medium vs high (ref)	-0.559	0.016	0.580	0.329	-1.741	0.642
Support from family – low vs high (ref)	-0.725	0.006	0.697	0.306	-2.112	0.653
Support from father – medium vs high (ref)	1.079	0.013	0.454	**0.022**	0.177	2.060
Support from father – low vs high (ref)	2.985	0.034	0.642	**0.001**	1.523	4.315
Support from friends – medium vs high (ref)	1.125	0.001	0.408	**0.004**	0.370	1.975
Support from friends – low vs high (ref)	1.937	0.011	0.615	**0.005**	0.780	3.174
Support from mother – medium vs high (ref)	0.458	-0.015	0.599	0.455	-0.712	1.595
Support from mother – low vs high (ref)	-0.257	-0.009	0.634	0.654	-1.499	0.960
Support from mother – none vs high (ref)	1.027	0.011	0.646	0.125	-0.221	2.335
(Constant)	5.433	0.068	1.715	**0.002**	2.204	8.965

Table 2.17 Results of linear regression assessing the effect of increasing parity on PND severity, after controlling for other PND risk factors. Bias corrected accelerated bootstrapping based on 1000 samples.

0.479 one-tailed, EPDS p = 0.489 one-tailed, actual diagnosis p = 0.397 one-tailed, actual diagnosis or *both* BPDS and EPDS p = 0.436 one-tailed.

Variable				**95% Wald CI**		**Hypothesis Test**		
		b	**SE**	**Lower**	**Upper**	**Wald Chi-Square**	**df**	***p***
(Intercept)		23.925	37.870	-50.300	98.149	0.399	1	0.528
Parity		**-0.037**	**0.202**	**-0.433**	**0.359**	**0.033**	**1**	**0.855**
Age at birth		0.022	0.037	-0.050	0.094	0.356	1	0.551
Infant birth weight	Abnormal	-1.006	0.382	-1.754	-0.258	6.942	1	**0.008**
	Normal (ref)	-	-	-	-	-	-	-
Infant health issues	Yes	0.383	0.470	-0.538	1.304	0.665	1	0.415
	No (ref)	-	-	-	-	-	-	-
Emotional experience of birth	Negative	2.273	0.481	1.330	3.216	22.320	1	**0.000**
	Mixed	1.314	0.334	0.659	1.970	15.454	1	**0.000**
	Positive (ref)	-	-	-	-	-	-	-
General tendency towards DAS		0.056	0.011	0.035	0.077	28.334	1	**0.000**
Occurrence of birth complications	No complications	0.598	0.573	-0.525	1.721	1.088	1	0.297
	Minor complications	0.695	0.525	-0.333	1.724	1.756	1	0.185
	Major complications (ref)	-	-	-	-	-	-	-
SES	Low	1.627	0.423	0.798	2.455	14.808	1	**0.000**
	Medium	0.474	0.410	-0.329	1.277	1.337	1	0.248
	High (ref)	-	-	-	-	-	-	-
Support from family	Low	0.227	0.566	-0.882	1.335	0.161	1	0.689
	Medium	-0.313	0.551	-1.392	0.767	0.322	1	0.570
	High (ref)	-	-	-	-	-	-	-
Support from father	Low	0.559	0.421	-0.267	1.385	1.761	1	0.185
	Medium	0.321	0.339	-0.344	0.986	0.895	1	0.344
	High (ref)	-	-	-	-	-	-	-
Support from friends	Low	0.832	0.442	-0.034	1.699	3.543	1	**0.060**
	Medium	0.471	0.409	-0.331	1.273	1.324	1	0.250
	High (ref)	-	-	-	-	-	-	-
Support from mother	None	0.824	0.666	-0.481	2.130	1.532	1	0.216
	Low	-0.081	0.633	-1.322	1.161	0.016	1	0.899
	Medium	0.020	0.596	-1.147	1.187	0.001	1	0.973
	High (ref)	-	-	-	-	-	-	-
Year of mother's birth		-0.015	0.019	-0.054	0.023	0.631	1	0.427
(Scale)		1						

Table 2.18 Results of multilevel GEE modelling with a binary logistic structure assessing the effect of increasing parity on PND incidence, after controlling for other PND risk factors.

Measure	Percentage of PND by birth type	
	Single (N = 664*)	Multiple (N = 11)
BPDS	14.0	18.2
EPDS	22.7	27.3
Actual diagnosis	8.0	0.0
Actual diagnosis or *both* BPDS & EPDS	13.1	18.2

Table 2.19 The percentage distributions of PND by birth type. *EPDS N = 661, combined measure N = 673.

Iiv) PND will be more likely in association with male births than female births

Binary logistic regression analysis found the birth of male infants to increase the odds of PND by 68% (OR 1.678, p = 0.028) (Table 2.20). After controlling for individual effects of the mother the birth of male infants increased the odds of PND by 47% (OR 1.467, p = 0.059) (Table 2.21). However, infant sex was found to not interact with factors that should influence maternal investment decisions, both when assessed individually or as a cumulative measure (Table 2.22).

Variable						95% CI for OR	
		b	**SE**	***p***	**OR**	**Lower**	**Upper**
Infant sex	**Male**	**0.518**	**0.235**	**0.028**	**1.678**	**1.058**	**2.662**
	Female (ref)	-	-	-	-	-	-
Constant		-2.170	0.184	0.000	0.114	-	-

Table 2.20 Results of binary logistic regression assessing the effect of infant sex on PND incidence. OR = odds ratio. Pseudo R2's: Cox & Snell 0.007; Nagelkerke 0.014.

Variable				95% Wald CI		Hypothesis Test			
		b	**SE**	**Lower**	**Upper**	**Wald Chi-Square**	**df**	***p***	**OR**
Infant sex	**Male**	**0.383**	**0.203**	**-0.015**	**0.781**	**3.561**	**1.000**	**0.059**	**1.467**
	Female (ref)	-	-	-	-	-	-	-	-
(Intercept)		-2.076	0.188	-2.444	-1.708	122.366	1.000	0.000	0.125
(Scale)		1.000							

Table 2.21 Multilevel GEE results assessing relationship between infant sex and PND incidence. OR = odds ratio.

Variable		b	SE	95% Wald CI Lower	95% Wald CI Upper	Hypothesis Test Wald Chi-Square	df	p	OR
Maternal investment decision factor/PND risk factor individually									
Infant sex	Female	-0.394	0.290	-0.962	0.173	1.853	1.000	0.173	0.674
	Male (ref)	-	-	-	-	-	-	-	-
Age at birth (years)		0.007	0.028	-0.048	0.061	0.054	1.000	0.816	1.007
Year of mother's birth		0.000	0.019	-0.037	0.037	0.000	1.000	0.990	1.000
General tendency towards DAS		0.054	0.010	0.035	0.073	31.352	1.000	0.000	1.056
Infant sex – general tendency towards DAS interaction		**-0.014**	**0.018**	**-0.048**	**0.020**	**0.629**	**1.000**	**0.428**	**0.986**
Occurrence of birth complications	None (ref)	-0.410	0.266	-0.931	0.110	2.388	1.000	0.122	0.663
	Complications	-	-	-	-	-	-	-	-
Infant sex - occurrence of birth complications interaction		**0.835**	**0.571**	**-0.284**	**1.953**	**2.140**	**1.000**	**0.143**	**2.304**
Increasing SES		-0.578	0.212	-0.993	-0.164	7.468	1.000	0.006	0.561
Infant sex - SES interaction		**0.345**	**0.358**	**-0.356**	**1.047**	**0.932**	**1.000**	**0.334**	**1.413**
Increasing social support		-0.841	0.251	-1.333	-0.349	11.217	1.000	0.001	0.431
Infant sex - social support interaction		**-0.279**	**0.409**	**-1.080**	**0.523**	**0.464**	**1.000**	**0.496**	**0.757**
(Intercept)		-2.352	0.174	-2.693	-2.011	182.785	1.000	0.000	0.095
(Scale)		1.000							
Maternal investment decision factor/PND risk factor combined									
Infant sex	Female	-0.329	0.265	-0.848	0.189	1.548	1.000	0.213	0.719
	Male (ref)	-	-	-	-	-	-	-	-
Age at birth (years)		0.005	0.025	-0.043	0.054	0.046	1.000	0.830	1.005
Year of mother's birth		0.011	0.018	-0.024	0.046	0.376	1.000	0.540	1.011
Maternal circumstance		0.785	0.107	0.575	0.995	53.665	1.000	0.000	2.192
Infant sex - maternal circumstance interaction		**-0.146**	**0.187**	**-0.512**	**0.219**	**0.616**	**1.000**	**0.433**	**0.864**
(Scale)		1.000							

Table 2.22 Results of multilevel generalised estimating equations assessing the interaction effects between infant sex and factors which should influence maternal investment decisions. All variables are continuous having been centred; however the originally binary categorical variables (infant sex and occurrence of birth complications) are presented as if categorical for ease of interpretation. OR = odds ratio.

Further analysis

The risk of PND increased, irrespective of the sex of the infant born, in mothers who had a higher general tendency towards depression, anxiety, and stress symptoms (male infants OR 2.589, $p < 0.001$; female infants OR 2.272, $p < 0.001$; OR difference z = 0.452, $p = 0.326$ one-tailed) and those experiencing low social support (male infants OR 4.712, $p = 0.012$; female infants OR 5.821, $p = 0.011$; OR difference z = 0.228, $p = 0.410$ one-tailed) (Figure 2.5). The risk of PND also increased in mothers who had complications at birth, but only when they gave birth to male infants

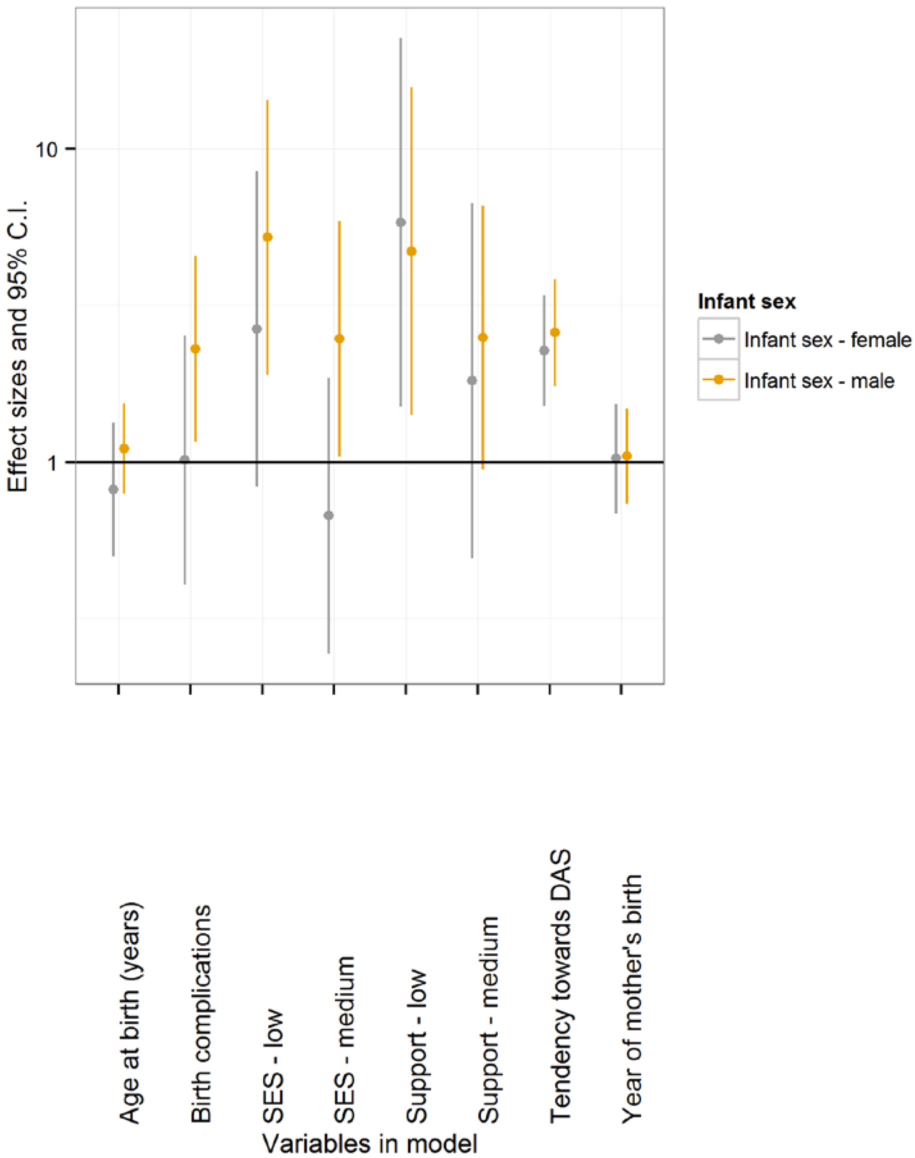

Figure 2.5 Effect sizes and 95% confidence intervals of variables effecting PND incidence depending on whether the infant was male or female. The continuous variables have been centred and standardised to make the regression coefficients interpretable as effect sizes.

(birth complications – male infants OR 2.296, *p* = 0.017; female infants OR 1.014, *p* = 0.976; OR difference z = 1.404, *p* = 0.080 one-tailed) (Figure 2.5). The same was true of women whose SES was indicated by managerial and technical employment as opposed to professional employment (SES – male infants OR 2.473, *p* = 0.041; female infants OR 0.674, *p* = 0.445; OR difference z = 1.911, *p* = 0.028 one-tailed) (Figure 2.5). Lower SES indicated by skilled non-manual, skilled manual, partly-skilled, and unskilled employment was also only a significant predictor of PND

Variable		*b*	SE	95% Wald CI Lower	Upper	Hypothesis Test Wald Chi-Square	df	*p*	OR/ Effect Size
Male infants									
Age at birth (years)		0.100	0.169	-0.231	0.430	0.348	1.000	0.556	1.105
Year of mother's birth		0.043	0.179	-0.309	0.395	0.057	1.000	0.811	1.044
Tendency towards DAS		**0.951**	**0.201**	**0.558**	**1.345**	**22.432**	**1.000**	**0.000**	**2.589**
Occurrence of birth complications	Complications	**0.831**	**0.349**	**0.148**	**1.515**	**5.683**	**1.000**	**0.017**	**2.296**
	No complications (ref)	-	-	-	-	-	-	-	-
SES	3) skilled non-manual - unskilled	**1.651**	**0.515**	**0.641**	**2.661**	**10.270**	**1.000**	**0.001**	**5.213**
	2) managerial and technical	**0.905**	**0.442**	**0.039**	**1.772**	**4.196**	**1.000**	**0.041**	**2.473**
	1) professional (ref)	-	-	-	-	-	-	-	-
Social support	Low	**1.550**	**0.616**	**0.343**	**2.757**	**6.334**	**1.000**	**0.012**	**4.712**
	Medium	**0.915**	**0.496**	**-0.056**	**1.886**	**3.410**	**1.000**	**0.065**	**2.497**
	High (ref)	-	-	-	-	-	-	-	-
(Intercept)		-3.655	0.537	-4.707	-2.603	46.369	1.000	0.000	0.026
(Scale)		1.000							
Female infants									
Age at birth (years)		-0.201	0.251	-0.692	0.291	0.640	1.000	0.424	0.818
Year of mother's birth		0.026	0.205	-0.376	0.429	0.017	1.000	0.897	1.027
Tendency towards DAS		**0.821**	**0.208**	**0.412**	**1.229**	**15.504**	**1.000**	**0.000**	**2.272**
Occurrence of birth complications	Complications	0.014	0.466	-0.900	0.928	0.001	1.000	0.976	1.014
	No complications (ref)	-	-	-	-	-	-	-	-
SES	3) skilled non-manual - unskilled	**0.979**	**0.592**	**-0.181**	**2.140**	**2.735**	**1.000**	**0.098**	**2.662**
	2) managerial and technical	-0.395	0.517	-1.408	0.619	0.583	1.000	0.445	0.674
	1) professional (ref)	-	-	-	-	-	-	-	-
Social support	Low	**1.761**	**0.691**	**0.408**	**3.115**	**6.507**	**1.000**	**0.011**	**5.821**
	Medium	0.597	0.666	-0.708	1.902	0.804	1.000	0.370	1.817
	High (ref)	-	-	-	-	-	-	-	-
(Intercept)		-3.305	0.580	-4.441	-2.169	32.499	1.000	0.000	0.037
(Scale)		1.000							

Table 2.23 Results of GEEs assessing the differential effects of PND risk factors by infant sex. Continuous variables have been centred and standardised to enable the interpretation of the odds ratio as an effect size. OR = odds ratio.

when the infant was male, however the direction of the effect was the same for female infants at a level approaching significance (male infants OR 5.213, $p = 0.001$; female infants OR 2.662, $p = 0.098$; OR difference z = 0.856, $p = 0.196$ one-tailed) (Figure 2.5). For full regression results see Table 2.23.

Discussion

The detrimental consequences of PND on mother-offspring relationships over the short-term are well documented, but until now little was known about any of its longer term impacts. PND was found to reduce mother-offspring relationship quality into the offspring's adult years; this effect was found to remain both when comparing between all births and when comparing across individual mother's births after controlling for other factors which may influence relationship quality. Intergenerational relationships were also shown to be affected, with PND negatively impacting on grandmother-grandchild relations. These results are in line with the elements of the adaptationist perspective viewing PND as a mechanism to facilitate maternal divestment of resources. However, given the long-term detrimental impact of PND on mother-offspring relations these results do call into question the efficacy of PND as a bargaining mechanism to gain resources with which to subsidise maternal investment.

Whether PND is a proxy for a low investment strategy in offspring, or if reductions in maternal investment are instead a non-adaptive by-product of PND, PND is likely to correlate with low investment in offspring across the offspring's life course and manifest in lower mother-offspring relationship quality beyond the postnatal period. Thus, mother-offspring relationship quality may be indicative of offspring quality. When comparing mother-offspring relationship quality between a mother's children, relationships were worse the higher PND symptom severity after birth. This points to either a mother's levels of emotional investment remaining relatively stable over time and being set during infancy by factors affecting the pay-offs of maternal investment in terms of offspring quality or that the memory of depression has a permanent detrimental impact on relations with the child to which it was associated. Lower mother-offspring relationship quality is linked to reduced offspring self-esteem and social competence (Kim and Cicchetti, 2004), and by extension leads to offspring having lower embodied capital, for example as result of being less able to achieve high social status (Rudolph, Hammen, and Burge, 1995) or succeed in the job market (Baron and Markman, 2003), with which to invest in their own offspring (respondents' grandchildren).

Mother-offspring and grandmother-grandoffspring relationship quality are also likely to influence maternal/grandmaternal subsidy of offspring parenting costs, in turn impacting grandoffspring quality. Grandmothers rated their relationship with their child to be more likely to have a negative impact on their relationship with the grandchildren if their child's birth was associated with PND, and rated their emotional closeness to their grandchildren as lower. This effect is likely to be mediated by the reduced mother-offspring relationship quality experienced in association with PND (Michalski and Shackleford, 2005), and, in the United States at least, this results in lower levels of grandmother involvement both in terms of contact frequency with grandchildren and help raising them (Barnett *et al*., 2010). Such intergenerational effects highlight one of the many costs which the benefits proposed in adaptationist accounts of PND must outweigh. If offspring quality is being traded for offspring quantity, then such costs associated with PND may well be surpassed by benefits to reproductive success; however, this does not appear to be borne out by results of the analyses assessing the impact of PND on fertility related metrics.

By showing that PND at the first or second birth is associated with lower completed fertility, that increasing bouts of PND and increasing PND severity at the first birth reduce the likelihood of a third birth, and that interbirth intervals (IBIs) are longer after births associated with PND, potential pathways are identified by which PND is detrimental to fitness, rather than providing benefits as might be expected under an adaptationist explanation of PND. Additionally, moderation analysis showed women in poorer circumstances have reduced parity progression, women whose poor circumstances improve between their first and second births were less likely to have a third child if they experienced PND at their first birth, and only 54% of women who had PND at their first birth experienced improved circumstances at their second birth (see Appendix D). Therefore, women who have PND do not appear to be benefiting from social subsidy enabling future reproductive opportunities as proposed by adaptationist accounts, calling into question evolutionary explanations of PND based on its having adaptive value. Rather these results contribute to the growing understanding of the importance of emotional wellbeing on fertility decisions. However, PND was found to have a positive intergenerational effect on fertility, increasing the fertility of sons whose birth is associated with PND. This is suggestive of both support for an adaptive explanation and conversely that the fertility is too simplistic on its own as a measure of fitness.

PND at parities one and two was found to be costly when analysing completed fertility, being significantly associated with reductions in the number of offspring born to women who experienced PND. Repeat bouts of PND, and PND at the first birth, are particularly costly in terms of parity progression; they produced the strongest models, and show effect sizes comparable to factors with well-documented influence on fertility such as complications at birth (Priddis *et al*., 2013; Smith *et al*., 2006). Impacts on parity progression may be more strongly seen after two bouts due to the additive physical or emotional costs of PND. Alternatively, the impact of repeated PND on offspring quality is too great to risk a third bout of PND or the additional costs of having a third child. PND at the first birth has a stronger negative impact on progression from parity two than parity one. This indicates it reduces a mother’s capacity to cope with increasing numbers of offspring. Of the women in the sample who had a second birth, roughly 50% of women who experienced PND at their first birth also had it after their second (Appendix A), mirroring the general population (Weissman and Olfson, 1995). Depression has a priming effect on the immune system, causing epigenetic changes that lower stress reactivity thresholds, which may increase the likelihood of future bouts (Slavich and Cole, 2013). PND is as likely, if not more likely, to be experienced at the first birth (Appendix A), raising the probability of repeat bouts if childbearing continues and also increasing the likelihood of depression at other points in the life course. That PND is also found to increase the length on IBIs also indicates that women who experience PND are carrying some form of cost which prevents them having another child as soon as they would otherwise.

In terms of evolutionary trade-offs between current vs. future offspring, when viewed across one generation, PND appears to be costly. Low fertility strategies in modern post-industrial societies do not result in increased reproductive success in descendants (Goodman, Koupil, and Lawson, 2012), so it was hypothesised that there were unlikely to be longer term gains from the lower fertility of women with PND. However, analysis of the effect of PND across two generations potentially indicates otherwise. The fertility of the sample's offspring (aged forty or over at the time of questioning) was found to be higher when their birth was associated with PND. Closer inspection showed that this was the result of increased male fertility, while the fertility of female offspring was unaffected by their mother's postnatal depressive state after their birth. Thus, while women experiencing PND may experience lower fertility themselves, their experience of PND may result in their having more grandchildren *if* they have it in association with sons.

The finding of a sex difference in offspring fertility is perhaps unsurprising. Maternal sensitivity in early life, as measured by maternal depression in the first five years, mediates the relationship between environmental harshness and unpredictability and an accelerated life history strategy (Belsky and Schlomer, 2012). Belsky and Schlomer (2012) found the effect of maternal sensitivity to be greater on males than females, yet chose to interpret finding as resulting by chance due to their statistical procedure. However, PND has been found to have more detrimental impacts on the interactions, and by extension attachment, between mothers and sons (Grace, Evindar, and Stewart, 2003), resulting in more behavioural problems and lower social and emotional competency in males whose birth was associated with PND than females (Carter *et al*., 2001). Mother-offspring relationship quality also negatively predicted fertility in male offspring, suggesting the sons of mothers who report poor quality relationships with them are of lower quality themselves and trade-off offspring quality in favour of quantity. As male mating effort increases, paternal investment decreases (Apicella and Marlowe, 2007), adding to the probability that while the grandchildren from sons whose births were associated with PND are of greater number, they will also be of lower quality. Thus these results indicate that Belsky and Schlomer's (2012) findings were robust. Further, while maternal depression in the first five years leads to more prolific sexual activity by age 15 in both sexes (Belsky and Schlomer, 2012), daughters whose mothers experienced PND are at greater risk of PND themselves (Séjourné *et al*., 2011), so any increases in fertility as a result of a faster life history strategy in women may be counteracted by the negative impact of experiencing PND themselves. It should be noted that as the offspring are aged 40 and over, male fertility may not be completed. Higher quality males may delay fertility for the purposes of status attainment, and then have more children at later ages (Weeden *et al*., 2006). The upper age of offspring sampled is limited by the age of the mothers being surveyed; the mean age of male offspring was 44.72 (s.d. 3.98) with the oldest being 57 years of age. However, offspring's year of birth was controlled for in the *full model* and showed no significant effect on fertility, further it was not retained during model selection, thus fertility delay in male offspring does not appear to underlie these results.

With regards to the incidence of PND, contrary to previous studies (Bottino *et al*., 2012; Hagen, 2002), no support was found for the hypothesis that older women will be less likely to experience PND because of their reduced reproductive potential. The difference between prior studies and these results may stem from the small sample size used by Hagen (2002) and the crude measure of prior reproductive history employed by Bottino *et al*. (2012). Given the reductive impact PND was found to have on parity progression (see *hypothesis Fiii*), it seems probable that fewer women at risk of PND make it to higher parities. Although the available sample sizes at higher parity levels is inadequate to confirm this, a trend towards lower PND symptom severity as number of existing children increased approached significance (p = 0.069) when assessed by linear regression. This is not supportive of the notion that PND is simply triggered by a lack of maternal resources, which are likely to decline as offspring numbers increase.

The percentage distribution of PND was higher for multiple births than singleton births when measured using the EPDS and BPDS, but lower when measured by actual diagnosis. With a sample size of only 11 multiple births, statistical power is lacking to determine whether a relationship between number of infants born at once and PND exits. This is an area that needs to be pursued by further research as the additional stress of multiple infants seems a good candidate for increasing PND incidence. Mothers of five year old twins have been found to be more likely to be depressed (Thorpe *et al*., 1991) and mothers giving birth to multiple infants as a result of IVF experience greater levels of stress than those who have a singleton birth as a result of either IVF or natural conception (Glazebrook *et al*., 2004).

Exploration of the Trivers-Willard hypothesis (Trivers and Willard, 1973) found that PND is more likely with male infants; this is consistent with the predictions of the Trivers-Willard model and on first inspection appears supportive of existing adaptationist accounts of PND (Couch, 1999; Hagen 1999, 2002; Thornhill and Furlow, 1998). However, contrary to Trivers-Willard predictions, infant sex did not interact with standard PND risk factors. Under an adaptationist explanation of PND these risk factors are hypothesised to increase the costs/reduce the benefits of maternal investment, and male infants born under such circumstances should be more likely to trigger the PND-mechanism signalling to a mother that continued investment poses a threat to her fitness. Instead, low support and a general tendency towards depression, anxiety, and stress symptoms similarly increased PND risk irrespective of infant sex. The finding regarding low support is particularly problematic for current adaptationist explanations, as support is a focal risk factor hypothesised to constrain maternal investment and trigger the proposed PND mechanism. However, two risk factors that only increased PND risk in association with male infants were found, namely birth complications and being of lower, but not the lowest, SES.

In explaining the apparent increased risk of PND in association with male infants whose births were accompanied by complications or who were born to mothers of lower, but not the lowest SES, maternal disinvestment and the Trivers-Willard hypothesis may be tentatively invoked, though in a different manner to Hagen (1999, 2002) and Thornhill and Furlow (1998). It is possible to dispute the notion that PND is a signalling mechanism, while agreeing that there are circumstances in which the fitness of a mother is best served by her reducing or eliminating maternal investment. There is a growing body of sociological literature documenting the current era of ‘intensive mothering' in contemporary Western societies (Hays, 1996; Lee, 2008), and the pressures placed on women to protect their infants from risk (Lee, 2008; Lee, Macvarish, and Bristow, 2010). In such a sociocultural mothering environment, a low maternal investment strategy seems likely to leave a mother at heightened risk of psychosocial stress. PND may therefore be a by-product of women conforming to the predictions of the Trivers-Willard hypothesis and withdrawing their investment in their infant, rather than PND being an adaptive causal mechanism aiding them in doing so. This is a subject area which will be returned to in later chapters.

Humans have been found to follow quality-quantity offspring trade-offs in a number of societies (Borgerhoff Mulder, 2000; Gibson and Lawson, 2011; Huber, Bookstein, and Fieder, 2010; Meij *et al*., 2009). PND poses risks to the mother and her offspring, and if taken at face value it would seem unlikely that these women are benefiting in terms of reproductive success from higher quality offspring. However, ceasing to reproduce could provide protective benefits to existing offspring whose level of maternal investment, already impoverished by PND, would be further reduced by the addition of siblings. Women with PND may be employing a longer-term strategy, trading off grandoffspring quality for quantity. Offspring whose births are not associated with PND do not suffer the costs of developmental deficits caused by PND (Beck, 1998; Cogill *et al*., 1986; Gelfand and Teti, 1990; Halligan *et al*., 2007; Murray and Cooper, 1997; Wright, Parkinson, and Drewett, 2006) and benefit from higher quality relationships with their mother, thus are of higher embodied and somatic capital. These offspring have fewer offspring themselves, which will in turn be of higher quality due to their ability to invest in them, and the increased investment they receive from their grandmother who is emotionally closer to them. When PND is associated with the birth of a son, women suffer a cost in terms of grandoffspring quality, yet gain in terms of grandoffspring quantity. However, when women experience PND in association with the birth of a daughter they potentially suffer a cost in terms of grandoffspring quality without any compensating benefit from grandoffspring quantity, possibly due in part to their daughters being at increased risk of PND.

These results may reflect PND just being maladaptive in contemporary environments (Crouch, 1999), where fertility behaviour in general is not fitness maximising (Kaplan, 1996). Model comparison indicated that the effect of PND is cumulative, suggesting a physical cost is incurred, even in contemporary populations, in line with medical literature (Harlow *et al*., 2003; Keicolt-Glaser and Glaser, 2002; Mykletun *et al*., 2009; Vliegen, Casalin, and Luyten, 2014; Young *et al*., 2000); it is unclear why the physical costs of depression to health and reproductive function would not be detrimental in past environments. Crouch (1999) suggests that in the dense social settings of small-scale societies maternal distress would be quelled by support before it developed into depression. Little research has been conducted on depression in small-scale societies; yet recent findings in the Tsimane, Bolivian forager-horticulturalists, run counter to the notion that depression is simply one of modernity's by-products (Myers *et al*., 2016; Stieglitz *et al*., 2015). If the effects on fertility are psychological rather than physical in origin, then PND may simply increase the use of contraception and abortion in modern environments. However, cross-cultural data on infanticide and child abandonment are consistent with the optimisation of available resources for reproductive effort (Clarke and Low, 2001; Craig, 2004); if potential future offspring are avoided by postnatally depressed women in contemporary developed settings via increased use of modern birth control, then 'unavoidable' offspring born to postnatally depressed women without access to contraception seem likely candidates for experiencing much heightened risk of infant death.

Whilst results from testing a number of the hypotheses regarding the long-term impact of PND on mother-offspring relationship quality are supportive of an adaptationist explanation of PND, the majority of findings regarding effects on fertility (*Fi*-*v*) and patterns of incidence are not (*Ii*-*ii*, *iv*). One fertility finding (*Fvi*) which is potentially favourable for an adaptationist perspective is that the sons whose births were associated with PND produce more offspring themselves, leading to women who have PND to have more grandchildren. However, the enhanced grandoffspring quantity from male offspring whose birth was associated with PND seems more likely to a coincidental by-product of a generalised accelerated life history strategy in response environmental stress (Belsky and Schlomer, 2012), rather than a specific outcome for which PND was adapted. Also, there was not adequate data to fully examine the effect of PND at higher parities. Therefore the possibility cannot be ruled out that PND has a positive effect on parity progression likelihood at level three and beyond. The moderation analysis does provide limited support for adaptionist explanations of PND in that its effect was found to be fitness neutral in women experiencing low support from their offspring's father and a mixed emotional experience of birth at parity 2. However, for the most part the results are not supportive of the adaptive explanations proposed by Hagen (1999, 2002), Crouch (1999), Thornhill and Furlow (1998), with the vast majority of moderation models finding no interaction between PND and circumstance, tests of the Trivers-Willard hypothesis finding no interaction between factors influencing maternal investment and infant sex, and PND not providing fertility benefits to women whose circumstances improved after PND. That PND significantly reduces the chances of progression from parity 2 in women who had high levels of paternal support or positive emotional experiences of birth also raises the question as to why women of such good circumstances become depressed in the first place, and how PND can occur in such women and reduce fitness. These results do not preclude 'mismatch hypotheses' (Hahn-Holbrook and Haselton, 2014) or maintenance based adaptive explanations of PND such as the Pathogen Host Defence hypothesis (Raison and Miller, 2013) and the related psychobiological model of depression and social rejection (Slavich *et al*., 2010a). It has been proposed that PND is a product of particular sociocultural environments (Crouch, 1999; Stern and Kruckman, 1983). It is possible that, in contemporary developed populations at least, PND is a product of a stress response to low investment under certain circumstances, masking the benefits of a current vs. future trade-off. PND may not be an evolved signalling mechanism to cease investment, but instead be the by-product of responding to some other signal of threatened fitness, a conjecture which will be explored in later chapters.

Potential limitations

Unmeasured factors that might be important to these results include abortions, miscarriages, or illness, which may impede fertility. Such factors undoubtedly affected some women, yet for this to be a substantial issue they would have to have disproportionately affected women with PND. Marital/long-term partnership status throughout the reproductive lifespan was not taken into account; however from an evolutionary perspective this can be taken as a proxy for underlying mate quality, for which there are other measures such as general tendency towards depression, anxiety and stress depressive tendency. A drawback of this dataset is that level of educational attainment, which is known to influence fertility (Martin, 1995), cannot be specifically controlled for. However, due to the methods of respondent recruitment, that the majority of the sample were educated to at least university undergraduate level is highly probable. A major pathway by which education affects fertility is in the shifting of childbearing to older ages (Rindfuss, Morgan, and Offutt, 1996), and age at childbirth is controlled for various models. SES is highly positively correlated with educational attainment (Caro, McDonald, and Williams, 2009) and this is also controlled for. The premise, based on medical and psychological literature, was that PND was costly, and thus unlikely to be an adaptive signal to a woman that she is too low on resources to continue investing. Therefore, it is particularly interesting to see what effect PND has in contemporary, developed populations where costs may be borne more easily. However, future research should be aimed at assessing how the results vary across other social and economic contexts.

The EPDS is preferentially used in predicting outcomes of PND due to findings that it produces stronger models (see Appendix C), however the use of the EPDS as a retrospective measure of PND may capture women who would not be clinically diagnosed with depression if showing symptoms today. Of this sample 36.9% of women met the EPDS cut-off for PND at least once, while 13.4% reported receiving at least one medical diagnosis; this may indicate a bias in EPDS evaluation. Prevalence scores of PND ascertained by screening measures are generally higher than rates of diagnosis (Beck *et al.*, 2011); over 80% of postnatally depressed women in the UK have been found to not report their symptoms (Whitton, Warner, and Appleby, 199), symptoms are often missed in clinical practice (Hearn *et al.*, 1998; Heneghan *et al.*, 2000), and widespread screening for PND was not implemented in the UK or US at the time this sample of women were giving birth (Musters *et al.*, 2008; O'Connor *et al.*, 2016). The retrospective nature of this screen may be problematic; however specific depressive symptoms are more likely to be forgotten than incorrectly reported as having occurred (Wells and Horwood, 2004). As the percentages classified as depressed at each parity fall within the range of findings from contemporary applications of the EPDS (Halbreich and Karkun, 2006), and a large-scale, nation-wide screening study in the US put PND symptomology at 42% 13 months post-birth (Beck *et al*, 2011), the percentage of women meeting the EPDS cut-off for PND in this sample is not unduly high. The pattern of resulting completed fertility dependent on our EPDS cut-off mirrors that based on actual diagnosis, supporting our cut-off as appropriate, and the use of the EPDS is very similar to that of Meltzer-Brody *et al*. (2013). The potential of having chosen a depression cut-off which is too low is also eschewed by using the raw EPDS scores where possible; thus the impact of increasing severity of postnatal depressive symptoms is assessed, rather than PND *per se*. When predicting PND itself a more conservative strategy was adopted to maximise the chances that PND is what is actually being measured, using a combined measure that utilises all three of the PND diagnostic methods employed during data collection.

Conclusions

The results presented in this chapter (and by the published paper in Appendix A) represent the first evidence regarding the curtailing impact of PND on female reproductive decisions, and adds to findings emphasising the importance of parental wellbeing (Myrskylä and Margolis, 2014). It is also the first to frame the increased risk of PND with the birth of male infants from a Trivers Willard perspective, bringing an evolutionary understanding to a phenomenon which the medical literature has struggled to explain. The results, in combination with the culturally widespread nature (Halbreich and Karkun, 2006) and high prevalence of PND, indicate the importance of factoring in women's emotional experience of early motherhood to demographic models of fertility. The long-term negative impacts of PND on mother-offspring relationships also point to the need for early intervention with mother-infant dyads to help build positive interactions. Future research is needed to clarify the effect of PND at higher parities, assess the risks of PND with multiple births, ascertain the cross-cultural range of these findings, and also further assess the influence on fertility of depression at other points in the life course. Nonetheless, these results are generally unsupportive of existing adaptationist explanations of PND. Instead, they add to the body of data indicating the very costly nature of depression, which the benefits of depression must outweigh for it to be adaptive, while also failing to identify benefits in terms of offspring quantity or quality. Taken together, these findings provide ample justification for exploring alternative evolutionary explanations of PND, and this will be the focus of the following chapters.

Chapter 3 – Testing a Social Genome Approach to Postnatal Depression

Chapter outline

A more nuanced evolutionary approach to PND is required; results of the previous chapter pose problems for adaptationist maternal signalling accounts of PND (Crouch, 1999; Hagen, 1999 and 2002; Thornhill and Furlow, 1998) and the presence of PND in the pre-industrialised Tsimane, forager horticulturalists from the Bolivian Amazon (Myers *et al*., 2016), challenges the 'disease of modern civilisation' mismatch approach (Hahn-Holbrook and Haselton, 2014) (discussed in Chapter 1). However, none of the results preclude approaches to depression based on it being an evolved inflammatory response to social evaluative threat; it is proposed that this approach to depression, outlined in detail below, is a productive line for further inquiry in relation to PND.

Work on general depression in the Tsimane suggests an immune role for depression in this pre-industrial context, with depression occurring in association with higher pathogen loads (Stieglitz *et al*., 2015). Pathogen load is unlikely to play a large role in the aetiology of PND in Western, educated, industrialised, rich, and democratic (WEIRD) (Henrich, Heine, and Norenzayan, 2010) settings, although infection by *Chlamydia trachomatis* is associated with depressive symptoms in women with premenstrual syndrome (PMS) (Doyle *et al*., 2015). However, studies of general depression highlight the causal role of social stress, which triggers the same inflammatory response as biological stress (Slavich and Cole, 2013). Kendall-Tackett (2007) contends the main risk factors identified for PND trigger psychosocial stress, yet the moderation analysis in Chapter 2 regarding the effect of PND on parity progression highlighted the fact that commonly recognised risk factors cannot account for all cases of PND indicating a gap in the current understanding of who is in danger of experiencing depression after giving birth. Sociologists, amongst others, have produced a large body of literature documenting the social pressures mothers in contemporary industrialised settings are under regarding their mothering decisions and behaviour. Scant attention has been paid to the consequences of this pressure, yet it seems an obvious place to seek further causal factors for PND when taking an evolutionary approach based on a maternal stress response. The sociocultural mothering environment in contemporary, particularly Western, industrialised settings and the importance of bonding and attachment theory in shaping notions of maternal behaviour will be the initial focus of this chapter, after which a study designed to assess whether social stress predicts PND will be presented.

Depression and human social genomics

As many as 82% of depressive episodes are preceded by a stressful life event (Mazure, 1998), and onset and progression have been found to be approximately three times faster in those individuals experiencing an event characterised by targeted social rejection (Slavich *et al*., 2009). In recent years neurobiological concepts of depression have developed from it being a receptor regulation disorder, to a neurodegenerative disorder, to contemporary ideas supposing it to be a neuroprogressive and inflammatory process (Rahola, 2012). This change in emphasis regarding the causal factors of depression has gone hand in hand with a conceptual shift in the understanding of the relationship between genes and social behaviour in the last two decades (Cole, 2009).

There is an extensive literature documenting the correlations between shame and depression (Andrews, Qian, and Valentine, 2002); shame is the ‘premier social emotion’ (Scheff, 2000), relating to feelings of self-consciousness, powerlessness, inferiority, and the desire to hide inadequacies (Andrews, Qian, and Valentine, 2002) and a causal relationship between shame and depression is indicated by findings that shame at Time X predicts depression at Time X+1 (Andrews, Qian, and Valentine, 2002; Rüsch *et al*., 2007). It has long been known that social stress and isolation impact the onset and progression of disease in general and, in particular, viral infections (Cole, 2009); research in the last few years has begun to unpick why. Genome wide investigations by Cole *et al*. (2007) have shown that in people who report feeling socially disconnected, three groups of genes are differentially expressed – genes involved in the immune systems initial, inflammatory, response are *upregulated* and genes involved in the following progression of the immune response, those involved in reaction to viral infections (especially Type 1 interferons) and those triggering B lymphocytes to produce antibodies, are *downregulated*. The variation in gene expression profiles has also been found to be most firmly linked to a person's subjective feeling of isolation, rather than objective measures of their social connections (Cole *et al*., 2007). Other teams have since found similar correlations with chronic threat of social loss, low socioeconomic status (with socioeconomic status seemingly affecting the way people interpreted threat) (Cole, 2009), shame and social evaluative threat (Slavich *et al*., 2010a), and acute social stress (Slavich *et al*., 2010b). Social circumstances have also been found to modulate the expression of genes involved in the nervous system, for instance the gene for glucocorticoid receptors (GR) and the Nerve Growth Factor (NGF) gene are both altered by negative social perceptions (Cole, 2009).

Perception of social conditions by the brain mediates the turning of socioenvironmental influences into functional genomic responses via the modulation of neurotransmitters, hormones, and other signalling molecules, which in turn trigger cellular receptors and transcription factors into activation (Cole, 2009). The central nervous system (CNS) utilises two major conduits to disseminate its perception of social information; the sympathetic nervous system (SNS) and the aforementioned HPA axis. GRs usually inhibit the inflammation producing transcription factor NF-κB, however threat of social loss and chronic loneliness appear to breakdown the HPA's feedback system, rendering GRs less sensitive to the HPA's release of anti-inflammatory cortisol, leaving people at risk of inflammation-related disease (Cole, 2008). The transcription of RNA determines the make-up of proteins in cells which then regulate cellular function; therefore, the psychological mediation of gene expression means the functional characteristics of the human body can be remodelled by the social world (Cole, 2009). Because this includes the alteration of cells in the CNS, the socioenvironment can also change psychological and behavioural reactions to future environments (Irwin and Cole, 2011), potentially explaining the recurrent nature of depression and the long lasting impact of stress. As it is the perception of the social environment that initiates responses from the SNS and the HPA axis, rather than the social environment *per se*, it is perception which is the key to gene expression (Cole, 2009).

Cole and others advocate a “new ‘environmentally conscious’ conception of genetics in which cellular and organismic behavior constitute the fundamental units of evolutionary selection, and genes and environments depend mutually on one another to shape that behavior by structuring our brains and bodies” (Cole, 2009: 137). The inflammatory response seen in reaction to social-evaluative threat has been termed the ‘conserved transcriptional response to adversity’ by Slavich and Cole (2013), and is argued to be adaptive due to the varying threats posed by different social environments; socially isolated individuals are postulated to have been historically more at risk of injury and infection, thus a pre-emptive inflammatory response to social stress was advantageous, whist socially active individuals were more prone to viral infections (Raison and Miller, 2013; Slavich and Cole, 2013). Alleles such as the *IL6* G allele, which causes greater production of the pro-inflammatory cytokine IL6 in response to social threat (Slavich and Cole, 2013), have been labelled *phenotypic plasticity alleles* because their expression varies in response to social perceptions and enhances inflammatory response in some individuals (Raison and Miller, 2013; Slavich and Cole, 2013). Phenotypic plasticity alleles are thought likely to be varied and remain polymorphic due to their conveying costs as well as benefits depending on environmental conditions (for a review see Slavich and Cole, 2013).

The Pathogen Host Defence theory of depression

There is an increasingly large literature linking the risk alleles for depression to innate immune inflammatory responses (Raison and Miller, 2013), suggesting they represent such phenotypic plasticity alleles. The links to the inflammatory system are further supported by the finding that most antidepressant drugs have anti-inflammatory effects (Maes *et al*., 2009). Such findings have led Raison and Miller (2013) to propose the Pathogen Host Defence theory for the evolution of depression, the foundations of which can be seen in Table 3.1. They go a step beyond previous

Pathogen Host Defence (PATHOS-D) theory of depression: foundational hypotheses
1. Depression should be associated with increased inflammation and inflammatory activation should induce depression.
2. Allelic variants that increase the risk for major depressive disorder (MDD) should enhance host defence mechanisms in general and innate immune inflammatory responses in particular.
3. Environmental risk factors for MDD should be associated with increased risk of infection and attendant inflammatory activation.
4. On the whole, patterns of increased immune activity associated with MDD should have decreased mortality from infection in ancestral environments.
5. Depressive symptoms should enhance survival in the context of acute infection and in situations in which risk of infection from wounding is high.

Table 3.1 Pathogen Host Defence (PATHOS-D) theory of depression (Raison and Miller, 2013: 18).

suggestions that depression is a by-product of prolonged activation of inflammatory systems, and contend instead that "depressive symptoms were integral components of immune-mediated host defense against pathogens in the ancestral environment" (Raison and Miller, 2013: 16). They note that infections produce an inflammatory response in mammals which generates a tightly controlled group of behaviours known collectively as 'sickness behaviour', which bears an impressive similarity to both stressed animals in the laboratory and symptoms of depression in humans.

Various lines of evidence are put forward to support the contention that depressive symptoms may enhance survival in the context of infection or risk of infection (for a more detailed review see Raison and Miller, 2013): One of the main characteristics of sickness behaviour is fever, which whilst entailing an energetic cost enhances resistance to pathogens, beyond the effects of the inflammatory response by which it is produced (Raison and Miller, 2013). This effect is also enhanced by low levels of iron, with cytokines reducing iron levels causing hypoferremia (Raison and Miller, 2013). A reliable association exists between depression and elevated body temperatures to within the optimal range for fighting infection, and various studies have found depressed people to possess reduced iron stores. A behavioural state of *conservation-withdrawal* is induced by pro-inflammatory cytokines, marked out by depressed mood, social avoidance, psychomotor retardation, anhedonia, fatigue and anorexia – all primary symptoms of major depressive disorder (Raison and Miller, 2013). Such behaviour is thought to promote energy conservation whilst the body focuses on the expensive tasks of inflammatory response, fever and tissue repair. Benefits may also be gained by reducing social contact, behaviour which appears to be mediated by the amygdala (Inagaki *et al*., 2012), thus limiting infectious exposure both to the self while in a vulnerable state and to kin, promoting inclusive fitness (Raison and Miller, 2013). Both depression and prolonged cytokine activation are characterised by hypervigilance, anxiety, and insomnia and Raison and Miller argue "evolutionary logic dictates that inflammatory processes – especially when chronic – might promote hypervigilant behavior that, while shunting energy away from fighting infection, would nonetheless serve adaptive purposes by protecting against environmental dangers engendered by sickness" (2013: 25). The energetic costs of fighting infection render observations of anorexia potentially paradoxical, however, data from animal and clinical studies indicate feeding increases infection risk and associated mortality (Raison and Miller, 2013). Lipid consumption appears particularly dangerous, with critically ill patients receiving parenteral nutrition including lipids having higher complication rates than those fed without lipids. Also in line with this, depressives who express increased appetites or hyperphagia, rather than anorexia, consume proportionally more carbohydrates than lipids, even though lipids are a superior source of energy. The Pathogen Host Defence theory is conceptually very similar to the infection-defence hypothesis (Anders, Tanaka, and Kinney, 2013; Kinney and Tanaka, 2009), which proposes depression to be an adaptive set of behaviours aiding individuals to fight existing infection and helping individuals and their kin to avoid new infections, but has a broader explanatory power by incorporating social risk factors.

It must be noted that not all people with depression display elevated inflammatory biomarkers, and whether those that do represent a distinct subgroup of major depressive disorder is a focus of current research. There are a number of evolutionary hypotheses regarding general depression (for a review see Nettle, 2004) and Raison and Miller (2013) suggest that they may not necessarily be mutually exclusive of the Pathogen Host Defense theory. Current research has found a general lack of epistatic inhibitive interactions between the alleles conferring depressive risk, and a possible reason for this is that immune/inflammatory alleles deliver one hit and social/stress factors deliver a second (biologically separate) hit, which in combination cross a major depressive disorder symptom threshold. In a similar vein, Slavich *et al*. (2010a) have proposed the psychobiological model of social rejection and depression, seen in Figure 3.1, suggesting the combined role of genetic factors, prior psychiatric history and life stress.

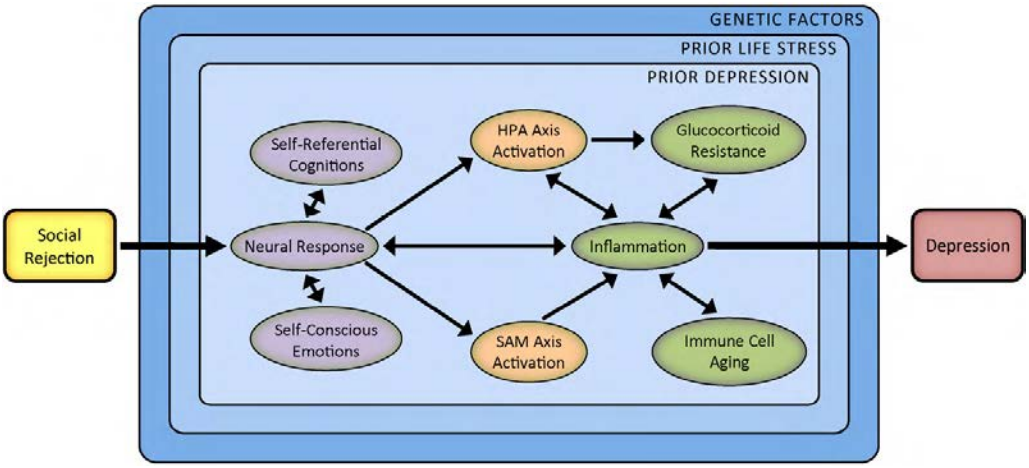

Figure 3.1 A psychobiological model of social rejection and depression. Abbreviations: hypothalamic-pituitary-adrenal (HPA), sympathetic-adrenal-medullary (SAM). Image reproduced from Slavich *et al*. (2010a: 42).

Work by Slavich *et al*. (2010b) has highlighted the speed at which inflammatory responses occur on exposure to social stress in the form of perceived social rejection. Participants were given 5 minutes to prepare a 5 minute speech and then deliver it to an unresponsive, nonverbally dismissive review panel, and then asked do 5 minutes of difficult mental arithmetic whilst being requested to go faster by a seemingly exasperated experimenter. Measuring the inflammatory indicators IL-6 and tumour necrosis factor-α (sTNFαRll), it was found that the inflammatory reaction was mounted within 30 minutes of beginning the task, indicating that prolonged social stress is not required before an effect occurs.

Postnatal depression and the social genome

Yim *et al*. (2015) called for an integrative approach to PND, one that combines the psychosocial and biological perspectives presently taken separately by researchers and that deals with the current inability to explain how "psychosocial stress processes are instantiated in women's brains and bodies, nor how genetic or epigenetic changes interact with psychosocial risk factors to influence PPD risk" (2015: 102). By incorporating inflammatory immune activation coordinated by the CNS in response to both infection and social evaluative threat the Pathogen Host Defence theory and the psychobiological model of social rejection and depression provide such a framework. In a recent review article entitled *The Emerging Field of Human Social Genomics*, Slavich and Cole (2013) use the phrase 'human social genomics' to summarise the growing literature supporting the role of subjective experiences of social conditions in influencing gene expression. As both of the Pathogen Host Defence theory and the psychobiological model of social rejection and depression fall under the umbrella of human social genomics, they will be referred to collectively as 'social genome approaches to depression' from now on for the purposes of shorthand, which reflects a phrase of my own design. Women in the perinatal period are potentially at heightened biological risk of inflammatory activation (Skalkidou *et al*., 2012). However, given the inconsistency and variety of results it is likely that there is more going on to cause PND in many women (Kendall-Tackett, 2007; Mott *et al*., 2011). The insights gained from a social genome approach to depression require that attention be paid to the social perceptions of postnatal women, rather than simply objective biological or demographic measures of risk as has been the case until now, to see if mothers are also exposed to social conditions which lead to the perception of social threat such that their immune systems react tipping them into depression. Many women with PND have no prior history of depression (Stowe, Hostetter, and Newport, 2005) and are likely to have been exposed to the proposed psychosocial risk factors prior to pregnancy without becoming depressed. Exposure to social threat does not have to be prolonged for an inflammatory response to occur (Slavich *et al*., 2010b); this suggests that there may be social stressors unique to the postpartum period causing women to become depressed within a short time of giving birth.

A meta-synthesis of qualitative studies of PND highlights the association between shame and PND (Beck, 2002). As noted, shame is associated with inflammatory immune activation (Slavich *et al*., 2010a), positively predicting cortisol levels released by the HPA (Gruenewald *et al*., 2004) and alpha-amylase, indicating inflammatory activation of the sympathetic nervous system (Rohleder *et* *al*., 2008). Given findings regarding the role of expectations not meeting experiences in PND (Beck, 2002), PNDs parallel occurrence with poor bonding (Pearce and Ayers, 2005), and the emphasis placed on the importance of bonding for infant development in contemporary, developed societies (Crouch, 2002), it would seem a logical step to investigate if there is a perception of social threat, measureable as shame, attached to experiencing poor bonding and whether the sociocultural mothering environment in the West creates circumstances in which mothers are at heightened risk of shame in the perinatal period.

The sociocultural environment of mothering in the West

Numerous authors have documented the historical development of modern notions of motherhood, charting an initial moralisation and then a medicalisation of mothering. This began with the philosophy of Locke in the 17th century, and continued with Rousseau in the 18th century; 19th century doctors combined Rousseauian ideals with new ideas of medical risk, to which Freud and his followers then added the idea that a mother was the sole source of her child's moral, physical and emotional well-being in the early 20th century (for example see Abrams, 2012; Badinter, 1981; Hardyment, 1983; Lee, Macvarish, and Bristow, 2010). These ideological changes played out over, and are intertwined with, a period of great demographic and economic change; mortality and then fertility rates declined during the Industrial Revolution of the 19th century (Teitelbaum, 1984), and working practices changed such that in the first half of the 20th century children shifted from being economically valuable to parents as producers to economically costly as consumers (Abrams, 2012). As children's social and economic value decreased, their emotional value to parents became increasingly culturally idealised (Eibach and Mock, 2011). Zelizer (1994) contends a new cultural model of childhood arose in which children were sacralised, becoming "economically worthless but emotionally priceless" (Zelizer, 1994: 3). Not only did children become emotionally priceless to parents, but the emotions of children themselves became priceless. In the 20th century the medicalisation of mothering and its attendant risk, which began in the 19th century, came to extend its purview beyond the physical to encompass the emotional as well, and mother-infant emotional relationships became central to cultural constructions of contemporary motherhood (Kanieski, 2010). Psychoanalysists in the early to mid-20th century began to link problematic mother-infant relationships with a range of disorders, with ideas which made their way into the public consciousness (Appignanesi, 2008); for instance, Franz Alexander's (1952) 'asthmatogenic' mothers were either overprotective or rejecting causing child anxiety to manifest as asthma; both R.D. Laing and Bruno Bettelheim linked bad parenting to schizophrenia (Appignanesi, 2008) and, perhaps most famously, Bettelheim (1967) popularised the origins of autism as lying with 'refrigerator mothers' – indeed, Bettelheim's (1967) *The Empty Fortress: Infantile Autism and the Birth of the Self* is still in print, ranking just outside the top 1000 bestsellers in both books on paediatrics and autism[7].

Although such psychoanalytic approaches have now been dismissed by the scientific mainstream (Appignanesi, 2008), mother-infant relations have remained a major focus for child development researchers, under the framework of attachment and bonding, since the pioneering work of Bowlby and Ainsworth in the 1950s and '60s (Bretherton, 1992), due to their supposed key role in the social, cognitive and emotional development of children (Balbernie, 2010; Bowlby, 1969; Chisholm, 2011; Kanieski, 2010; Liem and Boudewyn, 1999; McLaren *et al*., 2007; Moehler *et al*., 2006; Yozwiak, 2010). Information regarding the importance of attachment then began to filter down from the academic realm into the popular consciousness in the 1970s when it started appearing in pregnancy and childcare manuals and magazines (Kanieski, 2010), with an emphasis on bonding following soon after (Crouch, 2002).

The pressure to emotionally invest

In Chapter 1 the literature on bonding was critiqued for using ill-defined terminology; not only is this problematic from a research perspective, but misguided or misused popular conceptions of

[7] Paperback 1972 edition ranked #1164 for Paediatrics and #1342 for Autism on Amazon 03/08/2016.

bonding potentially have far reaching social and emotional consequences for mothers and infants too. For instance, Herbet, Sluckin, and Sluckin's (1982) critique of bonding notes "the negative and pessimistic implications of using this concept in social work and clinical practice" (1982: 205). It is perhaps telling that women who feel disappointed with their bonding experience have been found to have difficulty bonding (Pascoe, 1989). Indeed, if a woman has bought into the popular notion that it is innate to feel instantaneous positive emotions, "the warm glow…[at] her baby's bright eyes" (Kennell and McGrath, 2005: 775-6), and what she feels is a rather common indifference, then disappointment is probably the best emotion that could be hoped for. Ambivalence towards children is a characteristic which is recognised as common by psychoanalysists, who have described maternal resilience as the ability to bear and accept such ambivalence and not let it negatively impact on a woman's sense of self as a mother (Baraitser and Noack, 2007).

Kennell still views bonding as "essential for the infant to grow and thrive in the mother's care" (Kennell and McGrath, 2005: 775) and his work continues to encourage the intervention of medical staff to ensure mother-infant bonding, arguing that it is their role to mediate bonding by implementing immediate skin-to-skin contact and breastfeeding "even where the mother initially rejects her infant" (2005: 775). While physiological bonding responses may provide health benefits for both members of the mother-infant dyad, the supposed synonymous nature of physiological and emotional bonding brings the emotional relations between a mother and her infant in the medical sphere as well. The monitoring of emotional relationships by health professionals firmly links bonding and attachment with risk and lead to the cultural construction in the 1970s and '80s of the 'good' responsible mother who is responsive and empathic, and who must monitor her feelings towards her infant for risks which they might pose (Kanieski, 2010).

Numerous authors have decried the attention paid to bonding, contending it has made frank discussion of failure to 'bond' largely impossible for women and instead perpetuated an idealised picture of mother-infant relations (Sluckin, 1998). As one informant succinctly puts it, "It's not socially acceptable to actually dislike one's child, to feel no love for a defenceless baby" (Sluckin, 1993 in Sluckin, 1998: 13). An inevitable consequence of such an emphasis on bonding would seem to be the adherence of stigma to those women who do not bond. Stigmatisation is a form of targeted social rejection and, thus, women who perceive or experience such stigmatisation are exposed to a major risk factor for depression (Slavich *et al*., 2010a). This is backed by qualitative research indicating "postpartum depression occurs when women are unable to experience, express and validate their feelings and needs within supportive, accepting and non-judgmental interpersonal relationships and cultural contexts." (Mauthner *et al*., 1999: 148). Another consequence is that women who do not experience maternal 'bonding' will also encounter a distinct disconnect between expectation and experience, which as noted has repeatedly been found to be one of the main risk factors in PND (Beck, 2002). Thus, it is reasonable to look to pressure to 'bond' in the early postnatal period as a potential causal factor in PND.

Parenting culture

Notions of bonding form part of a wider parenting culture in the West in which mothers in the 21st century find themselves in a situation where the task of childrearing is seemingly ever expanding (Eibach and Mock, 2011; Faircloth, 2014a; Lee, Macvarish, and Bristow, 2010) and increasingly in need of expert guidance to be successfully achieved (Lee, 2014a). The noun 'parent' has been transformed into the verb 'parenting', a linguistic shift which gathered speed in the 1970s (Smith, 2010). 'Parenting' is not a neutral term to describe what parents do but instead a learned set of scientifically informed skills performed with the aim of educating children (Lee, 2014b) and "almost always discussed as a social problem" (Lee 2014b: 9). 'Intensive parenting' has become the prevailing parenting discourse (Arendell, 2000), defined by Hays (1996) as having three ideological principles: that mothers are the inherently superior parent, that mothering ought to be centred on the child, and that the child should be viewed as fulfilling and sacred to the parents. The conflict created between the inequality women face as a result of this view of parenting and the equality women have increasingly gained in other areas of life has been referred to as 'the myth of motherhood' (Hare-Mustin and Broderick, 1979). Under intensive parenting, appropriate methods of childrearing are “construed as *child-centred*, *expert-guided*, *emotionally absorbing*, *labor-intensive*, and *financially expensive*” (Hays, 1996: 9, emphasis in original). In a supposedly scientific age, misinformation and myths continue to swirl around pregnancy, with media and newspaper reports generating much fear amongst women of childbearing age (Geddes, 2013). Sociologist Frank Furedi (2002) coined the term ‘parental determinism’ to refer to the growing influence of a deterministic mode of thought which views the day to day activities of parents as directly and causally related to harming or failing children, and by extension, society as a whole. Successive governments have sought to blame the ills of society on poor parenting (Gillies, 2008) generating, in conjunction with the medical and psychological professions, a culture that views parents as inadequate risk monitors and yet charges mothers almost solely with the task (Lee, Macvarish, and Bristow, 2010). This has led to parenting routinely being represented “as the single most important cause of impaired life chances, outstripping any other factor” (Lee, Macvarish, and Bristow, 2010: 295).

The ‘risk’ associated with parenting culture today is no longer based on probability, but instead has become a loaded term which “connotes the possibility of an *unwanted* or *dangerous* outcome” and risk consciousness “is a way of thinking about the future in which *possibilities that are untoward* are taken into account more than *probabilities*” (Lee, 2014b: 11, emphasis in original). Such a perspective leads to speculation about what might go wrong, and often what might possibly go wrong is taken to be the same was what is likely to occur (Lee, 2014b). Foetuses, infants, and children are increasingly “defined as *de facto* ‘at risk’, but what exactly the ‘risk’ *is* is often admitted to be uncertain or unknown” (Lee, 2014b: 11, emphasis in original). Through this paradigm risk consciousness is not focused on collective concerns regarding identified and defined dangers, rather it is focused on “*individualized fears about uncalibrated risks*” and risk becomes “*free-floating anxiety*” (Lee, 2014b: 12, emphasis in original). In contemporary Western society the traditional grammar of morality surrounding dangers has been largely abandoned, and instead moral regulation has become amorphous and “often promoted indirectly through the language of health, science and risk” (Furedi, 2011: 96). Individual ‘risk management strategies’, which defer to expert guidance, thus become of moral imperative (Lee, 2014b). The grounding of risk in individual behaviour lends itself to the policing of behaviour at the individual rather than societal level, and maternal behaviour is thus targeted to effect social change.

The Western sociocultural world is one with ‘good mothers’ – who by being emotionally bonded, entirely devoted, married, obedient and fulfilled effectively manage risk – and ‘bad mothers’ – who by being emotionally distant, non-breastfeeding, unfulfilled, single, gay, and returning to employment expose their infants to risk (Badinter, 1981; Homans, 1994; Lee, 2014b; Marshall, 1991; Mauthner *et al.*, 1999; Nicholson, 2001; Ryan, Bissell, and Alexander, 2010). Women who do not fit into definitions of good mothers are perceived to be somehow unnatural (Nicolson, 2001), and often experience significant feelings of guilt and anxiety as a result (Crouch and Manderson, 1995). With specific reference to intensive parenting, a number of qualitative studies (Elvin-Nowak, 1999; Hays, 1996; Johnston and Swanson, 2006; Sutherland, 2010; Tummula-Narra, 2009) and one quantitative study (Rizzo, Schiffrin, and Liss, 2013) have linked conforming to the intensive parenting style of mothering and poor maternal mental health. Recent work suggests it is the contemporary cultural environment, rather than subscribing to intensive parenting ideologies *per se* that is detrimental, with pressure to be the perfect mother positively predicting stress, and guilt at not meeting parenting expectations positively predicting stress and anxiety in US mothers, irrespective of the way they parented (Henderson, Harmon, and Newman, 2016).

Viewed from an evolutionary perspective intensive mothering, being “*child-centred*, *expert-guided*, *emotionally absorbing*, *labor-intensive*, and *financially expensive*” (Hays, 1996: 9, emphasis in original), reflects a cultural idealisation of high maternal investment (Rotkirch and Janhunen, 2010). Maternal investment is conditional, and actual levels of maternal investment reflect the end result of trade-offs between the needs of the mother and needs of the offspring; offspring as well as fathers and other allocare givers (as a result of their own reduced investment costs) benefit from cultural messaging encouraging extensive maternal investment, whereas the myth of motherhood “denies the conditional nature of maternal strategies and may induce guilt in real mothers who fail to meet its requirements” (Rotkirch and Janhunen, 2010: 94). Guilt is a social emotion which arises in relation to wrong doing to others, and serves to inhibit or repair the consequences of wrongful behaviour. Finnish mothers were found to express guilt both in conjunction with high expectations of being a good mother and in situations of mother-offspring conflict, where it acted to control and ameliorate maternal feelings of anger, preferential treatment of other offspring, and consideration of abandonment.

While there is then growing evidence of the links between sociocultural environments which encourage high levels of maternal investment and the experience of negative emotions in mothers, so far, no studies have explicitly investigated perceptions of pressure to be a ‘good mother’ and PND. In her discussion of ‘attachment parenting’, a permutation of intensive parenting developed in the 1980s by William and Martha Sears advocating extended physical contact between mother and infant to promote a “legacy of love” (API, 2009), Faircloth (2014b) concludes such mothering styles can “pit groups of women *against* each other (those who do it ‘right’, those who do it ‘wrong’). The climate of intensive parenting…has created a situation where mothers feel less certain of the ability to turn to each other for support” (2014b: 163-164, emphasis in original). Such conditions are the perfect breeding ground for the perceptions of social threat and feelings of shame surrounding mothering behaviour, indicating they may play a causal role in PND via inflammatory stress responses, as predicted by a social genome approach to depression.

Research questions

> *Does social evaluative threat predict PND?*
>
> *Does the social construction of motherhood in WEIRD settings act as a source of social stress for mothers, thereby playing a causal role in PND?*

Prolonged activation of the immune system’s inflammatory response in reaction to social-evaluative threat results in a suite of behaviours phenotypically characteristic of depression, which social genome approaches to depression propose to be protective against the increased risk of injury and infection experienced by socially vulnerable individuals (Raison and Miller, 2013; Slavich and Cole, 2013). Social-evaluative threat comes in a number of forms, two of which – shame and social isolation – will be explored in relation to PND in the analysis which follows. Maternal investments, viewed through the lens of life history theory, are held to be contingent on maternal circumstance; if mother-infant relationships reflect maternal investments, the perception of extrinsic environmental risk should be expected to influence maternal investment trade-offs, resulting in not all mothers being highly emotionally invested in their infants. Strong attachment is a key element in the Western culturally and socially defined 'good mother' (Kanieski, 2010), generating social pressures to successfully 'bond' to protect infants from risk and attaching stigma in association with poor emotional bonding and (presumed) subsequent poor attachment. As a consequence, being a low emotionally investing mother, and thus exposing the infant to risk in a society which lauds high maternal investment is thought likely to trigger shame. Another social stress to which postnatal women in WEIRD contexts are often exposed (Morgan, 1996), and which has been causally linked to general depression (Cole *et al*., 2007), is that of social isolation. The following hypotheses (summarised in Table 3.2) are put forward to assess the links between social pressures on mothers to invest, risk, and social stress and the utility of a social genome approach to PND.

Hypotheses

-Shame (S)

Si) *Shame will be predicted by stigma consciousness surrounding mothering and the perception of social pressures on mothers*

As argued above, the contemporary sociocultural environment creates conditions likely to induce feelings of shame in pregnant women and mothers of young infants, thus awareness of stigma and social pressures attached to mothering will predict shame. Perceiving that there is stigma attached to mothering and perceiving that there are social pressures on mothers are different experiences that

Hypothesis	Dependent variable	Independent variable(s)	Statistical approach
Shame			
Si. Shame will be predicted by stigma consciousness surrounding mothering and the perception of social pressures on mothers	**Si**. General shame or maternal shame	**Si.** *Stigma consciousness*, *perception of social pressure*, SES, maternal age	**Si.** Linear regression
Sii. Shame will be predicted by strength of bonding, confidence in bonding, and time to bond	**Sii.** General shame or maternal shame	**Sii.** *Bonding*, *bonding confidence*, or *time to bond*	**Sii.** Linear regression
Siii. The perception of stigma and social pressure surrounding mothering will moderate the relationship between bonding and shame	**Siii.** Maternal shame	**Siii.** *Bonding*, *bonding confidence*, or *time to bond*, stigma consciousness or perception of social pressure	**Siii.** Moderation analysis
Siv. Shame will predict PND	**Siv.** Current PND or PND ever	**Siv.** *Maternal shame*, antenatal depression	**Siv.** Binary logistic regression
Sv. Shame will moderate the relationship between bonding and PND	**Sv.** Current PND or PND ever	**Sv.** *Bonding* or *bonding confidence*, maternal shame	**Sv.** Moderation analysis
Svi. Stigma consciousness and the perception of social pressures on mothers will interact with bonding to predict PND	**Svi.** Current PND or PND ever	**Svi.** *Bonding* or *bonding confidence*, stigma consciousness or perception of social pressure	**Svi.** Moderation analysis
Risk			
Ri. Stigma consciousness and the perception of social pressures surrounding mothering will positively correlate with the perception of risk surrounding mothering	**Ri.** Perception of risk	**Ri.** *Stigma consciousness*, *perception of social pressure*, SES, maternal age	**Ri.** Linear regression
Rii. The perception of risk surrounding mothering will predict shame regarding mothering	**Rii.** Maternal shame	**Rii.** *Risk perception*	**Rii.** Linear regression
Riii. The relationship between the perception of risk and shame will be moderated by bonding and confidence in bonding	**Riii.** Maternal shame	**Riii.** *Risk perception*, bonding or bonding confidence	**Riii.** Moderation analysis
Riv. The relationship between the perception of risk and shame will be moderated by stigma consciousness and perception of social pressure	**Riv.** Maternal shame	**Riv.** *Risk perception*, stigma consciousness or perception of social pressure	**Riv.** Moderation analysis

Table 3.2 Hypotheses tested in Chapter 3 and the measures and methods used to test them. Measures in *italics* denote the variable of interest, measures underlined denote moderator variables in moderation analyses. Abbreviations: postnatal depression (PND), socioeconomic status (SES).

Hypothesis	Dependent variable	Independent variable(s)	Statistical approach
Rv. The perception of risk will predict PND	**Rv.** Current PND or PND ever	**Rv.** *Perception of risk*, antenatal depression	**Rv.** Binary logistic regression
Rvi. The relationship between risk and PND will be moderated by shame	**Rvi.** Current PND or PND ever	**Rvi.** *Perception of risk*, <u>maternal shame</u>	**Rvi.** Moderation analysis
Social isolation			
SIi. Social isolation will positively predict PND	**SIi.** PND ever	**SIi.** *Time spent alone*, antenatal depression	**SIi.** Binary logistic regression

Table 3.2 (continued) Hypotheses tested in Chapter 3 and the measures and methods used to test them. Measures in *italics* denote the variable of interest, measures <u>underlined</u> denote moderator variables in moderation analyses. Abbreviations: postnatal depression (PND), socioeconomic status (SES).

may arise from the sociocultural environment, both of which are predicted to lead to shame; models are created employing them separately and together to explore which plays a larger role in the generation of shame.

The models are used to predict both *general shame* and *maternal shame* to assess whether stigma consciousness and the perception of social pressures surrounding mothering correlate with increased levels of overall shame or shame specifically relating to maternal behaviour.

Sii) *Shame will be predicted by strength of bonding, confidence in bonding, and time to bond*

The emphasis on intensive mothering and importance of 'bonding' in many WEIRD societies is hypothesised to lead to women feeling shame in relation to their emotional investment or emotional bonding experiences. Emotional investment and how they are experienced can be tapped in a number of ways; level of investment may be measured by the strength of emotional bond, whereas more subjective measures of the experience of investment may be reflected in the time it takes to feel bonded and the confidence a woman feels in her emotional bond. These three measures may be variably related to each other, and while all are hypothesised to predict shame, it seems likely that the confidence a woman has in her bond, as a marker of the confidence in her ability to protect her infant from risk, will be the strongest predictor of shame.

Siii) *The perception of stigma and social pressure surrounding mothering will moderate the relationship between bonding and shame*

The experience of social pressures to 'successfully emotionally bond' is hypothesised to moderate the relationship between the emotional investments a mother makes in her infant and her experience of shame regarding those investments, with women who experience more pressure experiencing more shame.

Siv) *Shame will predict PND*

The experience of shame is a manifestation of social stress which triggers an inflammatory immune response. Depression is thought to be a product of this immune response and thus the experience of shame during the postnatal period will lead to PND.

The available sample size limits the number of variables it is possible to enter into the model; however as antenatal depression is the most important risk factor for PND and mediates the effect of income, history of abuse, major life events, antenatal anxiety, negative cognitive style, self-esteem, and social support on PND (Leigh and Milgrom, 2008), it is considered to be an adequate control variable for this and all subsequent models predicting PND.

Sv) *Shame will moderate the relationship between bonding and PND*

Low emotional investment, or lack of confidence in such investment, reflects a low investment strategy aimed at increasing net fitness gains, with low confidence potentially indicating imminent investment withdrawal. Unlike current adaptationist explanations of PND, which view PND as a mechanism to signal to a mother she should pursue a low investment strategy, an alternative view, informed by a social genome approach to depression, is that PND is a by-product of pursuing a low investment strategy in sociocultural environments which make such as strategy socially stressful. The costs incurred by the prolonged inflammatory response and other behaviours characteristic of PND, which are problematic for adaptationist accounts, are proposed to be outweighed, at least ancestrally, by benefits to individual survival. Under a social genome approach, PND is the manifestation of an inflammatory stress response, and as such should not always be associated with a low investment strategy because, rather than causal to such a strategy, PND is a by-product of low investment strategies when they are associated with social stress, i.e. shame. Therefore, the experience of shame will moderate the relationship between emotional investments and PND such that, PND will only be positively predicted by low emotional bonding strength or low confidence in bonding when high levels of shame are also experienced, whereas at low levels of shame low emotional bonding strength or low confidence in bonding will not predict PND.

Svi) *Stigma consciousness and the perception of social pressures on mothers will interact with bonding to predict PND*

Sociocultural pressures on women are proposed to be the cause of shame relating to mothering and will thus moderate the relationship between emotional investments and PND such that, at high levels of *stigma consciousness* and *perception of social pressures*, low bonding and low confidence in bonding will increase the likelihood of PND, but at low levels they will not.

-Risk (R)

Ri) Stigma consciousness and the perception of social pressures surrounding mothering will positively correlate with the perception of risk surrounding mothering

The sociocultural environment emphasising intensive mothering does so partly by stressing the risks to which infants are exposed and the damage that can be done when ‘normal’ mother-infant relationships are disrupted. This being the case, awareness of stigma attached to women who do not protect their infants from risk by, for instance ‘securely bonding’ with their infants, and the perception of social pressures on mothers to behave and feel appropriately should positively predict the perception of risk surrounding mothering. SES and maternal age are controlled for due to their potential effects on risk perception; SES is an indicator of maternal resources, and the lower a mother’s resources the more likely an infant is to be exposed to mortality risk (Stockwell, Goza, and Balistreri, 2005), and being older during pregnancy is widely conceived as increasing risk for mothers and infants (Jacobsson, Ladfors, and Milsom, 2004; Brown, 2016).

Rii) *The perception of risk surrounding mothering will predict shame regarding mothering*

In the contemporary WEIRD mothering environment ‘bad mothers’ are those who expose their infants to risk (Badinter, 1981; Homans, 1994; Lee, 2014b; Marshall, 1991; Mauthner *et al.*, 1999; Nicholson, 2001; Ryan, Bissell, and Alexander, 2010), and ‘bad mothers’ are looked down upon by society (Nicolson, 2001). Thus mothers who perceive their infants are exposed to risk are likely to experience shame.

Riii) *The relationship between the perception of risk and shame will be moderated by bonding and confidence in bonding*

Women who behave as 'good mothers' and make high emotional investments will be buffered against shame as their perception of risk increases while women making low investments will experience greater shame the higher their perception of risk.

Riv) *The relationship between the perception of risk and shame will be moderated by stigma consciousness and perception of social pressure*

The perception of risk should not be inherently shame inducing, rather shame will accompany risk perception only when sociocultural pressures are also perceived.

Rv) *The perception of risk will predict PND*

The perception of risk will predict PND as a result of the relationship between risk perception and emotional investment and possibly as a result of stress directly induced by perceived risks.

Rvi) *The relationship between risk and PND will be moderated by shame*

Those who experience maternal shame in conjunction with increasing perceived risks surrounding mothering will be increasingly likely to become postnatally depressed, while those who do not experience maternal shame will not be more likely to become depressed as risk perception increases.

-Social isolation (SI)

SIi) *Social isolation will positively predict PND*

By the late twentieth century mothers in WEIRD societies had become highly isolated, relegated to a ghetto "splintered into thousands of individual homes" (Morgan, 1996: 114). For instance, a study of mothers of infants in the UK and Australia found that 38% of mothers were on their own for between 8 to 12 hours a day during the week, and another 34% were alone for 4 to 8 hours

(Kitzinger, 1989). This isolation is the result of factors such as female workforce participation occupying other female members of a mother's social network, dispersed extended families (Aarssen, 2005), and working practices which encourage low uptake of paternity leave even where it is available (Bittman, Thompson, and Hoffmann, 2004). Social isolation has been found to be causally linked to general depression via the upregulation of inflammatory immune responses (Cole *et al*., 2007). Thus time spent alone with their infant, without the company of another adult, is hypothesised to positively predict PND.

Materials and Methods

-Data collection

To test the aforementioned hypotheses the subjective experiences of women were collected using a multi-wave questionnaire (Menard, 2007; Taris, 2000). Participants were recruited for the first wave during the second and third trimester of pregnancy (wave 1) and then emailed a link to the second wave of the study 4 weeks after their due date (wave 2), with a reminder email sent one week later if the questionnaire had not been completed. In the second questionnaire women were asked to report the date on which they gave birth, and the third wave of the study was emailed to them 5 months after this date (wave 3), with a reminder email sent one week later if the questionnaire had not been completed. Women who did not undertake the second stage were also emailed with the third questionnaire 6 months after their due date (wave 3), with a reminder email sent one week later if the questionnaire had not been completed. Finally, an abbreviated version of the third questionnaire (requiring approximately 5 minutes to complete compared to 30 minutes) was sent to all women who had not completed the full third questionnaire; this fourth questionnaire was aimed at increasing the sample size for which data on the experience of PND was gathered, and as such was not delivered to women at the same time post-birth (wave 4). Participants were recruited via advertising on various websites aimed at pregnant women and mothers, social media, flyers placed in the pregnancy books of a major London bookshop, and a poster in said bookshop, and were paid £5 (or the equivalent value in other currencies) in the form of a voucher for a major online retailor on completion of the final stage of the survey. The decision was taken to make this offer as part incentive and part thanks because participants were being requested to expend time on the study during a very busy period of their lives. The study was approved by the Research and Ethics Committee of the School of Anthropology and Conservation at the University of Kent. All participants read a statement regarding the aims and content of the study, namely that it was designed to understand how pressures on pregnant women and mothers of new infants affected emotional health in early motherhood, with the aim of helping women better understand their feelings and finding new ways to deal with things like PND. The potentially sensitive nature of some of the questions was highlighted and by proceeding participants were deemed to have given informed consent. The questionnaires were conducted online using the SurveyGizmo platform and, to minimise inaccurate reporting due to the sensitive nature of information requested, participants remained anonymous with the exception of their IP address, which was collected to control for multiple responses from the same address, and their email address collected for the purposes of delivering follow-up questionnaires. 97 valid responses to wave 1 were received, 57 to wave 2, 48 (including 2 partial) to wave 3, and 12 to wave 4 (including the two partial respondents to wave 3); 70 participants completed at least one wave beyond the first.

-Questionnaires

For the full questionnaires, along with rationales behind each question and relevant references see Appendix E.

-The mothering environment

Stigma consciousness

The pressures on mothers to conform to sociocultural expectations were assessed in two ways. *Stigma consciousness* reflected the extent to which participant's expected to be stereotyped in relation to being pregnant, being a mother and appropriate behaviour as such, irrespective of how they actually behaved. Stigma consciousness is known to reflect the extent to which individuals feel judged as a result of their group membership (Pinel, 1999), and, thus, women with higher levels of stigma consciousness surrounding motherhood detect greater levels of social threat. *Stigma consciousness* was measured using an adapted version of Pinel's (1999) Stigma Consciousness Questionnaire for Women; wording was altered to assess stigma perception regarding mothering, trying to avoid suggesting where stigma may be coming from by using 'others' or 'people' instead of a specific group (men were used in the original questionnaire for women). Wording was also adjusted to remove the original reverse scoring due to it being deemed too confusing, especially when combined with 'agree-disagree' questions which are cognitively complex (Fowler, 1995). Ten statements were presented and participants were asked to rate the extent to which they agree with them. The scoring ranges from 0 'Strongly disagree' to 6 'Strongly agree', with a midpoint of 3 'Neither agree nor disagree' (Pinel, 1999); the wording of the full scale was not detailed so 'moderately disagree/agree' and 'mildly disagree/agree' were utilised. Scores were summed to provide a continuous measure of *stigma consciousness* where higher scores indicate higher awareness regarding stigma attached to mothering. The original Stigma Consciousness Questionnaire for Women had a Cronbach's alpha of 0.770 (Pinel, 1999), the adapted version used here was found to have an alpha of 0.822.

Perception of social pressure

The *perception of social pressure* surrounding mothering was also measured using an adapted version of question 14 of Corning's (2000) Perceived Social Inequity-Women's Form with wording altered to tap the social pressures surrounding mothers and their sources. Participants were asked to rate their opinion on 16 statements regarding the portrayal of mothering by medical professionals, in pregnancy and childcare manuals/websites, and on TV, and the way other mothers behave on a 5-point scale of 'Very much' to 'Not at all' (direction of scoring depends on the statement). Scores were summed to provide a continuous measure of the *perception of social pressure* where higher scores indicate higher perceived pressures. A Cronbach's alpha is not available for the original Perceived Social Inequity-Women's Form as its structure precludes such reliability measures as its items are not necessarily expected to correlate (Corning, 2002), nonetheless the adapted measure was found to have an alpha of 0.844. Although awareness of stigma attached to mothering and awareness of social pressures on mothers are likely to overlap, one does not necessarily entail the other and reliability analysis shows the questions assessing *stigma consciousness* and *perceptions of social pressure* to have low correlation when combined with an alpha of 0.448. Both measures were taken during pregnancy (wave 1).

Perception of risk

Perception of risk surrounding mothering was measured with the following questions: How much risk do you feel your baby has been exposed to during your pregnancy so far? (0 'None', 1 'A little', 2 'Moderate', 3 'A lot', and 4 'Extreme'); How much risk do you feel your baby will be exposed to once it is born? (0 'None', 1 'A little', 2 'Moderate', 3 'A lot', and 4 'Extreme'); Do you feel under pressure to protect your baby from risk? (0 'No not at all', 1 'Yes a little', 2 'Yes moderately', 3 'Yes a lot', 4 'Yes extremely'), and; How confident are you in your ability to protect your baby from risk? (0 'Extremely', 1 'Very', 2 'Moderately', 3 'Quite', and 4 'Not at all'). The answers were summed to create a continuous measure of risk perception where higher scores indicated higher perceived risk. 'Risk' is purposefully undefined, rather than tapping concern regarding specified dangers to which mothers and their infants might be exposed. By letting participants freely interpret the concept of risk this measure instead encompasses the free-floating anxiety (Lee, 2014b) which scholars of parenting culture studies contend problematically dominates the contemporary Western mothering environment. Whilst it does not allow for the quantification of fear regarding particular threats, it also does not constrain what is deemed worthy of generating concern (which in the relative safety of a WEIRD context would be a short list) and, therefore, does not miss, for example, women who by the same token of subscribing to intensive parenting objectively protect their infants from risk and yet may subjectively perceive more risk. Measures were taken during pregnancy (wave 1) and approximately 6 months postnatally (wave 3).

Shame

The experience of shame was measured using Andrew, Qian, and Valentine's (2002) Experiential Shame Scale (ESS), designed to assess the causal relationship between shame and general depression. The ESS is a self-report questionnaire which asks direct questions regarding shame (21 questions) and the specific origins of shame (4 questions). The test was originally developed to test bodily shame and its role in the aetiology of depression, and these questions were replaced with ones regarding shame at maternal behaviour and feelings. Experience of shameful feelings are rated on a scale of 1 'Not at all', 2 'A little', 3 'Moderately', 4 'Quite a lot', and 5 'Very much'; scores are summed to provide a continuous measure of *general shame* (all scores summed) and *maternal shame* (just scores from maternal related questions), where higher scores indicate higher levels of shame. Exploratory analysis found the newly designed Maternal Shame Scale (MSS) to have a similar reliability as the original ESS: the ESS Cronbach's alpha was 0.959 (wave 1) and (wave 3) and for the *maternal shame* scale it was 0.803 (wave 1), 0.942 (wave 2), and 0.869 (wave 3). *Maternal shame* was measured during pregnancy (wave 1), at approximately 1 month postnatally (wave 2), and 6 months postnatally (wave 3), while *general shame* was measured during wave 1 and wave 3.

-Depression measures

Antenatal depression

Antenatal depression was assessed during pregnancy (wave 1) using Choi *et al*.'s (2012) simplified EPDS to detect antenatal depression. The recommended cut-off of 3 was used to create a binary categorical measure of antenatal depression experience. Antenatal depression is one of the strongest predictors of PND (Beck, 2001), with 80% of women depressed during pregnancy going on to suffer from PND (RCM, 2012b). Antenatal depression has also been associated with inflammation (for a review see Miller *et al*., 2013), it shares risk factors with PND (Lancaster *et al*., 2010), and has been found to mediate the relationship between a range of risk factors and PND

(Leigh and Milgrom, 2008). Thus it was used as a control in various analyses where PND is the outcome variable.

Postnatal depression

PND was assessed in a number of ways in the second, third, and fourth questionnaires. The EPDS (Cox, Holden, and Sagovsky, 1987: for more detail see Chapter 2) was used to measure current postnatal *depressive symptom severity* at approximately 1 month postnatal (wave 2), and a binary categorical measure of *current PND* experience was created using a cut-off of 12. The EPDS was again used to measure current postnatal *depressive symptom severity* at approximately 6 months postnatal (wave 3) or *current PND*, and categorical measures of PND experience were also provided by the BPDS (Stein and van den Akker, 1992: for more detail see Chapter 2) which assessed whether PND had been experienced at any point within the previous 6 months, and diagnostic history; the fourth questionnaire also contained the latter two measures. From these three measures the binary categorical variable *PND ever* was created, reflecting whether PND had been experienced according to at least one measure within approximately 6 months postnatal.

-Emotional investment

'Emotional bonding' was measured using the Mother-to-Infant Bonding Scale (MIBS) (Taylor *et al*., 2005). The MIBS requires participants to rate the extent to which they experienced 8 feelings of positive and negative affect towards their infant on a 4-point scale of 'Not at all' to 'Very much' (direction of scoring depends on the feeling); scores were summed providing a continuous measure of *bonding* where lower scores indicate greater strength of "bond". Scores were measured at approximately 1 (wave 2) and 6 months (wave 3) postnatally.

At approximately 6 months postnatal (wave 3) participants were asked to report in which month they first felt strongly emotionally bonded with their infant (the preceding question asked *if* they felt strongly emotionally bonded yet – to which all responded 'Yes'), providing a continuous measure of *time to bond* where higher scores indicated a longer time.

Finally, participants were asked to rate their confidence in their developing emotional bond with their infant on a scale of 1 'Not confident', 2 'Slightly confident', 'Moderately confident', 'Confident', and 5 'Very confident'. This was used as a continuous measure of *bond confidence* where higher scores indicated higher confidence. Ratings were measured at approximately 1 (wave 2) and 6 months (wave 3) postnatally.

While the case for a shift in terminology from 'bonding' to 'maternal investment' has been made in Chapter 1, these measures continue to make use of the phases 'bonding' and 'emotional bonding' as this is the language with which participants are familiar and has been previously used in relation to the MIBS.

-Social isolation

The amount of time mothers spent alone with their infants without the company of another adult was used as an indicator of their social isolation. A study by Kitsinger (1989) found that a large proportion of mothers were alone for long periods and the same question and response categories were employed in the present study; participants were asked 'On weekdays, how long are you usually alone at home without another adult?' with the response scale 1 'Less than 2 hours', 2 '2-4 hours', 3 ' 4-8 hours', 4 ' 8-12 hours', and 5 '12-24 hours'. Because the response categories do not reflect equal units of time using them as a continuous variable is not ideal, however the small sample size (N = 46) available also renders use of the full scale as a multiple categorical variable in logistic regression problematic due to there not being enough responses in some categories. Exploratory AICc comparison found splitting responses into a binary categorical variable where 0 = 'Less than 2 hours – 4-8 hours' and 1 = '8-12 hours – 12-24 hours' to lose the least information (compared to other combinations) when predicting PND (see Appendix F); this is used as a categorical measure of *time spent alone* in the following analyses and was measured at approximately 6 months postnatally (wave 3).

-Demographics

SES was determined by the Social Class Based on Occupation method (CeLSIUS, 2007: see Chapter 2 for more details); dummy binary variables were created for use in linear regression analysis where high SES (‘Professional’) acted as the reference category and was compared with either medium SES (‘Managerial and technical’) or low SES (‘Skilled non-manual, skilled manual, partially skilled, unskilled’). The highest level of education attained was reported, categorised as either ‘Less than a Bachelor’s degree’, ‘Bachelor’s degree’, or ‘Postgraduate degree’. Participants also reported their date of birth from which *maternal age* was calculated, country of residence, their relationship status, and their number of existing biological children.

-Sample characteristics

The average age of women at the time they completed the first wave of the study during pregnancy was 31.7 years (s.d. 4.7, range 25.0). The mean number of pre-existing biological children was 0.7 (s.d. 0.8, range 3) and for 45.7% of women this was their first child. The majority of women resided in the UK (62.5%) or North America (29.7%). The majority of women were married or in a civil partnership (85.7%) and only 4.3% were single; 98.5% cohabited with a partner. Of the people making the majority of the financial contributions to the household (either the woman or her partner), the majority were of ‘professional’ occupation (68.6%), 14.3% were in ‘managerial or technical’ roles, 12.8% were in ‘skilled’ roles, and 4.3% in ‘partly-skilled – unskilled’ occupations. The majority of women were university educated (72.8%), with 45.5% holding postgraduate degrees (statistics only available for women completing wave 3). At approximately 6 months after giving birth, on weekdays 41.3% of mothers spent 8 hours or more alone with their infant, without the company of another adult (Table 3.3). At the time they completed the first wave of the study 21 women (30.0%) met the cut-off criteria for antenatal depression, at one month postnatally 11 women (19.6%) met the cut-off criteria for PND, at six months postnatally 10 women (21.7%) met the cut-off criteria for PND, within approximately six months of giving birth 19 women (27.1%) met the criteria for PND according to at least one measure of PND used – 5 of the 67 women

(7.5%) of the women completing either wave 3 or 4 (data not available for those women whose last wave was wave 2 (N = 3)) had received an actual diagnosis of PND.

Time spent alone	Frequency	Percentage (95% CI)
Less than 2 hours	11	23.9 (11.58 – 36.22)
2-4 hours	5	10.9 (1.89 – 19.91)
4-8 hours	11	23.9 (11.58 – 36.22)
8-12 hours	17	37.0 (23.05 – 50.95)
12-24 hours	2	4.3 (-1.56 – 10.16)

Table 3.3 Distribution of time spent alone without the company of another adult on weekdays at 6 months postnatally.

-Modelling approach and data handling

Due to the small sample sizes available for each wave on the study the number of control variables it was possible to enter in the subsequent models was limited. The education variable, having been collected in the third wave is particularly restrictive; however exploratory analysis finds education to be significantly related to SES, mirroring results found elsewhere (Caro, McDonald, and Williams, 2009), and so SES is used preferentially as a demographic control variable, along with maternal age. Exploratory analysis also found no differences in *risk perception*, *stigma consciousness*, *perception of social pressure*, *general* and *maternal shame*, *bonding*, *bond confidence*, *time to bond*, or the incidence of PND dependent on whether or not a woman had pre-existing biological children and so this was not controlled for.

Bias corrected and accelerated (BCa) bootstrapping was performed on some models to counter heteroscedasticity indicated by analysis of the residuals; this is a robust procedure and avoids potential complications associated with data transformation (Field, 2013). Where bootstrapping is applied the number of samples used is indicated in the relevant results table and any bootstrapped significance values reported in the text are preceded by the notation BCa.

Multicollinearity between variables was assessed via inspection of variance inflation factors (VIF) and tolerance statistics. In all models presented no VIFs were found to be greater than 10, the average VIF was never noticeably greater than 1, and no tolerance statistics were less than 0.2 (Field, 2013); thus no variables were deemed to be problematically correlated.

-Statistical approach

Si) *Shame will be predicted by stigma consciousness surrounding mothering and the perception of social pressures on mothers*

Linear regression models were run in which either *general shame* (waves 1-2) or *maternal shame* (waves 1-3) acted as the dependent variable and *stigma consciousness*, *perception of social pressure*, or *stigma consciousness and perception of social pressure* (wave 1) acted as the predictor variables, and *SES* and *maternal age* acted as controls. Bias corrected and accelerated (BCa) bootstrapping was performed on some models to counter heteroscedasticity indicated by analysis of the residuals (Field, 2013).

Sii) *Shame will be predicted by strength of bonding, confidence in bonding, and time to bond*

Linear regression models were run in which either *general shame* (wave 1-2) or *maternal shame* (waves 1-3) acted as the dependent variable and *bonding* (wave 2), *bonding confidence* (wave 2), or *time to bond* (wave 3) acted as the predictor variables either individually or in combination. BCa bootstrapping was performed on some models to counter heteroscedasticity.

Siii) *The perception of stigma and social pressure surrounding mothering will moderate the relationship between bonding and shame*

Moderation analysis was conducted using the Process tool in SPSS (Hayes, 2013); Process centres the variables entered, and tests whether the predictor variable and the moderator variable significantly interact to predict the outcome variable. Moderation analyses were run with s*tigma consciousness* or the *perception of social pressure* acting as the moderator variable (wave 1), the predictor variable was either *bonding* (wave 2), *bonding confidence* (wave 2), or *time to bond* (wave 3) and the outcome variable was *maternal shame* (wave 2-3). *General shame* was not analysed, as the preceding two analyses found stronger effects regarding *maternal shame*. Process automatically applies either percentile or bias corrected bootstrapping; bias corrected was applied using 1000 samples (Field, 2013).

Siv) *Shame will predict PND*

Binary logistic regression models were run with either *current PND* at approximately 1 month postnatal (wave 2) or *PND ever* by approximately 6 months postnatally (wave 3) acting as the binary dependent variable and *maternal shame* during pregnancy (wave 1) acting as the predictor variable, whilst also controlling for *antenatal depression*. The *maternal shame* variable was also centred and standardised to enable the odds ratio to be interpreted as an effect size and compared to *antenatal depression*.

Sv) *Shame will moderate the relationship between bonding and PND*

Moderation analysis was conducted using the Process tool in SPSS (Hayes, 2013) to test whether the experience of *maternal shame* (wave 1) moderates the relationship between *bonding* (wave 2) or *bond confidence* (wave 2) and *current PND* (wave 2) or *PND ever* (wave 3), controlling for *antenatal depression*. Bias corrected bootstrapping was applied.

Svi) *Stigma consciousness and the perception of social pressures on mothers will interact with bonding to predict PND*

Moderation analysis was conducted using the Process tool in SPSS (Hayes, 2013) to test whether *stigma consciousness* or *perception of social pressure* (wave 1) moderates the relationship between *bonding* (wave 2) or *bonding confidence* (wave 2) and *current PND* (wave 2) or *PND ever* (wave 3), controlling for *antenatal depression*. Bias corrected bootstrapping was applied.

Ri) Stigma consciousness and the perception of social pressures surrounding mothering will positively correlate with the perception of risk surrounding mothering

Linear regressions models were run in which *perception of risk* (wave 1) acted as the dependent variable and either *stigma consciousness* (wave 1), *perception of social pressure* (wave 1), or both acted as the predictor variable, while also controlling for *SES* and *maternal age*. The residuals generated by regressing *perception of social pressure* showed a lack of linearity thus the variable was subjected to a log transformation using base 10.

Rii) *The perception of risk surrounding mothering will predict shame regarding mothering*

Linear regression models were run in which *maternal shame* (wave 1-3) acted as the dependent variable and *perception of risk* (wave 1 and 3) acted as the predictor variable. BCa bootstrapping was performed to counter heteroscedasticity.

Riii) *The relationship between the perception of risk and shame will be moderated by bonding and confidence in bonding*

Moderation analysis was conducted using the Process tool in SPSS (Hayes, 2013) to test whether *bonding* and *bonding confidence* (wave 2 and 3) moderate the relationship between *perception of risk* (wave 1 and 3) and *maternal shame* (wave 2-3). Bias corrected bootstrapping was applied.

Riv) *The relationship between the perception of risk and shame will be moderated by stigma consciousness and perception of social pressure*

Moderation analysis was conducted using the Process tool in SPSS (Hayes, 2013) to test whether *stigma consciousness* and the *perception of social pressure* (wave 1) moderate the relationship between *perception of risk* (wave 1 and 3) and *maternal shame* (wave 1-3). Bias corrected bootstrapping was applied.

Rv) *The perception of risk will predict PND*

Binary logistic regression models were run in which the *current PND* at approximately 1 month postnatally (wave 2) or *PND ever* (wave 3) acted as the dependent variable and the *perception of risk* during pregnancy acted as the predictor variable, while also controlling for *antenatal depression*.

Rvi) *The relationship between risk and PND will be moderated by shame*

Moderation analysis was conducted using the Process tool in SPSS (Hayes, 2013) to test whether the experience of *maternal shame* (wave 1 and 2) moderates the relationship between *perception of* *risk* (wave 1) and *current PND* (wave 2) or *PND ever* (wave 3), controlling for *antenatal depression* (wave 1). Bias corrected bootstrapping was applied.

SIi) *Social isolation will positively predict PND*

A binary logistic regression model was run in which the categorical measure of whether PND was experienced within 6 months of giving birth (*PND ever*) (wave 3) acted as the dependent variable and the categorical measure *time spent alone* (wave 3) acted as the predictor variable, while controlling for *antenatal depression* (wave 1).

Results

Si) *Shame will be predicted by stigma consciousness surrounding mothering and the perception of social pressures on mothers*

Stigma consciousness surrounding mothering positively predicted *general shame* during pregnancy and 1 month postnatally (BCa $p < 0.05$) and *maternal shame* during pregnancy and at 6 months postnatally (BCa $p < 0.05$) (Table 3.4). The variable *perception of social pressure* surrounding mothering positively predicted *maternal shame* during pregnancy (BCa $p = 0.039$) (Table 3.4). When *stigma consciousness* and the *perception of social pressure* were entered together, only *stigma consciousness* positively predicted *general shame* during pregnancy (BCa $p = 0.001$) and at 1 month postnatally ($p = 0.003$), while *maternal shame* was positively predicted by *stigma consciousness* (BCa $p = 0.001$) and *perception of social pressure* at a level approaching significance (BCa $p = 0.061$) during pregnancy and at 6 months postnatally (BCa $p = 0.037$ and 0.067 respectively) (Table 3.4). The most variance in *maternal shame* both during pregnancy and 6 months postnatally was captured by models including both *stigma consciousness* and the *perception of social pressure* (all models performed poorly when predicting *maternal shame* 1 month postnatally).

Variable	General Shame During Pregnancy					Maternal Shame During Pregnancy				
	Unstandardised coefficient	Standardised coefficient		95% CI for *b*		Unstandardised coefficient	Standardised coefficient		95% CI for *b*	
	b	***β***	***p***	**Lower**	**Upper**	***b***	***β***	***p***	**Lower**	**Upper**
Social pressure only										
Constant	61.579		0.001	26.373	96.784	3.552		*0.383*	*-3.942*	*13.490*
Perception of social pressure	**2.140**	**0.181**	**0.124**	**-0.604**	**4.883**	**0.739**	**0.348**	***0.039***	***0.343***	***2.365***
Maternal age	-0.630	-0.148	0.239	-1.688	0.428	0.025	0.033	*0.556*	*-2.299*	*1.279*
High (ref) vs medium SES	-5.250	-0.092	0.435	-18.601	8.100	-0.547	-0.053	*0.254*	*-0.707*	*3.731*
High (ref) vs low SES	13.107	0.248	**0.053**	-0.158	26.372	1.779	0.187	*0.825*	*-0.206*	*0.183*
Adjusted R^2					0.101					0.112
Stigma only										
Constant	9.025		*0.588*	*-21.299*	*58.299*	-4.668		*0.176*	*-10.714*	*4.330*
Stigma consciousness	**1.288**	**0.573**	***0.001***	***0.935***	***1.685***	**0.222**	**0.550**	***0.001***	***0.136***	***0.318***
Maternal age	-0.307	-0.072	*0.448*	*-1.104*	*0.272*	-0.282	-0.027	*0.744*	*-2.146*	*1.428*
High (ref) vs medium SES	-2.402	-0.042	*0.442*	*-8.985*	*3.669*	1.585	0.166	*0.188*	*-0.700*	*3.349*
High (ref) vs low SES	11.949	0.226	***0.075***	*-0.921*	*22.391*	0.101	0.132	*0.236*	*-0.085*	*0.221*
Adjusted R^2					0.408					0.299
Both										
Constant	9.026		*0.562*	*-16.955*	*45.789*	-4.516		*0.217*	*-11.062*	*4.041*
Perception of social pressure	**0.003**	**0.000**	***0.997***	***-2.256***	***4.155***	**0.411**	**0.193**	***0.061***	***0.004***	***1.472***
Stigma consciousness	**1.288**	**0.573**	***0.001***	***0.909***	***1.654***	**0.198**	**0.489**	***0.001***	***0.111***	***0.280***
Maternal age	-0.307	-0.072	*0.420*	*-1.307*	*0.412*	0.075	0.098	*0.420*	*-0.092*	*0.197*
High (ref) vs medium SES	-2.401	-0.042	*0.462*	*-8.838*	*3.716*	-0.109	-0.011	*0.899*	*-1.766*	*1.553*
High (ref) vs low SES	11.949	0.226	***0.063***	*-1.736*	*22.756*	1.601	0.168	*0.148*	*-0.388*	*3.161*
Adjusted R^2					0.398					0.323

Table 3.4 Results of linear regression analysis assessing the effect of the perception of social pressure and/or stigma consciousness during pregnancy and shame measured at various points in time, after controlling for maternal age and SES. Significance and 95% CIs in *italics* indicate results of bias corrected and accelerated (BCa) bootstrapping based on 1000 samples unless otherwise noted to counter heteroscedasticity: a=999, b=997, c=998 samples; e=Some results could not be computed from jackknife samples, so this confidence interval is computed by the percentile method rather than the BCa method.

Variable	General Shame at 1 Month Postnatally					Maternal Shame at 1 Month Postnatally				
	Unstandardised coefficient	Standardised coefficient		95% CI for *b*		Unstandardised coefficient	Standardised coefficient		95% CI for *b*	
	b	*β*	*p*	Lower	Upper	*b*	*β*	*p*	Lower	Upper
Social pressure only										
Constant	53.296		*0.018*	*11.143*	*105.165*	10.587		*0.010*	*4.540*	*16.421*
Perception of social pressure	**1.548**	**0.151**	***0.374***	***-0.848***	***9.288***	**0.263**	**0.115**	***0.326***	***-0.120***	***2.140***
Maternal age	-0.418	-0.107	*0.473*	*-1.549*	*0.393*	-0.166	-0.189	*0.105*	*-0.406*	*0.038*
High (ref) vs medium SES	-8.685	-0.161	***0.059***	*-17.349*	*-0.390*	-1.088	-0.090	*0.234*	*-2.978*	*0.663*
High (ref) vs low SES	8.093	0.165	*0.293*	*-6.954*	*20.439*	1.275	0.116	*0.496*	*-2.288*	*5.214*
Adjusted R^2					0.042					0.017
0.Stigma only										
Constant	20.130		*0.303*	*-18.870*	*72.576*	7.613		*0.073*[a]	*-1.685*[a]	*16.428*[a]
Stigma consciousness	**0.816**	**0.411**	***0.003***	***0.239***	***1.455***	**0.080**	**0.179**	***0.232***[a]	***-0.088***[a]	***0.223***[a]
Maternal age	-0.192	-0.049	*0.683*	*-1.291*	*0.533*	-0.137	-0.157	*0.176*[a]	*-0.367*[a]	*0.068*[a]
High (ref) vs medium SES	-5.740	-0.107	*0.203*	*-14.449*	*3.958*	-0.878	-0.073	*0.311*[a]	*-2.531*[a]	*0.825*[a]
High (ref) vs low SES	7.519	0.153	*0.297*	*-6.892*	*18.788*	1.214	0.110	*0.524*[a]	*-3.066*[a]	*5.871*[a]
Adjusted R^2					0.192					0.036
Both										
Constant	20.236		0.324	-20.556	61.028	7.670		*0.092*	*0.176*	*14.722*
Perception of social pressure	**0.285**	**0.028**	**0.831**	**-2.387**	**2.957**	**0.152**	**0.066**	***0.504***	***-0.221***	***2.004***
Stigma consciousness	**0.799**	**0.402**	**0.003**	**0.279**	**1.318**	**0.070**	**0.158**	***0.281***	***-0.092***	***0.200***
Maternal age	-0.211	-0.054	0.689	-1.263	0.842	-0.147	-0.168	*0.154*	*-0.407*	*0.115*
High (ref) vs medium SES	-5.628	-0.105	0.410	-19.242	7.987	-0.818	-0.068	*0.375*	*-2.572*	*1.000*
High (ref) vs low SES	7.543	0.153	0.258	-5.696	20.782	1.226	0.111	*0.511*	*-2.132*	*5.386*
Adjusted R^2					0.177					0.021

Table 3.4 (continued) Results of linear regression analysis assessing the effect of the perception of social pressure and/or stigma consciousness during pregnancy and shame measured at various points in time, after controlling for maternal age and SES. Significance and 95% CIs in *italics* indicate results of bias corrected and accelerated (BCa) bootstrapping based on 1000 samples unless otherwise noted to counter heteroscedasticity: a=999, b=997, c=998 samples; e=Some results could not be computed from jackknife samples, so this confidence interval is computed by the percentile method rather than the BCa method.

Variable	Maternal Shame at 6 Months Postnatally				
	Unstandardised coefficient	Standardised coefficient		95% CI for ***b***	
	b	***β***	***p***	**Lower**	**Upper**
Social pressure only					
Constant	7.468		*0.195*[b]	*-2.271*[b]	*22.382*[b]
Perception of social pressure	**0.625**	**0.295**	***0.131***[b]	***-0.156***[b]	***2.453***[b]
Maternal age	-0.111	-0.166	*0.544*[b]	*-0.429*[b]	*0.055*[b]
High (ref) vs medium SES	-0.253	-0.029	*0.865*[b]	*-2.370*[b]	*1.738*[b]
High (ref) vs low SES	2.855	0.306	*0.263*[b]	*-2.759*[b,e]	*6.918*[b]
Adjusted R^2					0.147
Stigma only					
Constant	-0.203		*0.973*[c]	*-9.270*[c]	*15.501*[c]
Stigma consciousness	**0.165**	**0.438**	***0.023***[c]	***0.042***[c]	***0.262***[c]
Maternal age	-0.004	-0.006	*0.979*[c]	*-0.287*[c]	*0.153*[c]
High (ref) vs medium SES	0.862	0.099	*0.569*[c]	*-1.366*[c]	*3.168*[c]
High (ref) vs low SES	2.599	0.279	*0.167*[c]	*-0.873*[c]	*5.796*[c]
Adjusted R^2					0.238
Both					
Constant	0.125		*0.979*[a]	*-9.695*[a]	*20.681*[a]
Perception of social pressure	**0.478**	**0.226**	***0.067***[a]	***-0.639***[a]	***1.800***[a]
Stigma consciousness	**0.149**	**0.395**	***0.037***[a]	***0.042***[a]	***0.208***[a]
Maternal age	-0.051	-0.076	*0.751*[a]	*-0.343*[a]	*0.080*[a]
High (ref) vs medium SES	0.788	0.090	*0.630*[a]	*-1.498*[a]	*2.322*[a]
High (ref) vs low SES	2.409	0.258	*0.223*[a]	*-1.335*[a]	*5.170*[a]
Adjusted R^2					0.271

Table 3.4 (continued) Results of linear regression analysis assessing the effect of the perception of social pressure and/or stigma consciousness during pregnancy and shame measured at various points in time, after controlling for maternal age and SES. Significance and 95% CIs in *italics* indicate results of bias corrected and accelerated (BCa) bootstrapping based on 1000 samples unless otherwise noted to counter heteroscedasticity: a=999, b=997, c=998 samples; e=Some results could not be computed from jackknife samples, so this confidence interval is computed by the percentile method rather than the BCa method.

SES predicted *general shame* in various models but it did not predict *maternal shame* in any models at any time point, and *maternal age* did not predict either measure of shame at any time point (Table 3.4).

Sii) *Shame will be predicted by strength of bonding, confidence in bonding, and time to bond*

Strength of *bonding* at approximately 1 month postnatally negatively predicted the experience of *general shame* at approximately 1month postnatally (BCa $p = 0.002$) and *maternal shame* at both approximately 1 (BCa $p = 0.001$) and 6 months postnatally ($p = 0.001$) (Table 3.5). *Bonding confidence* at approximately 1 month postnatally negatively predicted the experience of *general shame* at approximately 1 month postnatally ($p = 0.000$) and *maternal shame* at both approximately 1 (BCa $p = 0.003$) and 6 months postnatally ($p = 0.000$) (Table 3.5). The *time to bond* positively predicted *maternal shame* at 6 months postnatally (BCa $p = 0.021$) (Table 3.5). When entered together, only *bonding confidence* negatively predicted *general shame* at approximately 1 month postnatally ($p = 0.002$), while *maternal shame* was negatively predicted by both *bonding confidence* (BCa $p = 0.024$) and *bonding* approaching significance (BCa $p = 0.088$) (Table 3.5). When *bonding*, *bonding confidence*, and *time to bond* were entered together they accounted for 58% of the variance in *maternal shame* experience at approximately 6 months postnatal, with *bonding confidence* remaining significant (BCa $p = 0.009$) and *time to bond* remaining significant at a level approaching significance (BCa $p = 0.077$) (Table 3.5).

Siii) *The perception of stigma and social pressure surrounding mothering will moderate the relationship between bonding and shame*

Stigma consciousness had a moderating effect on the relationship between *bonding confidence* at approximately 1 month postnatally and *maternal shame* at approximately 6 months postnatal (interaction $p = 0.014$), such that while there was a general decline in shame as confidence increased, women who were highly conscious of stigma experienced the most shame when they were least confident and showed the sharpest decline in shame as confidence increased (Figure 3.2). The *perception of social pressure* had a moderating effect on the relationship between

Variable	Unstandardised coefficient		Standardised coefficient	*p*	95% CI for *b*		Adjusted R^2
	b	**SE**	***β***		**Lower**	**Upper**	
Bonding wave 2 and general shame wave 2							
Constant	38.936	3.387		*0.001*	*33.025*	*45.774*	0.131
Bonding	2.852	0.928	0.383	***0.002***	*1.143*	*4.505*	
Bonding wave 2 and maternal shame wave 2							
Constant	4.330	0.718		*0.001*	*3.239*	*5.681*	0.221
Bonding	0.809	0.197	0.485	***0.001***	*0.417*	*1.149*	
Bonding wave 2 and maternal shame wave 3							
Constant	4.843	0.665		0.000	3.494	6.193	0.269
Bonding	0.629	0.164	0.537	**0.001**	0.295	0.962	
Bonding confidence wave 2 and general shame wave 2							
Constant	106.382	13.933		0.000	78.459	134.305	0.243
Bonding confidence	-13.493	3.101	-0.506	**0.000**	-19.707	-7.729	
Bonding confidence wave 2 and maternal shame wave 2							
Constant	21.648	2.968		*0.001*	*13.734*	*28.118*	0.315
Bonding confidence	-3.419	0.660	-0.572	***0.003***	*-4.926*	*-1.484*	
Bonding confidence wave 2 and maternal shame wave 3							
Constant	19.658	2.043		0.000	15.514	23.801	0.520
Bonding confidence	-3.025	0.472	-0.730	**0.000**	-3.982	-2.067	
Time to bond and maternal shame at wave 3							
Constant	4.437	0.748		*0.001*	*2.952*	*6.283*	0.170
Time to bond	1.250	0.387	0.434	***0.021***	*0.292*	*2.093*	
Bonding and bonding confidence wave 2 and general shame wave 2							
Constant	92.075	16.423		0.000	59.149	125.001	0.263
Bonding	1.507	0.947	0.202	0.117	-0.392	3.402	
Bonding confidence	-11.169	3.389	-0.419	**0.002**	-17.964	-4.375	
Bonding and bonding confidence wave 2 and maternal shame wave 2							
Constant	17.014	3.389		*0.012*	*6.549*	*26.984*	0.375
Bonding	0.488	0.195	0.292	***0.088***	*-0.065*	*.897*	
Bonding confidence	-2.666	0.699	-0.446	***0.024***	*-4.456*	*-.762*	
Bonding and bonding confidence wave 2, time to bond, and maternal shame wave 3							
Constant	13.258	2.455		*0.001*	*5.553*	*19.570*	0.579
Bonding	0.191	0.134	0.178	*0.290*	*-0.206*	*0.480*	
Bonding confidence	-2.009	0.487	-0.518	***0.009***	*-3.300*	*-0.520*	
Time to bond	0.846	0.348	0.290	***0.077***	*-0.212*	*1.723*	

Table 3.5 Results of linear regression analysis assessing the effect of emotional investment measures on shame at various time points: approximately 1 month postnatally (wave 2) and 6 months postnatally (wave 3). Significance and 95% CIs in *italics* indicate results of bias corrected and accelerated (BCa) bootstrapping based on 1000 samples to counter heteroscedasticity.

bonding confidence at approximately 1 month postnatal and *maternal shame* at approximately 6 months postnatally (interaction p = 0.005), such that at women who perceived low levels of social pressure experienced moderate (relative to the sample) levels of shame irrespective of their level of confidence, while women with mean and high perceptions of social pressure showed declines in shame as confidence increased, with women perceiving the highest levels of social pressure

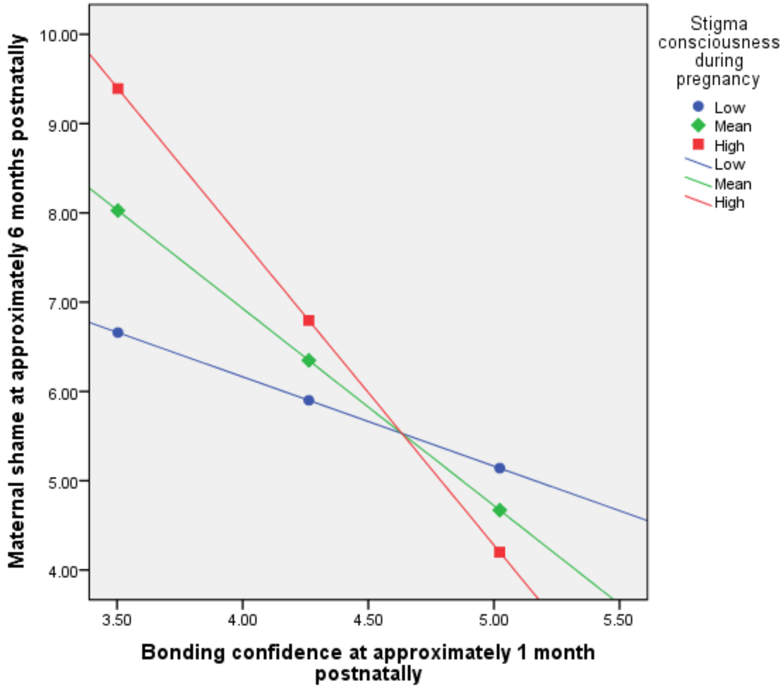

Figure 3.2 Simple slopes equations of the regression of *bonding confidence* at approximately 1 month postnatally on *maternal shame* at approximately 6 months postnatally at three levels of *stigma consciousness* during pregnancy. Values for *stigma consciousness* are the mean and +/- one standard deviation of the mean.

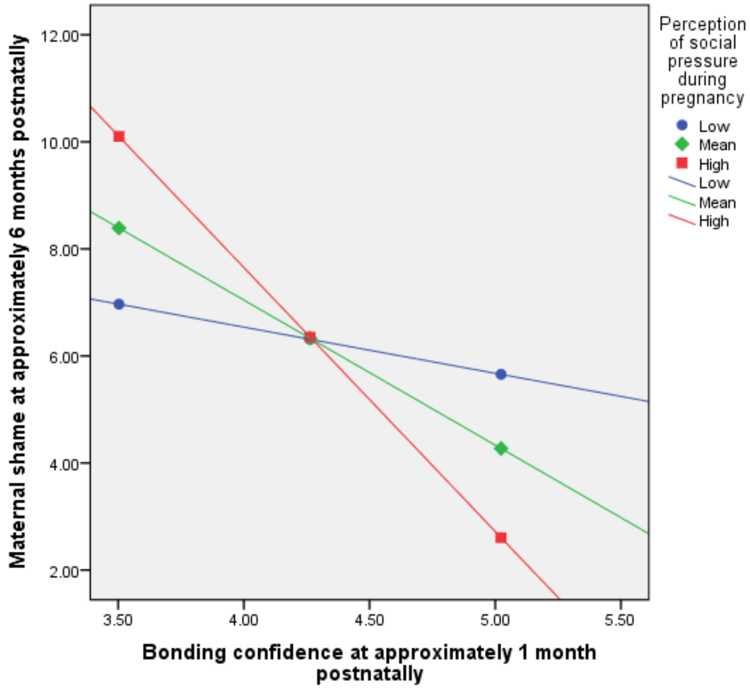

Figure 3.3 Simple slopes equations of the regression of *bonding confidence* at approximately 1 month postnatally on *maternal shame* at approximately 6 months postnatally at three levels of *perception of social pressure* during pregnancy. Values for *perception of social pressure* are the mean and +/- one standard deviation of the mean.

experiencing the most shame at low confidence levels and the least at high confidence levels (Figure 3.3).

The following interaction also approached significance if the significance is one-tailed and, thus, is suggestive of a moderation relationship: the conditional effect of the experience of *perception of social pressure* during pregnancy on the relationship between *bonding* at approximately 1 month postnatally and *maternal shame* at approximately 6 months approached one-tailed significance (interaction p = 0.082 one-tailed). The negative relationship between strength of *bonding* and *maternal shame* was stronger the higher the *perception of social pressure* (Figure 3.4).

Full significant moderation results can be seen in Table 3.6.

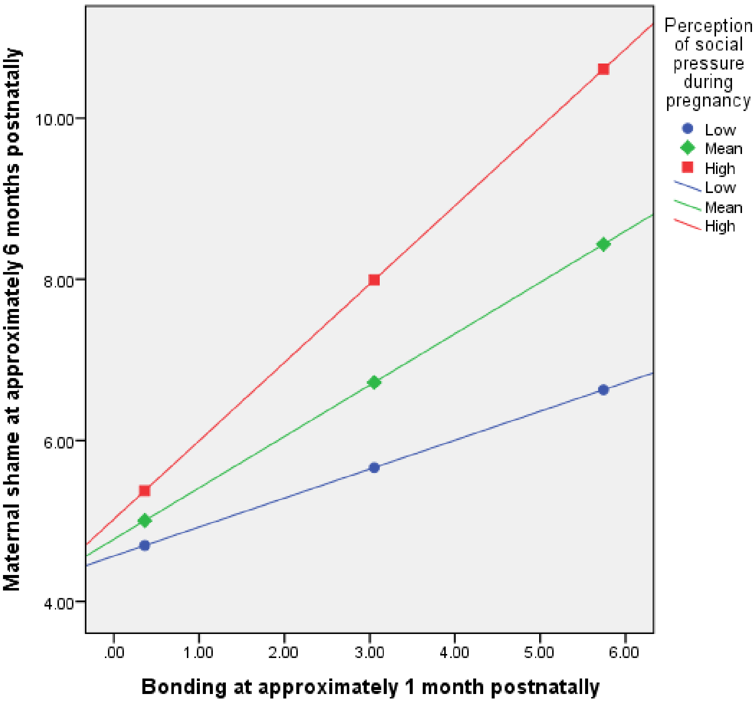

Figure 3.4 Simple slopes equations of the regression of *bonding* (higher score = lower bond strength) at approximately 1 month postnatally on *maternal shame* at approximately 6 months postnatally at three levels of *perception of social pressure* during pregnancy. Values for *perception of social pressure* are the mean and +/- one standard deviation of the mean.

Variable	Unstandardised coefficient *b*	SE	*p*	95% CI for *b*		R^2
				Lower	Upper	
Outcome – maternal shame at wave 3						
Constant	-9.553	10.138	0.353	-30.157	11.050	0.633
Stigma consciousness	0.636	0.223	**0.007**	0.184	1.089	
Bonding confidence	3.255	2.326	0.171	-1.473	7.983	
Stigma consciousness*bonding confidence	**-0.173**	**0.053**	**0.014**	**-0.245**	**-0.030**	
Outcome – maternal shame at wave 3						
Constant	-5.781	8.381	0.495	-22.813	11.251	0.639
Perception of social pressure	5.958	1.936	**0.004**	2.023	9.893	
Bonding confidence	2.828	1.973	0.161	-1.181	6.838	
Perception of social pressure*bonding confidence	**-1.394**	**0.468**	**0.005**	**-2.345**	**-0.443**	
Outcome – maternal shame at wave 3						
Constant	4.152	1.545	0.011	1.005	7.299	0.398
Perception of social pressure	0.157	0.375	0.678	-0.605	0.919	
Bonding	-0.197	0.590	0.741	-1.397	1.003	
Perception of social pressure*bonding	0.210	0.148	0.164	-0.090	0.510	

Table 3.6 Significant moderation results from testing the hypothesis that stigma consciousness and the perception of social pressure will moderate the relationship between emotional investment measures and maternal shame. Wave 3 = approximately 6 months postnatally. Significance and 95% CIs are the result of bias corrected bootstrapping based on 1000 samples.

Siv) *Shame will predict PND*

Maternal shame during pregnancy positively predicted a respondent having PND (*current PND*) at approximately 1 month after having given birth at a level approaching significance ($p = 0.051$), with an effect size over a third that of *antenatal depression*; together *maternal shame* and *antenatal depression* accounted for 19-30% of the variance in PND (Table 3.7). *Maternal shame* also positively predicted *PND ever* occurring at any time during the 6 month period since giving birth ($p = 0.048$), with an effect size 40% that of *antenatal depression*; together *maternal shame* and *antenatal depression* accounted for 17-25% of the variance in PND (Table 3.7).

Sv) *Shame will moderate the relationship between bonding and PND*

While no interactions were significant, the following two approach significance if the significance is one-tailed and thus are suggestive of a moderation relationship: The conditional effect of the experience of *maternal shame* during pregnancy on the relationship between *bonding confidence* and *current PND* at approximately 1 month approached one-tailed significance (interaction $p = 0.071$ one-tailed). Women who experienced low levels of shame were at relatively low risk of

Variable		*b*	SE	Wald	df	*p*	95% CI for odds ratio		Odds ratio	Effect size	Pseudo R^2's C&S/N
							Lower	Upper			
PND at approximately 1 month postnatally											
Antenatal depression	Yes	1.720	0.766	5.043	1	**0.025**	1.245	25.060	5.585	5.585	0.186/0.296
	No (ref)	-	-	-	-	-	-	-	-	-	
Maternal shame		**0.187**	**0.096**	**3.805**	**1**	**0.051**	**0.999**	**1.455**	**1.206**	**2.004**	
Constant		-3.666	1.003	13.363	1	0.000	-	-	0.026	0.103	
PND by approximately 6 months postnatally											
Antenatal depression	Yes	1.509	0.608	6.159	1	**0.013**	1.373	14.883	4.521	4.521	0.172/0.250
	No (ref)	-	-	-	-	-	-	-	-	-	
Maternal shame		**0.160**	**0.081**	**3.903**	**1**	**0.048**	**-.046**	**1.001**	**1.375**	**1.783**	
Constant		-2.815	0.752	14.023	1	0.000	-	-	0.060	0.198	

Table 3.7 Results of binary logistic models assessing the hypothesis that maternal shame during pregnancy will positively predict PND after controlling for antenatal depression. The odds ratio resulting from the use of a centred and standardised version of the maternal shame variable is also presented as a measure of effect size for comparison with antenatal depression.

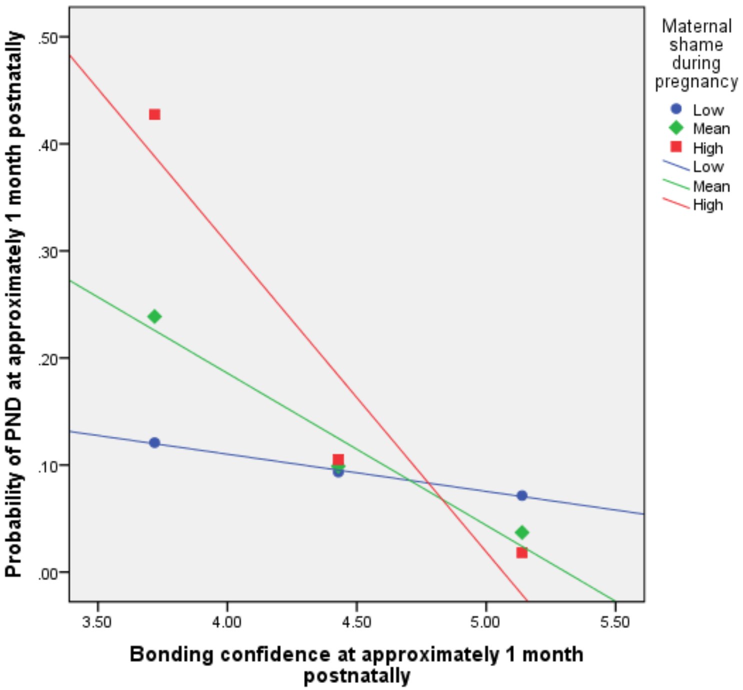

Figure 3.5 Simple slopes equations of the regression of *bonding confidence* at approximately 1 month postnatally on probability of PND at approximately 1 month postnatally at three levels of *maternal shame* during pregnancy. Values for *maternal shame* are the mean and +/- one standard deviation of the mean.

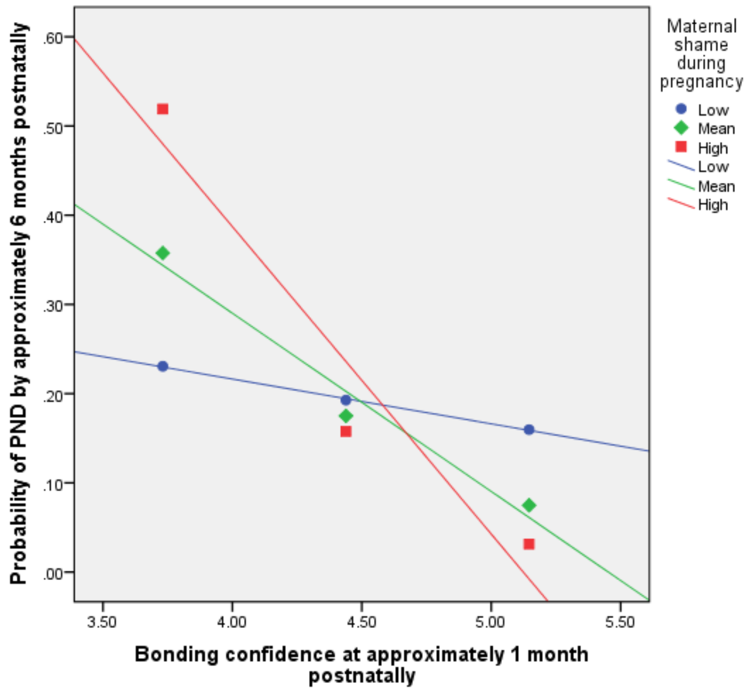

Figure 3.6 Simple slopes equations of the regression of *bonding confidence* at approximately 1 month postnatally on probability of PND by approximately 6 months postnatally at three levels of *maternal shame* during pregnancy. Values for *maternal shame* are the mean and +/- one standard deviation of the mean.

being postnatally depressed 1 month after giving birth, even if they were not confident about the bond between them and their infant; however, as shame increased, the risk of PND increased as confidence decreased, reaching approximately 40% in women who experience high levels of shame and low levels of confidence (Figure 3.5). A similar, approaching significance (interaction p = 0.060 one-tailed), relationship was found when assessing *PND ever* measured within approximately 6 months of giving birth (Figure 3.6), with the probability of PND in women of low confidence and high shame over 50%.

Full (approaching) significant moderation results can be seen in Table 3.8.

Variable	**Unstandardised coefficient *b***	**SE**	***p***	**95% CI for *b***		**Pseudo R^2's C&S/N**
				Lower	**Upper**	
Outcome – PND at wave 2						
Constant	-6.669	7.817	0.394	-21.990	8.651	0.336/
Maternal shame	1.359	0.889	0.127	-0.384	3.101	0.534
Bonding confidence	0.802	1.761	0.649	-2.650	4.254	
Maternal shame*bonding confidence	**-0.303**	**0.206**	**0.142**	**-0.706**	**0.101**	
Antenatal depression	2.701	1.038	**0.009**	0.666	4.736	
Outcome – PND by wave 3						
Constant	-5.942	6.803	0.383	-19.276	7.393	0.331/
Maternal shame	1.295	0.822	0.115	-0.316	2.906	0.483
Bonding confidence	0.875	1.518	0.564	-2.100	3.851	
Maternal shame*bonding confidence	**-0.299**	**0.188**	**0.119**	**-0.669**	**0.070**	
Antenatal depression	**2.703**	**.894**	**0.003**	**0.952**	**4.455**	

Table 3.8 Significant moderation results from testing the hypothesis that stigma consciousness and the perception of social pressure will moderate the relationship between emotional investment measures and maternal shame. Wave 2 = approximately 1 month postnatally, wave 3 = approximately 6 months postnatally. Significance and 95% CIs are the result of bias corrected bootstrapping based on 1000 samples. Pseudo R^2's: Cox & Snell (C&S), Nagelkerke (N).

Svi) *Stigma consciousness and the perception of social pressures on mothers will interact with bonding to predict PND*

While no interactions were significant, the following approached significance if the significance is one-tailed and thus is suggestive of a moderation relationship: The conditional effect of the *perception of social pressure* on the relationship between *bonding confidence* and *current PND* at approximately 1 month postnatally approached one-tailed significance (interaction p = 0.061 one-tailed). Women were unlikely to experience PND when their perception of social pressure was low, even if they were not confident about the bond between themselves and their infant; however, the likelihood of PND in women whose perception of social pressure was at mean levels for the sample decreased from moderate to low as their confidence increased, and women who perceived high levels of social pressure were at low risk of PND when their confidence was high but at high risk (over 40%) when their confidence was low (Figure 3.7).

Full (approaching) significant moderation results can be seen in Table 3.9.

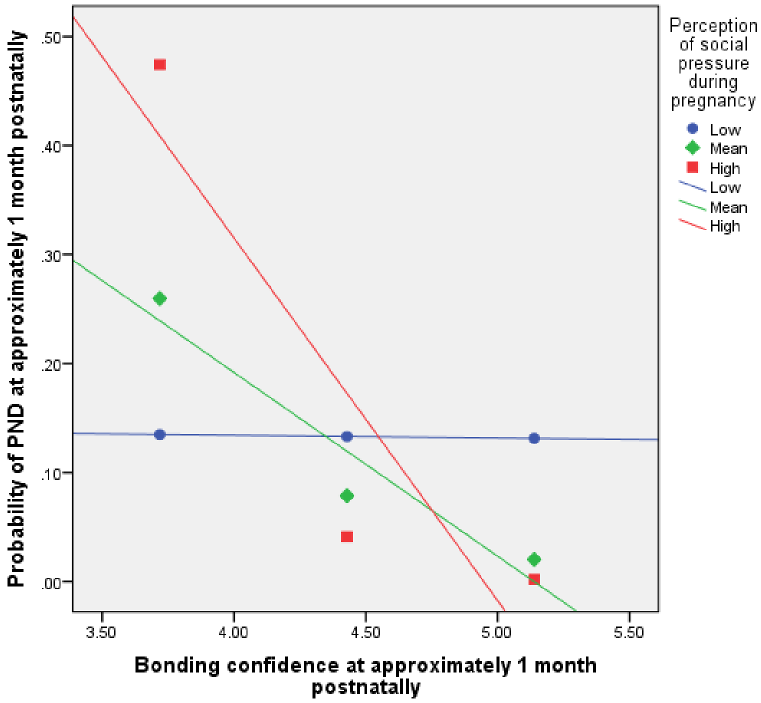

Figure 3.7 Simple slopes equations of the regression of *bonding confidence* at approximately 1 month postnatally on probability of PND at approximately 1 month postnatally at three levels of *perception of social pressure* during pregnancy. Values for *perception of social pressure* are the mean and +/- one standard deviation of the mean.

Variable	**Unstandardised coefficient *b***	**SE**	***p***	**95% CI for *b***		**Pseudo R^2's C&S/N**
				Lower	**Upper**	
Outcome – PND at wave 2						
Constant	-15.105	12.736	0.236	-40.066	9.857	0.337/
Perception of social pressure	5.111	3.271	0.118	-1.300	11.522	0.537
Bonding confidence	3.004	3.019	0.320	-2.913	8.290	
Perception of social pressure*bonding confidence	**-1.237**	**0.798**	**0.121**	**-2.802**	**0.327**	
Antenatal depression	2.907	1.057	**0.006**	0.834	4.979	

Table 3.9 Significant moderation results from testing the hypothesis that stigma consciousness and the perception of social pressure will moderate the relationship between emotional investment measures and PND. Wave 2 = approximately 1 month postnatally. Significance and 95% CIs are the result of bias corrected bootstrapping based on 1000 samples. Pseudo R^2's: Cox & Snell (C&S), Nagelkerke (N).

Ri) Stigma consciousness and the perception of social pressures surrounding mothering will positively correlate with the perception of risk surrounding mothering

The *perception of social pressures* during pregnancy did not predict *risk perception* surrounding mothering (Table 3.10). However, *stigma consciousness* did predict *risk perception* surrounding mothering, with the perception of risk increasing the higher a woman's awareness of stigma attached to maternal behaviour: when assessed individually $p = 0.000$, when both were assessed $p = 0.000$ (Table 3.10). *Stigma consciousness* was the only predictor of *risk perception* and, together with *SES* and *maternal age*, accounted for 20% of the variance in the perception of risk (Table 3.10).

Variable	Unstandardised coefficient		Standardised coefficient	*p*	95% CI for *b*	
	b	**SE**	***β***		**Lower**	**Upper**
Stigma consciousness only						
Constant	3.129	2.287		0.176	-1.438	7.695
Stigma consciousness	**0.122**	**0.029**	**0.469**	**0.000**	**0.065**	**0.179**
Maternal age	0.078	0.058	0.157	0.183	-0.038	0.193
High (ref) vs medium SES	-0.315	0.732	-0.048	0.668	-1.778	1.148
High (ref) vs low SES	-0.377	0.728	-0.062	0.607	-1.831	1.078
Adjusted R^2						0.196
Perception of social pressure only						
Constant	7.673	2.304		0.001	3.072	12.274
Perception of social pressure	**2.127**	**2.050**	**0.128**	**0.303**	**-1.966**	**6.221**
Maternal age	0.048	0.065	0.097	0.464	-0.082	0.178
High (ref) vs medium SES	-0.598	0.823	-0.091	0.470	-2.242	1.046
High (ref) vs low SES	-0.300	0.818	-0.049	0.715	-1.934	1.334
Adjusted R^2						-0.014
Both						
Constant	3.294	2.318		0.160	-1.337	7.926
Perception of social pressure	**-1.106**	**1.994**	**-0.067**	**0.581**	**-5.090**	**2.879**
Stigma consciousness	**0.129**	**0.031**	**0.495**	**0.000**	**0.067**	**0.191**
Maternal age	0.084	0.059	0.170	0.161	-0.034	0.202
High (ref) vs medium SES	-0.351	0.739	-0.053	0.636	-1.828	1.126
High (ref) vs low SES	-0.364	0.733	-0.059	0.621	-1.828	1.099
Adjusted R^2						0.187

Table 3.10 Results of linear regression analysis assessing the effect of the perception of social pressure and/or stigma consciousness during pregnancy on risk perception during pregnancy, after controlling for maternal age and SES.

Rii) The perception of risk surrounding mothering will predict shame regarding mothering

The *perception of risk* during pregnancy positively predicted *maternal shame* during pregnancy (BCa p = 0.001) and at approximately 6 months postnatally (BCa p = 0.004) (Table 3.11). The *perception of risk* at approximately 6 months postnatally also positively predicted *maternal shame* at this time at a level approaching significance (BCa p = 0.062) (Table 3.11).

Variable	Unstandardised coefficient		Standardised coefficient	***p***	95% CI for ***b***		Adjusted R^2
	b	**SE**	***β***		**Lower**	**Upper**	
Risk perception at wave 1 and maternal shame at wave 1							
Constant	0.406	1.351		0.731	-2.174	3.046	0.200
Perception of risk	0.717	0.132	0.455	**0.001**	0.462	0.955	
Risk perception at wave 1 and maternal shame at wave 2							
Constant	1.319	2.426		0.748	-5.288	7.698	0.063
Perception of risk	0.511	0.234	0.282	0.196	-0.228	1.322	
Risk perception at wave 1 and maternal shame at wave 3							
Constant	0.536	1.805		0.743	-2.608	3.804	0.193
Perception of risk	0.587	0.168	0.458	**0.004**	0.237	0.923	
Risk perception and maternal shame at wave 3							
Constant	3.518	1.409		0.025	0.103	6.578	0.089
Perception of risk	0.456	0.193	0.329	**0.062**	0.041	0.915	

Table 3.11 Results of linear regression models assessing the effect of risk perception on maternal shame at various time points: during pregnancy (wave 1), at approximately 1 month postnatally (wave 2), and approximately 6 months postnatally (wave 3). Significance and 95% CIs reflect BCa bootstrapping based on 1000 samples to counter heteroscedasticity.

Riii) The relationship between the perception of risk and shame will be moderated by bonding and confidence in bonding

Strength of *bonding* at approximately 1 month postnatally moderated the relationship between *risk perception* during pregnancy and the experience of *maternal shame* at approximately 1 month postnatally (interaction p = 0.004). Women whose *bonding* was of average to high strength experienced relatively low levels of *maternal shame* irrespective of how much risk they perceived, whereas in women whose bond strength was low *maternal shame* increased as *perception of risk* increased (Figure 3.8). Strength of *bonding* at approximately 1 month postnatal also moderated (approaching significance when one-tailed) the relationship between *perception of risk* during pregnancy and the experience of *maternal shame* at approximately 6 months postnatally (interaction p = 0.085 one-tailed) (Figure 3.9).

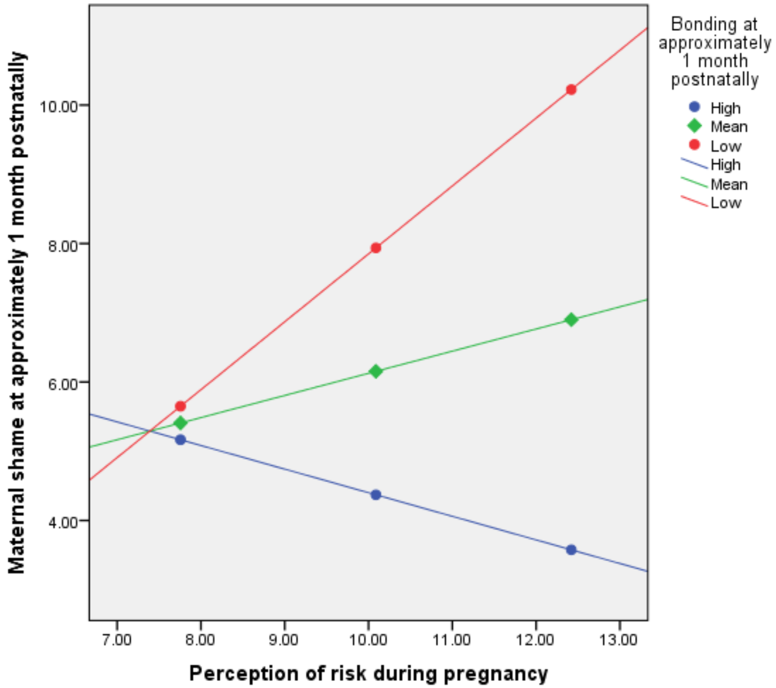

Figure 3.8 Simple slopes equations of the regression of *perception of risk* during pregnancy on the experience of *maternal shame* at approximately 1 month postnatally at three levels of strength of *bonding* at approximately 1 month postnatally. Values for *bonding* are the mean and +/- one standard deviation of the mean.

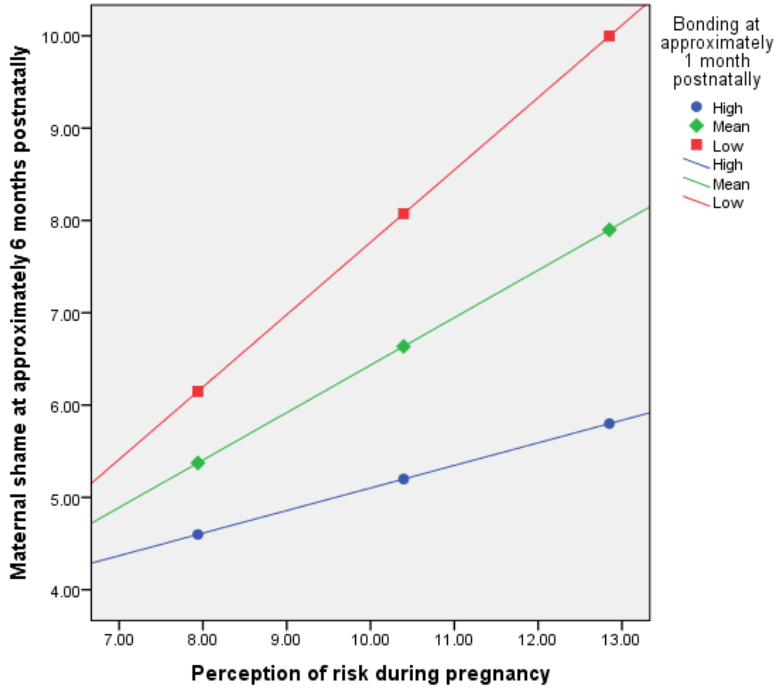

Figure 3.9 Simple slopes equations of the regression of *perception of risk* during pregnancy on the experience of *maternal shame* at approximately 6 months postnatally at three levels of strength of *bonding* at approximately 1 month postnatally. Values for *bonding* are the mean and +/- one standard deviation of the mean.

Bonding confidence moderated the relationship between *perception of risk* during pregnancy and *maternal shame* at approximately 6 months postnatal (interaction p = 0.015). In women of high *bonding confidence, maternal shame* was consistently relatively low irrespective of *perception of risk,* while women of mean and low confidence experienced increasing levels of shame as their *perception of risk* increased, with women of low confidence showing the sharpest inclines (Figure 3.10).

Full significant moderation results can be seen in Table 3.12.

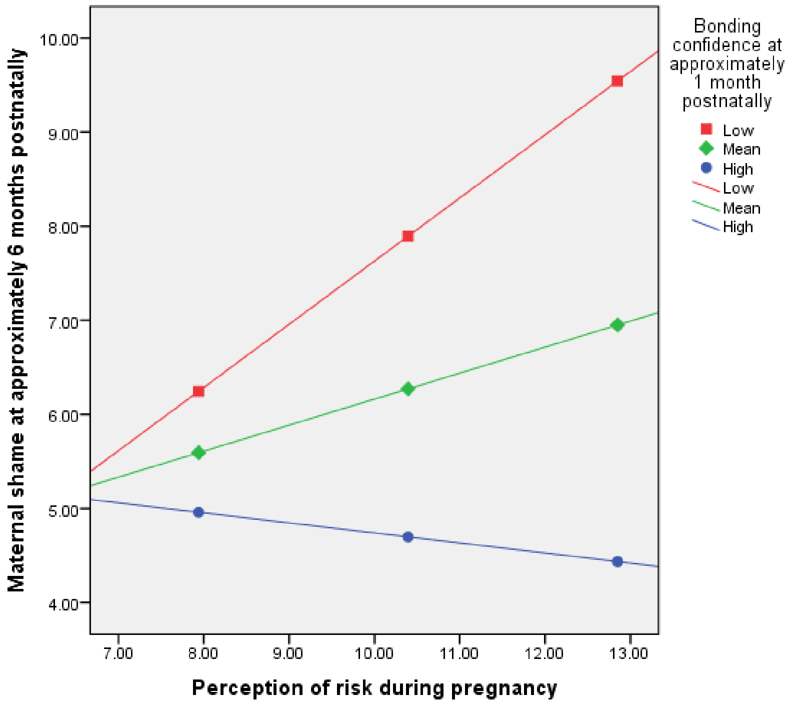

Figure 3.10 Simple slopes equations of the regression of *perception of risk* during pregnancy on the experience of *maternal shame* at approximately 6 months postnatally at three levels of *bonding confidence* at approximately 1 month postnatally. Values for *bonding confidence* are the mean and +/- one standard deviation of the mean.

Variable	Unstandardised coefficient *b*	SE	*p*	95% CI for *b* Lower	Upper	R^2
Outcome – Maternal shame at wave 2						
Constant	8.037	3.069	0.012	1.880	14.193	0.377
Bonding	-1.929	0.900	**0.037**	-3.734	-0.123	
Perception of risk (wave 1)	-0.372	0.309	0.235	-0.992	0.249	
Bonding*perception of risk (wave 1)	**0.261**	**0.086**	**0.004**	**0.088**	**0.434**	
Outcome – Maternal shame at wave 3						
Constant	2.841	2.838	0.324	-2.927	8.609	0.482
Bonding	-0.508	0.756	0.507	-2.045	1.029	
Perception of risk (wave 1)	0.208	0.279	0.461	-0.359	0.776	
Bonding*perception of risk (wave 1)	**0.100**	**0.071**	**0.169**	**-0.045**	**0.245**	
Outcome – Maternal shame at wave 3						
Constant	-10.530	10.820	0.337	-32.519	11.459	0.626
Bonding confidence	3.267	2.365	0.176	-1.539	8.074	
Perception of risk (wave 1)	2.492	0.901	0.009	0.661	4.323	
Bonding confidence*perception of risk (wave 1)	**-0.520**	**0.202**	**0.015**	**-0.931**	**-0.109**	

Table 3.12 Significant moderation results from testing the hypothesis that emotional investment measures will moderate the relationship between risk perception and maternal shame at various points in time. Wave 1 = during pregnancy, wave 2 = approximately 1 month postnatally, wave 3 = approximately 6 months postnatally. Significance and 95% CIs are the result of bias corrected bootstrapping based on 1000 samples.

Riv) *The relationship between the perception of risk and shame will be moderated by stigma consciousness and perception of social pressure*

Stigma consciousness moderated the relationship between *the perception of risk* during pregnancy and the experience of *maternal shame* during pregnancy (interaction $p = 0.007$). Women with low levels of *stigma consciousness* experienced relatively low levels of *maternal shame* irrespective of their *perception of risk*, whereas women of mean and high consciousness experienced increasing levels of shame as their risk perception increased, with women of high consciousness showing the sharpest increase (Figure 3.11). A similar relationship was found between the *perception of risk* during pregnancy, *stigma consciousness*, and the experience of *maternal shame* at approximately 1 month (interaction $p = 0.005$) (Figure 3.12) and 6 months postnatally (interaction $p = 0.007$) (Figure 3.13), and *perception of risk* at approximately 6 months postnatally and *maternal shame* at that time (interaction $p = 0.033$) (Figure 3.14).

The *perception of social pressure* during pregnancy moderated the relationship between the *perception of risk* during pregnancy and *maternal shame* at approximately 1 month postnatally (interaction $p = 0.016$). Women who perceived low levels of social pressure experienced relatively

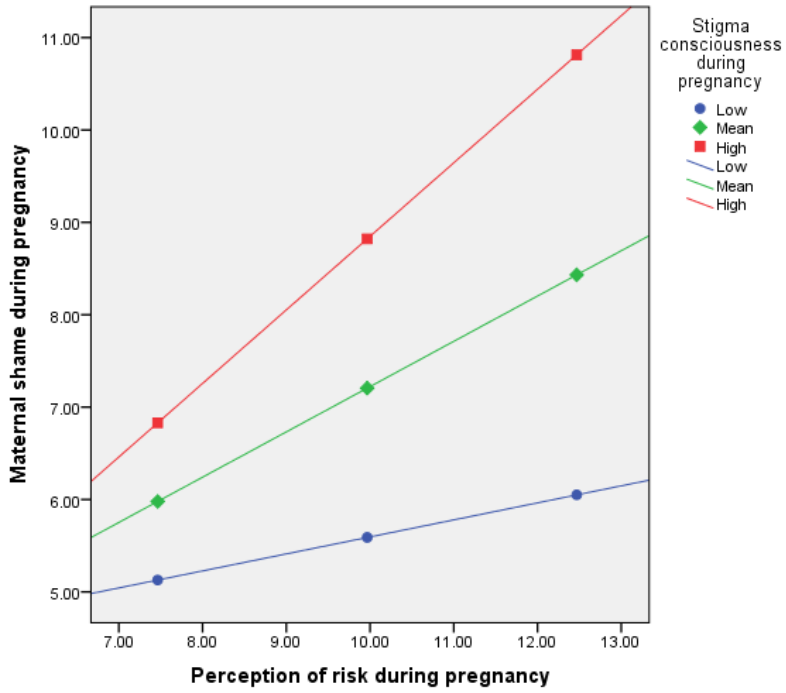

Figure 3.11 Simple slopes equations of the regression of *perception of risk* during pregnancy on the experience of *maternal shame* during pregnancy at three levels of *stigma consciousness* during pregnancy. Values for *stigma consciousness* are the mean and +/- one standard deviation of the mean.

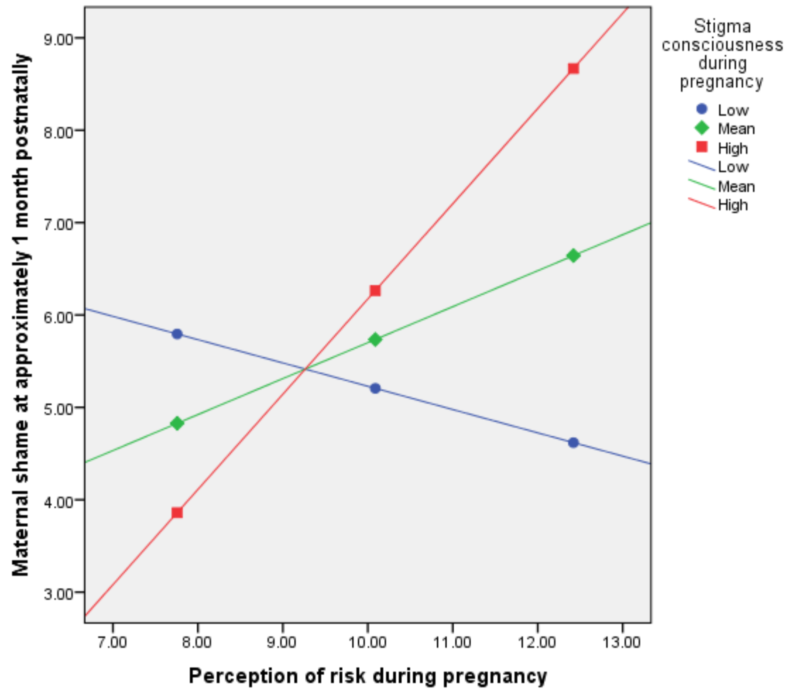

Figure 3.12 Simple slopes equations of the regression of *perception of risk* during pregnancy on the experience of *maternal shame* at approximately 1 month postnatally at three levels of *stigma consciousness* during pregnancy. Values for *stigma consciousness* are the mean and +/- one standard deviation of the mean.

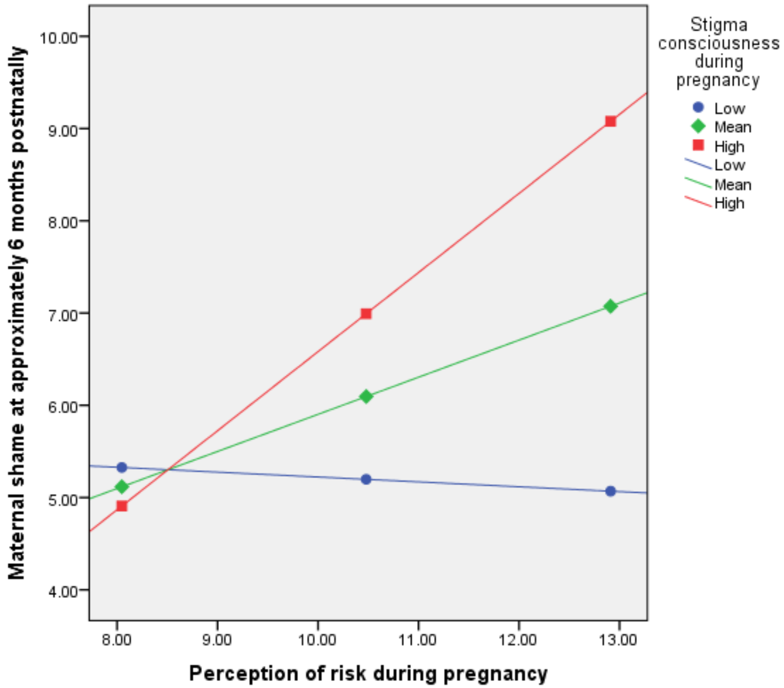

Figure 3.13 Simple slopes equations of the regression of *perception of risk* during pregnancy on the experience of *maternal shame* at approximately 6 months postnatally at three levels of *stigma consciousness* during pregnancy. Values for *stigma consciousness* are the mean and +/- one standard deviation of the mean.

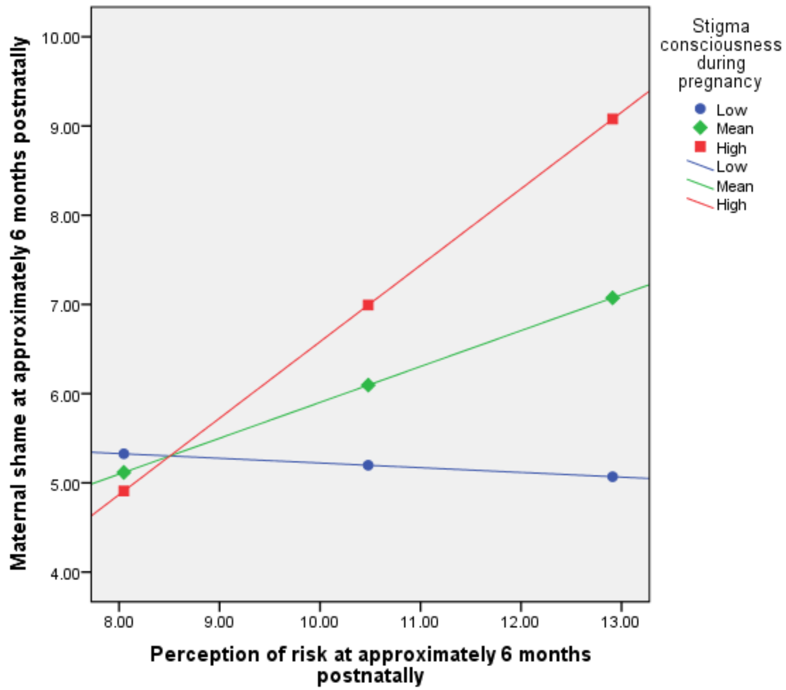

Figure 3.14 Simple slopes equations of the regression of *perception of risk* at approximately 6 months postnatally on the experience of *maternal shame* at approximately 6 months postnatally at three levels of *stigma consciousness* during pregnancy. Values for *stigma consciousness* are the mean and +/- one standard deviation of the mean.

low levels of shame irrespective of their risk perception, while women who perceived mean and high levels of social pressure experienced increasing levels of *maternal shame* as their *perception of risk* increased, with women perceiving the highest social pressure experiencing the sharpest increase in shame (Figure 3.15). The *perception of social pressure* did not moderate the relationship between *perception of risk* during pregnancy and *maternal shame* at approximately 6 months postnatally, however it did moderate the relationship between risk perception at approximately 6 months postnatally and shame at this time (interaction p = 0.010), showing as similar pattern as before (Figure 3.16).

Variable	Unstandardised coefficient *b*	SE	*p*	95% CI for *b*		R^2
				Lower	Upper	
Outcome – Maternal shame at wave 1						
Constant	7.664	3.896	0.052	-0.055	15.382	0.362
Stigma consciousness	-0.142	0.109	0.197	-0.358	0.075	
Perception of risk (wave 1)	-0.650	0.418	0.123	-1.479	0.179	
Stigma consciousness*perception of risk (wave 1)	**0.030**	**0.011**	**0.007**	**0.009**	**0.052**	
Outcome – Maternal shame at wave 2						
Constant	26.273	9.116	0.006	7.989	44.557	0.216
Stigma consciousness	-0.625	0.236	**0.011**	-1.099	-0.152	
Perception of risk (wave 1)	-2.252	0.941	**0.020**	-4.139	-0.365	
Stigma consciousness*perception of risk (wave 1)	**0.068**	**0.023**	**0.005**	**0.022**	**0.113**	
Outcome – Maternal shame at wave 3						
Constant	20.501	8.145	0.016	4.086	36.915	0.392
Stigma consciousness	-0.467	0.214	**0.034**	-0.898	-0.036	
Perception of risk (wave 1)	-1.787	0.780	**0.027**	-3.360	-0.214	
Stigma consciousness*perception of risk (wave 1)	**0.055**	**0.019**	**0.007**	**0.016**	**0.094**	
Outcome – Maternal shame at wave 3						
Constant	12.199	6.873	0.083	-1.654	26.051	0.359
Stigma consciousness	-0.190	0.167	0.260	-0.526	0.146	
Perception of risk (wave 3)	-1.687	0.944	**0.081**	-3.590	0.215	
Stigma consciousness*perception of risk (wave 3)	**0.049**	**0.022**	**0.033**	**0.004**	**0.094**	
Outcome – Maternal shame at wave 2						
Constant	16.827	6.973	0.019	2.841	30.814	0.181
Perception of social pressure	-3.567	1.533	**0.024**	-6.641	-0.492	
Perception of risk (wave 1)	-1.310	0.764	**0.092**	-2.841	0.222	
Perception of social pressure*perception of risk (wave 1)	**0.422**	**0.170**	**0.016**	**0.081**	**0.762**	
Outcome – Maternal shame at wave 3						
Constant	15.530	5.493	0.007	4.460	26.600	0.297
Perception of social pressure	-3.171	1.410	**0.030**	-6.012	-0.330	
Perception of risk (wave 3)	-1.523	0.751	**0.049**	-3.037	-0.009	
Perception of social pressure*perception of risk (wave 3)	**0.521**	**0.193**	**0.010**	**0.133**	**0.909**	

Table 3.13 Significant moderation results from testing the hypothesis that stigma consciousness and the perception of social pressure will moderate the relationship between risk perception and maternal shame at various points in time. Wave 1 = during pregnancy, wave 2 = approximately 1 month postnatally, wave 3 = approximately 6 months postnatally. Significance and 95% CIs are the result of bias corrected bootstrapping based on 1000 samples.

Full significant moderation results can be seen in Table 3.13.

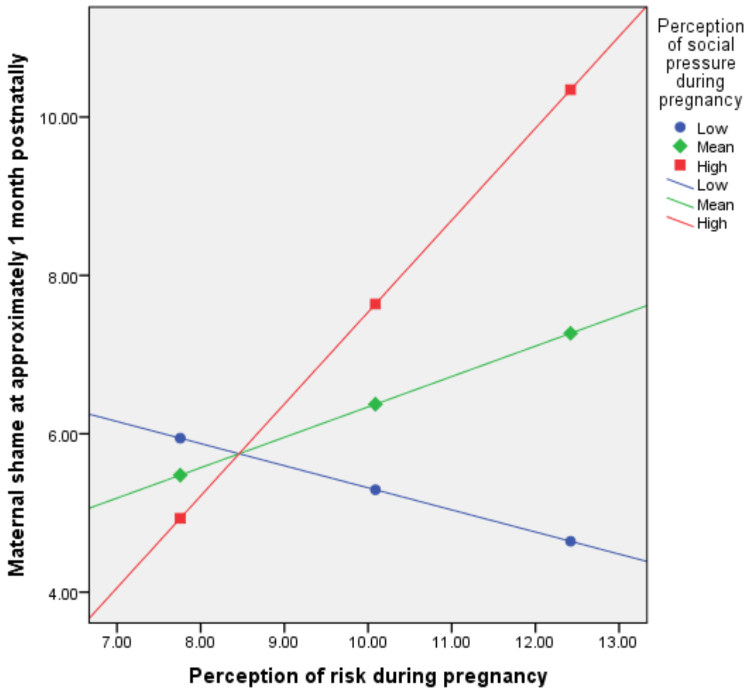

Figure 3.15 Simple slopes equations of the regression of *perception of risk* during pregnancy on the experience of *maternal shame* at approximately 1 month postnatally at three levels of *perception of social pressure* during pregnancy. Values for *perception of social pressure* are the mean and +/- one standard deviation of the mean.

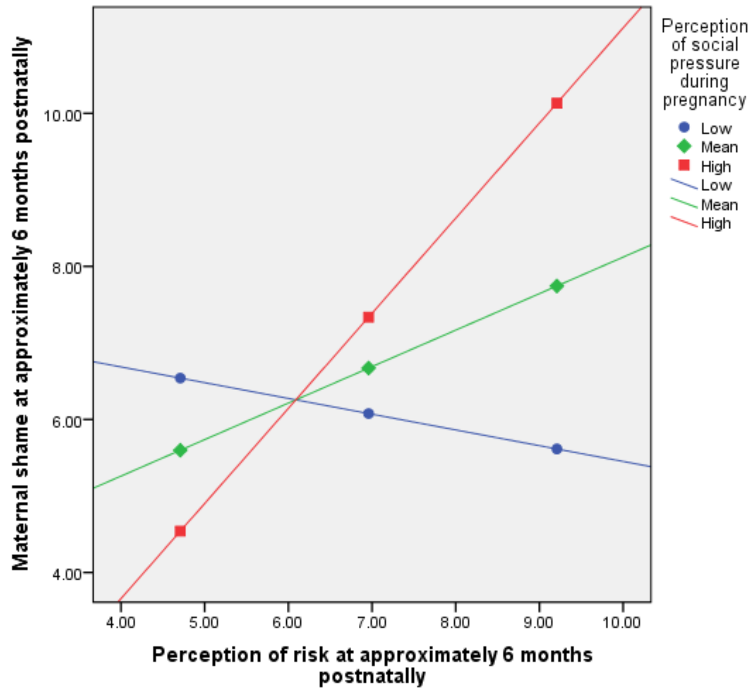

Figure 3.16 Simple slopes equations of the regression of *perception of risk* at approximately 6 months postnatally on the experience of *maternal shame* at approximately 6 months postnatally at three levels of *perception of social pressure* during pregnancy. Values for *perception of social pressure* are the mean and +/- one standard deviation of the mean.

Rv) *The perception of risk will predict PND*

The *perception of risk* did not predict *current PND* approximately 1 month (OR 1.015, p = 0.918) or *PND ever* within approximately 6 months postnatally (OR 1.168, p = 0.207) (Table 3.14).

Variables		***b***	**SE**	**Wald**	**df**	***p***	**95% CI for odds ratio**		**Odds ratio**	**Pseudo R2's C&S/N**
							Lower	**Upper**		
PND at approximately 1 month postnatally										
Antenatal depression	Yes	1.946	0.729	7.118	1	**0.008**	1.676	29.230	6.999	0.126/0.201
	No (ref)	-	-	-	-	-			-	
Perception of risk		**0.015**	**0.143**	**0.011**	**1**	**0.918**	**0.767**	**1.343**	**1.015**	
Constant		-2.347	1.542	2.317	1	0.128	-	-	0.096	
PND by approximately 6 months postnatally										
Antenatal depression	Yes	1.726	0.594	8.453	1	**0.004**	1.755	17.994	5.620	0.143/0.208
	No (ref)	-	-	-	-	-			-	
Perception of risk		**0.156**	**0.123**	**1.594**	**1**	**0.207**	**0.918**	**1.487**	**1.168**	
Constant		-3.250	1.361	5.700	1	0.017	-	-	0.039	

Table 3.14 Results of binary logistic regression models assessing the hypothesis that the perception of risk during pregnancy will positively predict PND after controlling for antenatal depression.

Rvi) *The relationship between risk and PND will be moderated by shame*

Maternal shame during pregnancy moderated the relationship between *perception of risk* during pregnancy and *current PND* at approximately 1 month postnatally at a level approaching significance (interaction p = 0.067). However, contrary to the hypothesis, at high levels of shame the probability of PND was consistently relatively high for the sample irrespective of the perception of risk, while at mean and low levels of shame the probability of PND decreased as risk perception increased, with women of low shame showing the sharpest declines (Figure 3.17).

Maternal shame during pregnancy moderated (approaching significance if one-tailed) the relationship between *perception of risk* during pregnancy and the occurrence of *PND ever* within 6 months postnatally (interaction p = 0.052 one-tailed). Women who experienced high levels of *maternal shame* were more likely to become postnatally depressed within approximately 6 months of giving birth as their *perception of risk* increased, while the opposite was the case in women of low shame (Figure 3.18).

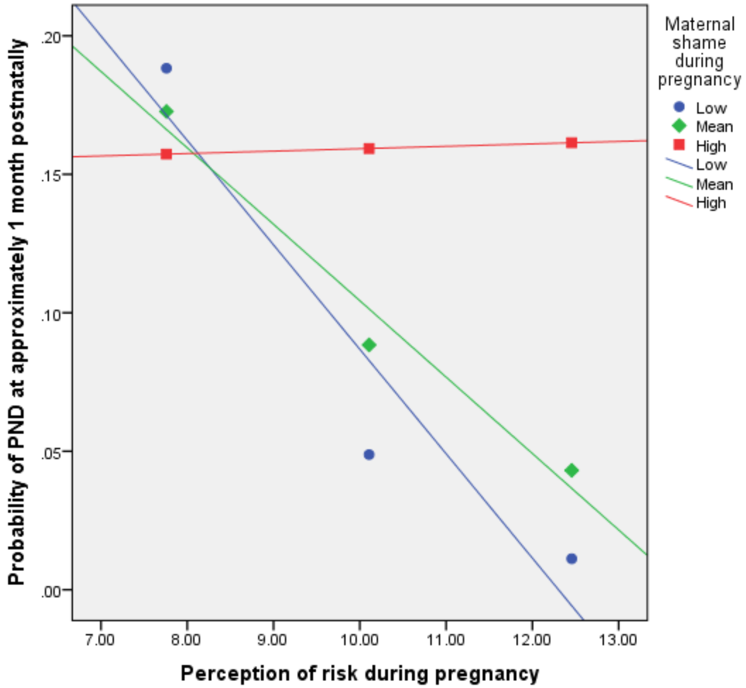

Figure 3.17 Simple slopes equations of the regression of *perception of risk* during pregnancy on the probability of PND at approximately 1 month postnatally at three levels of *maternal shame* during pregnancy. Values for *maternal shame* are the mean and +/- one standard deviation of the mean.

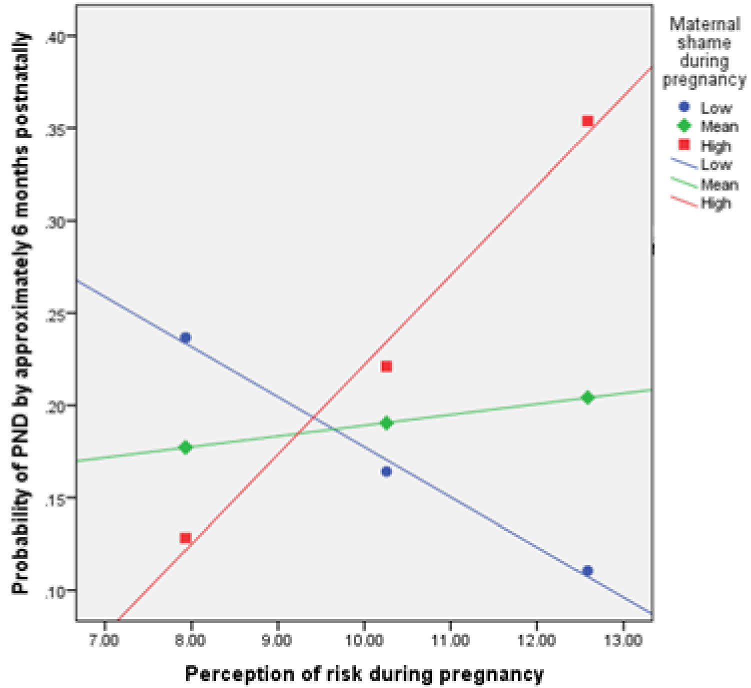

Figure 3.18 Simple slopes equations of the regression of *perception of risk* during pregnancy on the probability of PND by approximately 6 months postnatally at three levels of *maternal shame* during pregnancy. Values for *maternal shame* are the mean and +/- one standard deviation of the mean.

Maternal shame at approximately 1 month postnatally also moderated the relationship between *perception of risk* during pregnancy and the occurrence of *PND ever* within approximately 6 months postnatally at a level approaching significance (interaction $p = 0.082$).When women experienced low and mean levels of *maternal shame* their likelihood of PND remained relatively low irrespective of their *perception of risk* surrounding mothering, while in women of high shame the probability of PND declined as risk perception increased, although the probability of PND remained relatively high (between approximately 50-60%) even at high levels of perceived risk (Figure 3.19).

Full significant moderation results can be seen in Table 3.15.

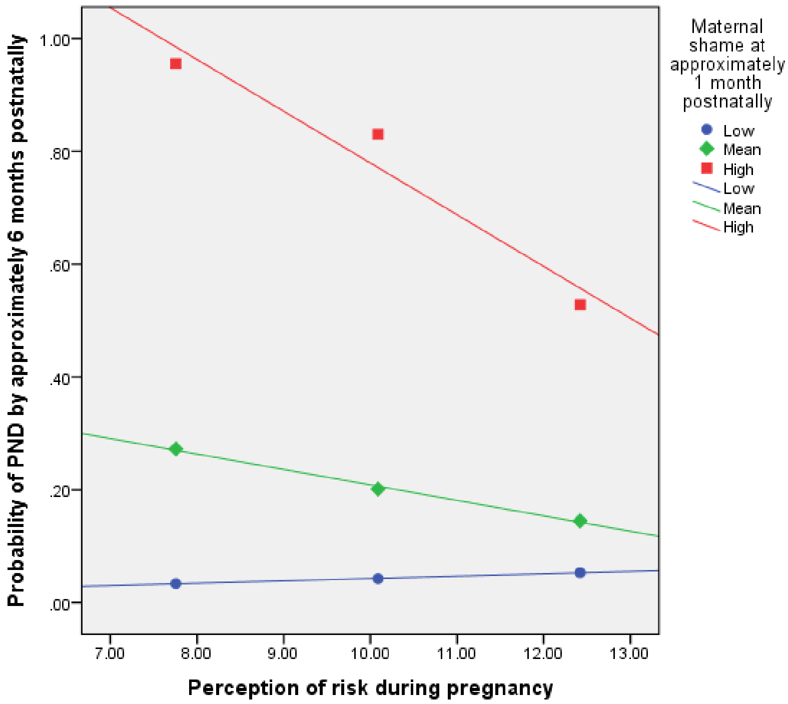

Figure 3.19 Simple slopes equations of the regression of *perception of risk* during pregnancy on the probability of PND by approximately 6 months postnatally at three levels of *maternal shame* at approximately 1 month postnatally. Values for *maternal shame* are the mean and +/- one standard deviation of the mean.

Variable	Unstandardised coefficient *b*	SE	*p*	95% CI for *b* Lower	Upper	Pseudo R^2's C&S/N
Outcome – PND at wave 2						
Constant	5.978	4.669	0.201	-3.174	15.130	0.267/ 0.425
Maternal shame (wave 1)	-0.724	0.554	0.191	-1.810	0.361	
Perception of risk (wave 1)	-1.001	0.486	**0.039**	-1.953	-0.049	
Maternal shame (wave 1)*perception of risk (wave 1)	**0.090**	**0.049**	**0.067**	**-0.006**	**0.185**	
Antenatal depression	1.567	0.848	**0.065**	-0.095	3.229	
Outcome – PND by wave 3						
Constant	2.503	3.554	0.481	-4.462	9.469	0.207/ 0.300
Maternal shame (wave 1)	-0.643	0.494	0.193	-1.610	0.325	
Perception of risk (wave 1)	-0.467	0.335	0.163	-1.124	0.189	
Maternal shame (wave 1)*perception of risk (wave 1)	**0.068**	**0.042**	**0.103**	**-0.014**	**0.149**	
Antenatal depression	1.516	0.633	0.167	0.275	2.757	
Outcome – PND by wave 3						
Constant	-12.385	5.644	0.028	-23.488	-1.322	0.401/ 0.587
Maternal shame (wave 2)	1.809	0.856	**0.035**	0.131	3.487	
Perception of risk (wave 1)	0.540	0.430	0.209	-0.302	1.382	
Maternal shame (wave 2)*perception of risk (wave 1)	**-0.110**	**0.063**	**0.082**	**-0.233**	**0.014**	
Antenatal depression	3.612	1.195	**0.003**	1.270	5.954	

Table 3.15 Significant moderation results from testing the hypothesis that maternal shame will moderate the relationship between risk perception and PND at various points in time. Wave 1 = during pregnancy, wave 2 = approximately 1 month postnatally, wave 3 = approximately 6 months postnatally. Significance and 95% CIs are the result of bias corrected bootstrapping based on 1000 samples.

SIi) Social isolation will positively predict PND

As *time spent alone* on weekdays at approximately 6 months after birth increased, the likelihood of whether PND was experienced within this time (*PND ever*) also increased (Table 3.16); mothers who spent between 8 and 24 hours alone had increased odds of PND with an OR = 9.356 (p = 0.010) when compared to women spending less time alone, after controlling for *antenatal depression*. Together *time spent alone* and *antenatal depression* accounted for 33-45% of the variance in PND experience.

Variable		*b*	SE	Wald	df	*p*	95% CI for odds ratio Lower	Upper	Odds ratio	Pseudo R^2's C&S/N
AND	Yes	2.534	0.884	8.222	1.000	**0.004**	2.230	71.295	12.610	0.328 / 0.452
	No (ref)	-	-	-	-	-	-	-	-	
Time spent alone	**8-24 hours**	**2.236**	**0.867**	**6.656**	**1.000**	**0.010**	**1.712**	**51.149**	**9.356**	
	0-8 hours (ref)	-	-	-	-	-	-	-	-	
Constant		-2.657	0.793	11.240	1.000	0.001	-	-	0.070	

Table 3.16 Binary logistic regression results assessing the effect of time spent alone without the company of another adult at approximately 6 months postnatally on the likelihood of having experienced PND within this time. AND = antenatal depression.

Discussion

A pathway to PND via life history trade-offs in emotional investment in infants relies on sociocultural environments creating pressures on women which result in the experience of shame in relation to investment decisions; these results are largely supportive of this being the case in contemporary industrialised settings. Consciousness of stigma surrounding mothering and the perception of social pressures on mothers positively predicted the experience of shame surrounding maternal behaviour highlighting the role of the mothering environment in generating feelings of shame in pregnant women and mothers of young infants; stigma consciousness significantly predicted maternal shame in all tests, social pressure significantly predicted maternal shame on its own and at a level approaching significance when combined with stigma consciousness. Shame was also found to be negatively related to the strength of emotional bonding between a mother and her infant and the confidence she has in her developing emotional bond, and positively related to the time it takes a mother to feel strongly emotionally bonded with her infant, supporting the hypothesis that emotional investments are a specific source of shame and that the current emphasis on intensive mothering may have a detrimental impact on mothers.

The experience of sociocultural pressures was found to partially moderate the relationship between emotional investments and shame, with the perception of social pressures surrounding mothering positively affecting, at a level approaching significance, the magnitude of the negative relationship between early emotional bonding strength and later feelings of shame. Stigma consciousness and the perception of social pressure were found to have a similar influence on the relationship between early bonding confidence and later shame. However, shame always increased the longer emotional bonding took, even at low subjective levels of sociocultural pressure, indicating the pervasiveness of the notion introduced by Klaus and Kennell in the 1970s that ‘normal bonding’ is instantaneous affair. Indeed, as part of the first wave of this study, whilst the participants were pregnant, they were asked how long they thought the maximum normal time to ‘emotionally bond’ was: 12% reported they thought emotional bonding should be instant, 18% within the first day, 26% within the first three days, and 42% within one week of giving birth (for full response details see

Appendix G). Participants were also asked about their actual experience of bonding; when asked six months after birth to reflect back on when they actually first felt strongly emotionally bonded with their infants, 38% of participants reported that it wasn't until after the first month (for full response details see Appendix G). That so many women view bonding as a process which normally occurs within one week of birth and, yet, many do not actually experience strong feelings of bonding until later than this would appear to leave many women at risk of characterising their emotional bonding experience as 'abnormal'. Six months after birth 46% of the participants reported they had not found the emotional bonding process to be as they had expected, and of these women 41% found this difference between expectation and experience to be negative (see Appendix G).

The experience of maternal shame during pregnancy was found to predict both PND one month after birth and PND occurring at any time within approximately six months of giving birth; to my knowledge this is the first study to quantitatively link maternal shame and PND. This result adds to the growing body of literature supporting a causal pathway between psychosocial stress and depression and maintenance based evolutionary explanations of depression such as the Pathogen-Host Defence Hypothesis (Raison and Miller, 2013) and the psychobiological model of depression and social rejection (Slavich *et al*., 2010a). Results from moderation analysis of the relationship between maternal shame and emotional bonding, and confidence in bonding, while only approaching statistical significance, are suggestive of shame moderating the relationship between emotional investments in the infant and PND, with emotional investments only predicting PND when shame is also experienced. This pattern is bolstered by the tentative interaction between confidence in emotional bonding and perception of social pressure, such that low confidence only predicts PND when the perception of social pressure was at average or above average levels.

Sociologists often refer to the 'culture of risk' surrounding parenting in Western society (Faircloth and Lee, 2010), and the finding that the awareness of stigma attached to maternal behaviour positively associated with a woman's level of risk perception provides quantitative evidence indicating that risk can originate from the sociocultural environment. The role of mothers, as socially constructed in WEIRD contexts, is to protect infants from risk for the good of society (Gillies, 2008; Lee, Macvarish, and Bristow, 2010) which creates conditions under which the perception of risk is likely to lead to feelings of shame. That this is the case is supported by the finding that risk perception during pregnancy predicts maternal shame during pregnancy. However, women who conform to sociocultural expectations and are strongly bonded to their infants within the first month after birth are buffered from experiencing shame even when they perceive their environment to be risky; this effect was significant at one month and approaching significance at six months postnatally. Women who express lower confidence in their emotional bond with their baby at one month postnatally are also more likely to experience later shame; it may be that these women are considering withdrawing their investment as a result of perceiving that it is not going to pay-off in terms of producing a high quality offspring, the perception of risk moderates the relationship between the strength of a woman's emotional bond and the confidence she has in it (see Appendix H for details). Women with low awareness of stigma attached to maternal behaviour and feelings experienced relatively low levels of maternal shame irrespective of their perception of risk, whereas women of mean and high stigma consciousness experienced increasing levels of shame as their risk perception increased, with women of high consciousness showing the sharpest increase; a similar moderating effect for perception of social pressure was also partially indicated by results.

Risk perception during pregnancy did not predict PND; while this may indicate that the measure failed to tap environmental risk, if it did then this potentially poses a problem for current adaptationist explanations of PND (Hagen, 1999 and 2002; Thornhill and Furlow, 1998) which hypothesise PND is a signal facilitating maternal divestment in response *to* risk. In fact, moderation analysis indicates the experience of maternal shame to influence the relationship between risk perception and PND at levels approaching significance, counter to adaptationist predictions, and suggesting that the measure was successful in tapping its target. When women experienced high levels of maternal shame during pregnancy their probability of being postnatally depressed one month after birth was consistently relatively high irrespective of the perception of risk, while at mean and low levels of shame the probability of PND *decreased* as risk perception increased. In line with adaptationist predictions the likelihood of experiencing PND within six months of giving birth increased as risk perception increased but only when maternal shame during pregnancy was also high; when lower levels of maternal shame were experienced risk perception negatively predicted PND. Finally, when women experienced low and mean levels of *maternal shame* one month after birth their likelihood of PND within six months remained relatively low irrespective of their *perception of risk* surrounding mothering, while in women of high shame the probability of PND decreased as risk perception increased, although the probability of PND remained relatively high even at high levels of perceived risk.

The amount of time mothers spent socially isolated from other adults during the week six months after giving birth positively predicted the likelihood of their having experienced PND by this time. Thus, these results are supportive of the social genome based prediction that social isolation is a causal factor in PND, and indicative of the long periods spent alone during the week placing women at a greater risk of an inflammatory immune response. Comparing the impact of the amount of time spent alone by mothers with that of antenatal depression, the strongest predictor of PND among commonly recognised risk factors (Beck, 2001; RCM, 2012b), found them to show a similar effect size, with confidence intervals overlapping to large extent, highlighting the importance of social isolation as a PND risk factor. While social isolation of mothers with young infants is common in contemporary WEIRD contexts (Morgan, 1996), it is likely to be a relatively novel risk in evolutionary terms. Although family patterns are likely to have varied over human history (Sear and Mace, 2008), cross-cultural evidence supports the view that cooperative breeding is obligate in humans (Scelza, and Silk, 2014), with kin networks living in close proximity providing large amounts of allocare (Hrdy, 2009). Kitzinger (1989) found that infants whose mothers were alone for longer periods of time cried more and mothers found them harder to care for and experienced more stress. Difficult infant temperament is a predictor of PND (Beck, 2001); thus the social isolation of WEIRD mothers may provide a double set of risks for PND, as a result of increased psychosocial stress from both being socially isolated and lacking in allocare to help with an infant that is less likely to settle. Hahn-Holbrook and Haselton (2014) cite isolation from extended kin networks in their mismatch approach to PND; however the presence of PND in the pre-industrialised Tsimane (Myers *et al.*, 2016) suggests a simple mismatch approach lacks nuance. Under the adaptationist paradigm PND is a bargaining tool with which to elicit support, and again a mismatch case could be used to argue that the adaptive PND signal, when expressed in contemporary industrial environments, now fails to reach its intended recipients. However, as shown in the results of testing *hypothesis Fiv* in Chapter 2, when women's circumstances did improve after PND, as measured by enhanced support at their second birth relative to their first, they still experienced reduced parity progression, suggesting the costs of PND outweigh the postulated benefits.

Together these results support the hypothesis that the sociocultural mothering environment in contemporary WEIRD settings generates feelings of shame in pregnant women and mothers of young infants, particularly in relation to their emotional investments and their experience of these investments. They are also indicative of the sociocultural mothering environment providing cues to risks surrounding mothering, again in relation to a mother's emotional investments.

They also add to findings that depression is the result of psychosocial stress, with PND being predicted by the experience of maternal shame and social isolation. This lends weight to evolutionary explanations of depression being the product of an inflammatory maintenance strategy mounted in response to social or biological threat. While previous qualitative studies of PND have highlighted the association between maternal shame and depressive symptoms (Beck, 2002), shame is generally taken to be a product of PND and is not commonly recognised as a risk factor (Beck, 2001) despite studies of depression at other points in the life course indicating a causal role. The modified version of Andrews, Qian, and Valentine's (2002) Experiential Shame Scale provides a novel antenatal screening tool to identify women at risk of developing PND, as do measures to detect the degree to which a woman is experiencing social pressures surrounding her impending motherhood. To my knowledge, this is also the first study to show that social isolation, as measured by time spent alone, is a risk factor for PND. Social support *has* previously been recognised as a risk factor for PND (Beck, 1996, 2001); while measures of social support vary (Leahy-Warren, McCarthy, and Corcoran, 2009), and may reflect the perspective of the mother or the support healthcare practitioners report providing, a comprehensive definition views social support as "the combination of social structures and social functions, where social structures demonstrate cohesiveness and there is a flow of emotional concern, instrumental aid, information and appraisal between people" (2009: 2). Thus, social isolation appears to be distinct from social support as utilised in the psychological literature, with time spent alone reflecting a previously unrecognised risk factor for PND.

Potential limitations

Due to small sample size the applicability of these results to the wider population is uncertain; however they certainly highlight the need for larger scale studies focusing on the subjective experience of pressures surrounding mothering and the role these play in aetiology of PND. The sample size also constrained the complexity of models and prevented the inclusion of more extensive control variables, an issue which again should be addressed by replication with a larger sample size.

Next steps

In Chapter 1 the case for moving away from the use of 'bonding' and related terminology in favour of using the phrases 'maternal investment', 'physical investment', and 'emotional investment' was made. For the purposes of the present chapter the link between maternal emotions and life history investments may be considered an analogy. Maternal life history investments in infants are energetic investments which enhance offspring survival and future reproductive potential and are the result of trade-offs between investments in current and future offspring; the emotional relationship a mother has with infant does not need to entail a literal investment of energy or convey benefits to the infant for it to be responsive to sociocultural messaging regarding risk and or for women to feel bad about their emotional relationship. However, in the following a framework for understanding maternal emotional behaviour towards infants in which such behaviour is considered as a literal investment will be outlined and tested.

Chapter 4 – An Emotional Capital Theory of Maternal Investment

Chapter outline

The brief review of the literature on the timing in which 'emotional bonding' occurs and the factors that effect this process, presented in Chapter 1, indicates that the emotional relationship mothers have with their infants is contingent on the stability of the environment and resource availability. Indeed the risk factors for delayed bonding bear a striking overlap with the risk factors for PND – risk factors which adaptationist accounts of PND cite as evidence that PND is a mechanism signalling to a mother she should withdraw her investment in her current infant in favour of future reproductive opportunities. Findings from Chapter 2 call into question the efficacy of PND in facilitating a trade-off between current and future offspring, at least in WEIRD contexts, and in Chapter 3 the relationship between perceived risk and PND was found to be the opposite to adaptationist predictions; taken together this suggests a fresh approach is required to understand PND from an evolutionary perspective. In this chapter it is proposed that the emotional relationships mothers have with their infants reflect an aspect of investment in those infants, and that such investments are subject to risk assessment and may be understood using the paradigm of parental investment theory. The chapter is split into two parts:

In *Part 1* an emotional capital hypothesis of maternal emotional investments, based on the embodied capital theory of life history investments (Kaplan, 1996), will be developed, and it will be argued that, rather than being a signalling mechanism involved in guiding investments, PND is the result of pursuing a low investment strategy under certain sociocultural conditions, and as such PND may be taken as a proxy for such a strategy. *Part 1* is further split into four sections and arranged as follows: *Section A* outlines embodied capital theory and the justification for incorporating emotional investment within this theoretical framework. In *Section B* the evidence supporting the case that mother-infant emotional relationships reflect an embodied capital investment is outlined along with the proposed benefits of emotional investment. *Section C* addresses the potential costs of emotional investment. Finally, *Section D* presents a model for predicting maternal emotional investments and PND likelihood based on mortality and characteristics of the sociocultural mothering environment.

In *Part 2* a number of hypotheses which can be generated under the framework of an emotional capital theory of maternal investment will be tested. In order to test such hypotheses, a way of quantifying emotional capital must first be determined, and this forms the beginning of *Part 2*. Once the proposed method for measuring emotional capital has been outlined, data from the longitudinal self-report questionnaire study first described in Chapter 3 will be analysed. This time the focus will be on the elements of the study designed to gather data to address the emotional capital theory of maternal emotional investments – that mothers make emotional investments in their infants contingent on their emotional capital and the perceived likelihood of such investments paying off – and a social stress pathway to PND resulting from low emotional investment strategies.

Part 1

Section A – Outlining emotional capital as embodied capital

-Embodied capital theory of life histories

Why would women in seemingly affluent, safe, stable, WEIRD environments pursue a low maternal investment strategy? Under parental investment theory women should cease to invest in their offspring when the benefits of investment are outweighed by the costs (Kaplan, 1996), and this is predicted to occur when the likelihood of the offspring surviving is in question, or when there is a threat to the mother's fitness and, therefore, her future reproductive success (Trivers, 1974). 'Emotional bonding' is often delayed (Figueiredo *et al*., 2009) and PND rates are higher (Vigod *et al*., 2010) among women with premature and low birth weight infants, suggesting women may be responding to the increased chance of their infant dying. PND also shows slight seasonality

(Sylvén *et al*., 2011), a pattern which mirrors seasonality in risk of infant death (Douglas, Allan, and Helms, 1996; Osmond and Murphy, 1988). However, as infant mortality rates in the West are very low, (currently 4 deaths per 1000 live births in both Northern and Western Europe (Population Reference Bureau, 2012)), it is unlikely the majority of women making low investments in their infants are responding to this source of risk. On the face of it at least, the costs of investing in a child in the West are also unlikely to pose a risk to a mother's somatic resources – the physical energetic resources available for survival and reproduction – and thus will not threaten her survival or future reproductive capacity, given the relative wealth and access to modern health care of even poor women in developed societies compared to the poor of women in other times and places.

What then constitutes 'risk' for the majority of contemporary WEIRD mothers who detect it? In Chapter 3 a view of risk derived from sociological literature on parenting was introduced in which risk is argued to have become divorced from probability in Western contexts, instead reflecting free-floating anxiety in response to unknown causal agents (Lee, 2014b). This perspective on risk suggests that the sociocultural mothering environment in the West, in which discourse focuses on nebulous yet pervasive threats to infants, causes maternal risk perception to be negatively skewed. Results from Chapter 3 showed that self-defined risks surrounding mothering were predicted by awareness of stigma attached to maternal feelings and behaviours, were unrelated to SES (a proxy for maternal resources) and maternal age, and that perception of such risks positively predicted shame surrounding mothering behaviour. The impact of perceived, self-defined, risk on maternal investment behaviours will be subject to investigation in *Part 2* of this chapter and also Chapter 5.

Under life history theory, the fundamental trade-off with regards to parental, and thus maternal, investment is between an individual's own reproduction and that of their offspring's reproduction, with the key assumption being that income invested in one's own reproduction reduces income available for investment in one's offspring's survival and future reproduction (Kaplan *et al*., 1995); with income being all of the physical and social resources and time that an individual has at their disposal. Offspring's (future) reproduction can be enhanced via parental investment that reduces mortality and that increases offspring embodied capital. Embodied capital may be defined as "the stock of attributes embodied in the soma of an organism which can be converted…into fitness enhancing commodities. Body mass and complexity as well as skills and knowledge are forms of embodied capital in which individuals can invest, either in themselves or in others" (Kaplan *et al.*, 1995: 328). Figure 4.1 illustrates the options for life history investments under embodied capital theory, with an individual's income influencing their parenting decisions (Kaplan, 1996): income can be invested in either reproductive effort or in embodied capital, and embodied capital can be divided into stock that affects the individual's ability to obtain resources for reproduction (income-related capital) and stocks that affect the likelihood of survival (survival-related capital). Offspring, in turn, are seen as providing income to their parents in terms of their future reproductive potential, and Kaplan demonstrates that marginal returns from investing in a fitness component *have to equal* the total returns divided by the sum of all investments in offspring to be worthwhile. This is a result of the parent trading off current investment in offspring income against future fertility, with each additional offspring costing them the sum of fixed costs, investments in survival and investments in

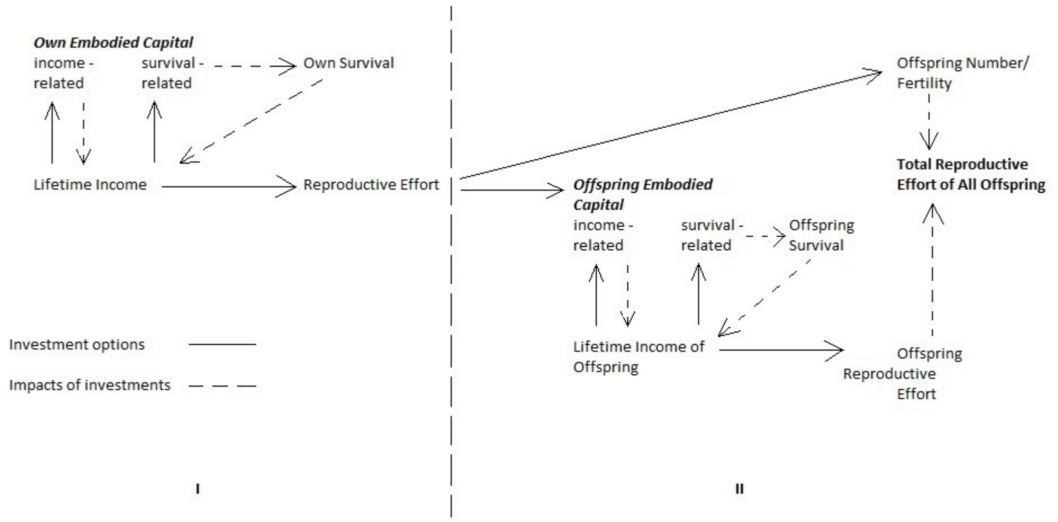

Figure 4.1 Decision model for the life history of investments, reproduced from Kaplan (1996: 94). Part I is the trade-off between current and future offspring, Part II is the trade-off between quality and quantity.

income. This interaction leads to a cascade effect in which small variations among individuals in one fitness component are capable of having "large effects on fertility through their impacts on optimal levels of investment in other fitness components" (Kaplan, 1996:99). From a theoretical perspective the investment per offspring is the total of age-specific investments in the survival of the offspring and in its embodied capital, each devalued by the likelihood of it reaching that age. If the age-specific level of investment is held constant, any rises in the likelihood of surviving to a given age will elevate the total expected parental investment per child. Kaplan applies the theory to explain the greater impact of education compared to wealth on fertility in a Western context (Kaplan *et al*., 2002), showing that in a society in which level of education is linked to both financial costs and personal success, "the principle effect of parental income on parental investment should be due to the education-based capital embodied in the parents. Therefore, within economic strata more educated parents should invest more in each child and should have lower fertility" (Kaplan, 1996:122).

-An emotional capital theory of maternal investment

The forms of extra-somatic embodied capital generally investigated by life history theorists have been knowledge, skills and education (Borgerhoff Mulder, 2000; Gibson and Lawson, 2011; Huber, Bookstein, and Fieder, 2010; Kaplan *et al*., 2002; Lancaster and Kaplan, 2010; Shenk, 2004), monetary wealth (Hopcroft, 2006; Kaplan and Lancaster, 2003; Shenk, 2004) or social status (Boone and Kessler, 1999; Hopcroft, 2006; Huber, Bookstein, and Fieder, 2010), with no attention paid to emotional resources. The embodied capital theory of life histories finds its foundations in the economic theory of capital investment; an area from which other disciplines have also drawn inspiration. For the past two decades sociologists have been building on the work of Bourdieu and his idea of 'cultural capital' (Reay, 2000), leading to the conceptualisation of 'emotional capital'. Emotional capital has been defined as "the emotional resources passed on from mother to child through processes of parental involvement" (Reay, 2000:569), and is utilised as an explanatory framework for mothers' involvement in the education of their children. It is argued that lack of resources, such as money and social support, have the power to curtail emotional capital, thus limiting a mother's involvement. The idea of emotional capital is also used extensively in the world of business management and leadership training and is seen as being crucial to success (Gendron, 2004), making it into the *Cambridge Business English Dictionary* under the definition: "the feelings and beliefs that help an organization's employees to form successful relationships with each other" (Cambridge University Press, 2013). Until now evolutionary theorists have ignored the potential role of the emotional state of an individual in life history trade-offs, highlighted in a recent call for a better understanding of the psychological mechanisms driving fertility motivation (McAllister *et al*., 2016). It is proposed here that the notion of embodied capital should be expanded to include a measure of emotional capital, with emotional capital comprising the emotional resources available to an individual for emotional investment in their offspring.

Emotional stability has consistently been found to be one of the most highly valued traits with regards to mate preferences (Botwin, Buss, and Shakelford, 1997; Buss *et al*., 1990 and 2001), and the business development literature indicates its perceived importance in wealth attainment in contemporary society, making the development of emotional competence in offspring a good candidate target for parental investment. Emotional capital, as proposed here, is conceptually similar to the concept of 'emotional energy' which is used by Goldberg *et al*. to refer to "the degree of interest and excitement that a father has available to bring to interactions with his infant" (2002: 380). It also has resonance with Zohar *et al*.'s (2005) 'cognitive-energy model' derived to explain the negative impact of sleep deprivation on emotions. This model posits the requirement of cognitive-energy resources to cope with goal-obstructing events or to capitalise on goal-enhancing events, the availability of which influences perception of goal oriented progression. Positive emotions are thought to be promoted when enough cognitive-energy to reach a goal is anticipated, and when a lack of resources is perceived, negative emotions arise. Investment in an infant's emotional capital entails an emotional investment from the mother and is theoretically similar to Mann's (1992) psychosocial investment, comprised of maternal behaviours which are thought to improve the future social prospects of an infant.

Under the framework of Kaplan's (1996) model, embodied capital is assessed once by the parent, and then the decision to conceive is taken. However when embodied capital is potentially variable, when measured as social status or monetary wealth for example, and as environments are not stable, it is more likely that assessments of embodied capital are, in reality, continuous. To better reflect continuous appraisal a two part decision model is proposed here (Figure 4.2), in which (I) an initial assessment is made to determine whether reproduction should occur, and, moving beyond Kaplan's model, (II) if conception does take place a second assessment occurs after birth to determine whether investment should be continued in the infant in the form of emotional investment contributing to the offspring's income-related capital (given current societal restrictions on abandoning/neglecting infants, physical investment is held to be largely invariable for the purposes of the model and independent of emotional investments). This is in line with Thornhill and Furlow's (1998) suggestion that "postnatal assessment of offspring fitness may allow a more subtle evaluation than prenatal maternal assessments" (1998: 346) which they suggest is necessitated by the heighted energetic costs of lactation relative to gestation. Given the precipitant role of 'bonding' to attachment, and the importance of the latter in the cognitive development of children, emotional investment may reflect the first form of embodied capital investment made in an infant, followed later by investments in other forms, such as education, when the child is older. Under this model, women who do not emotionally invest are detecting a risk to their fitness, in the form of insufficient payoffs from emotional capital investments in their infant during the second assessment of capital after birth, either because there is a tangible threat to infant survival or their exposure to a sociocultural environment leads them to conclude their emotional input is incapable of countering the damage done to their infant's emotional health by the wider world. This then leads them to not invest emotionally, or withdraw their emotional investment, in favour of future reproductive opportunities. Such women are then at risk of developing PND, due to the hypothesised stresses this strategy entails in a WEIRD sociocultural environment, which, as discussed in Chapter 2, may counteract any fertility benefits gained from a low investment strategy.

Traditional embodied capital theory has shown success in explaining the observed correlations between fertility and standard demographic variables such as educational level, social and economic status, which otherwise appear perplexing. If the energy input necessary to ensure the

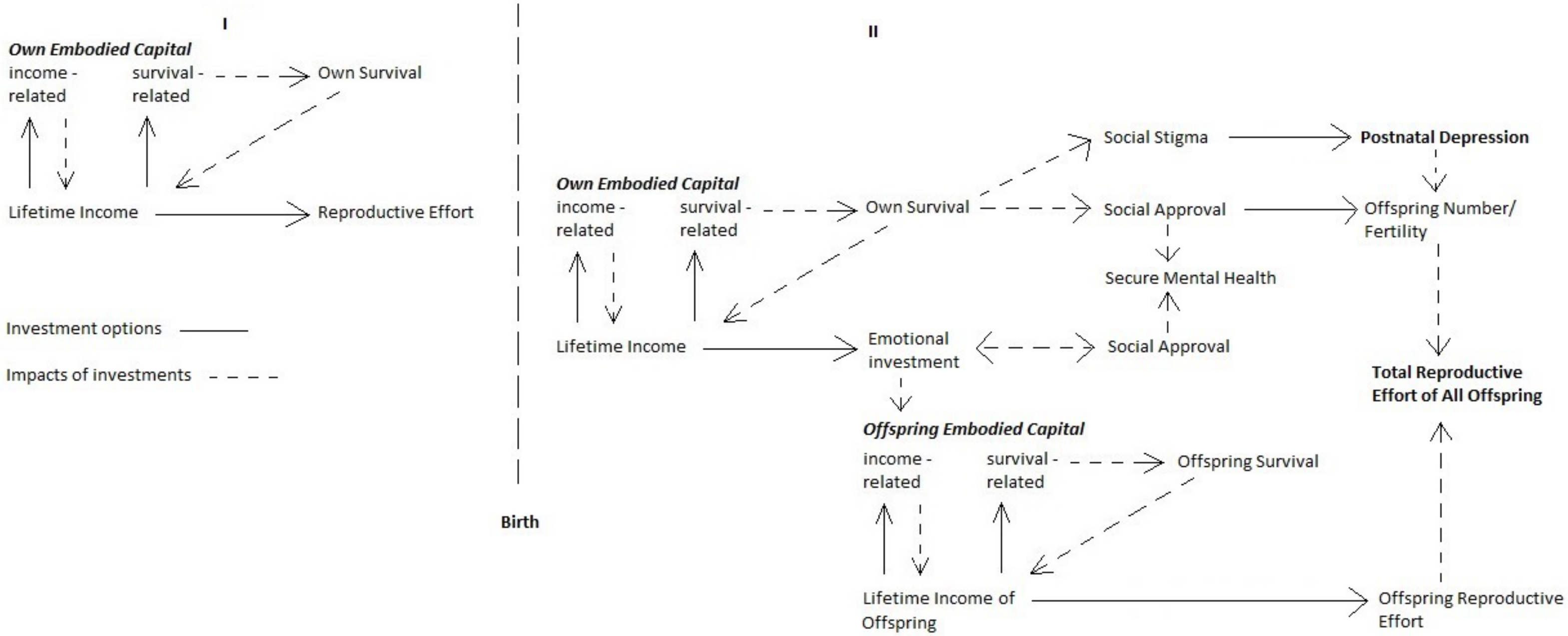

Figure 4.2 A two part decision model for embodied capital investments in terms of emotional investment. Part I is the trade-off between current vs future offspring in terms of reproductive effort before giving birth, and Part II is the trade-off between current vs future offspring in terms of emotional investment after birth.

desired level of offspring embodied capital is relative to the parent's own embodied capital, fertility will be constrained, to ensure offspring quality, to the same extent no matter what level of embodied capital a parent has (Kaplan, 1996; Kaplan *et al*., 2002). Therefore, in relation to education for instance, embodied capital theory predicts that in a society that values education, the higher a parent's level of educational attainment, the higher the level of investment in the educational success of their offspring the parent will deem necessary. Thus assuming education is valued equally across the population, fertility will be low across parental educational strata as all parents will proportionally speaking make the same degree of investment in offspring education; this argument is used by Kaplan *et al* to explain the generalised trend towards low fertility in the West (although see Sear *et al*. (2016) for a review of more recent and nuanced evolutionary perspectives on fertility in WEIRD contexts and Stulp and Barrett (2016) regarding variations within low fertility settings).

Current adaptationist explanations of PND based on demographic measures such as SES are not so successful; with wealthy, educated, socially secure women not being immune to depression (Myers, Burger, and Johns, 2016), as might be predicted. However, an embodied capital approach to maternal investments incorporating emotional investments (referred to from now on as the emotional capital hypothesis), combined with a social genome approach to depression aetiology, can illuminate the causal pathway for PND in women who do not exhibit the standard PND risk factors. The emotional capital hypothesis predicts (1) that in social contexts in which offspring emotional capital is valued, all mothers will view emotional investment in their offspring to be important, (2) 'emotional bonding', as a reflection of investment in offspring emotional capital, will correlate consistently with measures of maternal emotional capital, (3) where mothers perceive the likelihood of inadequate pay-offs from emotional investments they will withhold or withdraw investment, and (4) that maternal emotional income is fluid, thus improvements in maternal emotional capital will lead to renewed or later emotional investment. The emphasis on risk in relation to 'emotional bonding' in WEIRD contexts is proposed to skew women's assessments of the efficacy of their emotional investments, leading to the withdrawal of investment in otherwise objectively safe and stable environments. When such low emotional investment behaviour is combined with sociocultural pressures to be highly invested it leads to the experience of shame and its associated inflammatory response (Slavich *et al*., 2010a), the prolonged experience of which leads to PND. This pathway to PND potentially works irrespective of whether ‘emotional bonding’ (a) represents a tangible embodied capital investment resulting in actual benefits to the offspring or whether the benefits are just assumed by the mother/society and (b) represents an investment from a stock of capital which if invested in the offspring cannot be invested in the mother or rather emotional investments stem from an endless reserve of ‘emotional energy’. However, I will now present a brief overview of evidence supporting first the notion that offspring benefit from emotional investment and then that emotional investments are made from some form of limited ‘emotional energy reserve’ and thus entail costs.

Section B – The benefits of emotional investment

-The added value of emotional investment

Embodied capital is capital which improves an individual’s prospects of surviving and attracting a mate and then raising offspring which survive and are themselves attractive in a given environment. It has already been noted that secure attachment is linked to improved cognitive, physical, social and emotional development in infants, and that emotional stability is beneficial in adults. These points will now be explored in more depth to assess whether emotional investment meets the criteria of an embodied capital investment in offspring income-related capital.

-Emotional investment and brain development

The brain undergoes a growth spurt beginning in utero during the third trimester and lasting until around 18 to 24 months postnatally (Schore, 2001a), during which time the right hemisphere of the brain is dominant. A ‘transactional model’ of brain development is now widely accepted, under which neural development and organisation reflects a transaction between genetic programmes and environmental modifiers (Fox, Calkins, and Bell, 1994), allowing for constrained plasticity (Boyce and Ellis, 2005). When synaptic connections are stimulated by the environment, metabolic energy flows through them, increasing coherence between the areas involved (Schore, 2001a). During the development of the cortical and subcortical network, a primary excess production of synaptic connections appears to be pruned by an environmentally mediated process of selection in which those connections most effectively in tune with environmental information are at a competitive advantage. As an infant's initial environment is heavily influenced by its significant early relationships (Calkins and Hill, 2007) attachment theorists have naturally pointed to the importance of the mother in infant brain development (Schore, 2001a), even though not all the evidence is in their favour (Thompson, 2000).

The experience of stress during this postnatal period plays a navigational role in this synaptic pruning, altering thresholds for stress responses later in life (Ellis, Essex and Boyce, 2005; Francis and Meaney, 1999; Schore, 2001a, 2001b). At around 2 months of age during normal development, an infant under goes rapid metabolic alteration in the primary visual cortex thought to indicate the beginning of changes to the occipital cortex as a result of visual experience, and this is marked by a shift in infant socioemotional interactions (Schore, 2001a). The facial expression of emotions by the mother becomes of immense interest to the infant, and begins a pattern of affect synchronicity between the infant and mother which continues through the various later stages on infant neural and cognitive development. A lot of stress, or conversely very little stress, heightens reactivity (Ellis, Essex and Boyce, 2005), whereas moderate amounts such as those experienced in a secure attachment relationship in which a mother regulates the stress levels of her infant, with short bursts of stressful separation and then reassuring reunions, mediates the neural development of affective coping (Schore, 2001a). These "crescendos and decrescendos of the infant's peripheral (ANS) and central (CNS) arousal systems underlie emotions, and so the mutual entrainment of affective states in attachment transactions can be defined as the dyadic regulation of emotion" (Schore, 2001a: 21), with this regulatory process being "developmentally incorporated into emotion itself" (Thompson, 2011: 53).

One of the means by which this occurs is via activation of dopamine neurons in the right hemisphere of the infant brain, known to play a role in emotionality and reward, which change from 'pacemaker like firing' to 'burst firing' as a result of 'ethologically salient' auditory, visual and tactile input (Schore, 2001a). During bouts of emotional communication, for instance via face-to-face engagement, neurotrophins including BDNF are produced; BDNF promotes the growth of mesencephalic dopamine neurons, and dopamine itself plays a part in promoting the infantile growth of the cortex. The early activity of the dopamine system, as neural networks are being laid down, influences the evaluation of environments as positive in the future, with those neurons in the right hemisphere playing a key role (Besson and Louilot, 1995).

Attachment theory is both a theory of normal development and pathological development (Sroufe, 1999), and attachment theorists such as Schore have looked to the extremes of attachment relations for signs of psychopathology (Schore, 2001b), framing neurological development, and subsequent emotional regulation, as either adaptive or maladaptive (Schore, 2001a; Thompson, 2011). When viewed simplistically the potential implications of this on maternal responsibility become of concern, with a growing number of social scientists critiquing what has been referred to as 'neuroscientism' – the "ideological attempt to discover the essence of humanity in the brain" (Macvarish, 2013: 1), which enables the politicising parenting, and the laying of societal ills at the doors of mothers. However, the mother is not the only environmental influence on a developing infant and maternal sensitivity incompletely accounts for the quality of infant attachment (Grossmann *et al*., 1985). Children differ markedly as to whether their early attachments have a lasting impact on them (Thompson, 2000); attachment is also not stable, being capable of becoming more or less secure over infancy (Belsky *et al*., 1996), and whilst poor attachment raises the probability of later psychopathology it is not causally related to it in a linear fashion (Sroufe, 1999). Nevertheless, "the nature and nurture of the neurobiology of emotion are intertwined from birth in ways that affect the development of emotion and the growth of emotion regulation” (Thompson, 2011).

-Evolutionary explanations for neuroplasticity

The neuroplasticity of brain development has been interpreted in a number of different ways. Attachment theorists, with their roots in Developmental Evolutionary Psychology (Cassidy, 1999), view the products of this flexibility as either adaptive, producing individuals who effectively cope with their environments, or maladaptive, resulting in those who lack resilience to stress and are at risk of affective disorders (Schore, 2001a). Conversely, Thompson (2011) contends that emotion regulation should be viewed as context specific. While there is much debate as to the definition of emotion, intrinsic to most is the linking of different emotions to distinct goals, and thus the emotional products of regulation can be seen as trade-offs between immediate benefits and costs to long-term aims. When the goals of an individual in a given context are taken into account, the regulation of emotion is hardly ever optimal or maladaptive.

Chisholm (1996), taking a life history approach grounded in behavioural ecology, speculates that differences in attachment styles represent facultative adaptations to environmental risk. Externalising problems in children associated with coercive parenting are heritable and this heritability may be variable across a spectrum (Belsky, 1997b); Belsky (1997b) proposes that parents may hedge their bets with environmental risk by producing offspring with differential susceptibility to the influence of parenting and environment. The traits and developmental path of some offspring will then be more set by their genetics, whilst others will be more flexible. Those who are more set in type will be better able to survive and reproduce in ecological niches that suit their genotype, and those who are more behaviourally flexible are better able to mould themselves to a wider variety of niches, depending on the conditions they encounter during development (Belsky, 2005). These more flexible individuals are both more susceptible to negative environmental influences, as contended by the diathesis-stress model of psychopathology, which explores the interaction between biological traits (diatheses) and environmental factors (stressors), and the positive effects of enriching and supportive environments, or simply those lacking adversity (Belsky, Bakersmans-Kranenburg, and van IJzendoorn, 2007; Belsky and Pluess, 2009).

A similar stance is taken by Boyce, Ellis and colleagues in their evolutionary-developmental theory of stress reactivity (Boyce and Ellis, 2005; Ellis, Essex, and Boyce, 2005; Ellis, Jackson and Boyce, 2006). They conclude that neuroplasticity reflects a conditional adaption for biological sensitivity to context (BSC) (Boyce and Ellis, 2005), with high and low stress environments producing highly reactive phenotypes, and moderately stressful environments (thought to be the norm) resulting in phenotypes of low reactivity. Two large scale studies of the autonomic reactivity of children in relation to their familial environments provide support for such a curvilinear function (Ellis, Essex, and Boyce, 2005). Highly reactive individuals are conferred an advantage in high risk environments as a result of their quickened reactions to threat, whilst in protective and highly supportive environments they also appear best able to thrive, and low reactive phenotypes benefit in changeable environments of moderate risk but are desensitised to risk at high levels (Boyce and Ellis, 2005).

-'Bonding' and brain development

The extent of the influence the emotional relationship between mother and infant has on an infant's neurological and behavioural development may still be up for debate, but evidence firmly indicates that there is one, going part way to support emotional investment meeting the criteria for embodied capital. A further aspect of this influence, also of interest to the current hypothesis under investigation, is namely *when* this influence takes effect. As previously discussed, attachment is a reciprocal emotional relationship which takes full effect in the second half of the first year, and perhaps is seen in its earliest, tentative form at two months of age, when face-to-face emotional communication begins between a mother and her infant. 'Bonding', occurring in the first months after birth, can be split into a physical component and an emotional component, and this distinction appears salient when considering the influence of ‘bonding’ on neurological development.

The amygdala, part of the limbic system, is the only regulatory system active at birth, and is capable of altering the autonomic and arousal systems in response to only rudimentary appraisals of the external environment largely in the form of olfactory or gustatory information (Schore, 2001a). The primary somatosensory cortex is the only part of the cerebral hemispheres that is metabolically active at this time, and decodes tactile and kinesthetic information. Experiments with rat pups have shown that handling in infancy has a permanent effect on hypothalamic levels of corticotrophin-releasing factor (CRF), key in stress response systems (Campbell, Zarrow and Denenberg, 1973). In both rats and mice handling has been shown to decrease, and maternal separation increase, expression of the CRF gene in the hypothalamus and amygdala (Francis and Meaney, 1999). Repeated early maternal separation has also been found to increase serotonin and noradrenaline responses to stress in rhesus monkeys. Schore (2001a) proposes that mother-infant contact, and the tactile stimulation this provides, creates an environment which encourages the maturation of links between the amygdala and the paraventricular hypothalamic nuclei, enabling the coregulation of oxytocin and vasopressin in mother-infant interactions and prevents the development of stress responses which are highly reactive.

What appears influential, from a neural developmental perspective, in the first months after birth is the tactile stimulation a mother (or other care givers) provides to an infant. Whilst attachment theorists tend to equate the physical acts of caring for an infant with positive emotions towards the infant this need not necessarily be the case. In an ethnographic case study which will be returned to later in this chapter, Scheper-Hughes (1985) points out that in the high mortality environment of a Brazilian favela the physiological markers of ‘bonding’ are observed between mothers and infants – prolonged skin-to-skin contact, co-sleeping, breastfeeding in the initial weeks etc. – but the emotional markers are lacking in a way that is described as “often muted and *protectively distanced*” (1985: 311).

When Klaus and Kennell (1976) initially proposed their theory of bonding they employed the notion of 'critical periods', defining bonding as a period "in the first *minutes* and hours of life during which it is *necessary* that the mother and father have close contact with the neonate for later development to be optimal" (Klaus and Kennell, 1976: 14 in Scheper-Hughes, 1985: 307 – emphasis added). The notion of critical periods, limited periods in development in which particular events must take place to guarantee normal development (Maestripieri, 2001), is controversial (Bruer, 1999); the concept finds it roots in the work of Konrad Lorenz (1937), whose 'imprinted' geese have had a long lasting legacy in developmental psychology. However, since Lorenz, animal behaviourists have found that true critical periods do not exist in non-human animals, with the beginning and ending of such times showing greater plasticity than initially thought, and their products capable of being partially or entirely reversed (Maestripieri, 2001). This has led to the replacement of critical periods with 'sensitive periods'; periods of time in development whose boundaries are comparatively flexible and during which individuals are most responsive to stimuli from the environment and most likely to be influenced by them (Bateson, 1979). In line with this approach, a later 1982 edition of Klaus and Kennell's book revised their conclusions to reflect a sensitive rather than critical period (Maestripieri, 2001).

The use of critical periods persists in neuroscience, however, and the interest this field holds for attachment theorists perhaps explains the resurgence of the term's usage by contemporary psychologists working in this area; indeed the utilisation of critical periods is now widespread (Schore, 2001a). Yet the neuroscientific meaning of the term is more akin to ethologists' "sensitive periods". For neuroscientists, critical periods are complex and "far from being windows that slam shut" (Bruer, 1999), and this semantic conflation perhaps contributes to an underestimation of human neural developmental plasticity by attachment theorists.

Evidence from neuroscience suggests that in the early postnatal, 'bonding' period heightened infant reactivity results from physical separation (Campbell, Zarrow and Denenberg, 1973; Francis and Meaney, 1999; Schore, 2001a); there seems little evidence to suggest a physically attentive mother who is emotionally distant during this time will have a causal role in increasing her infant's reactivity. Conversely, evidence appears scant at the present time regarding a physically distant mother who is engaged emotionally playing a causal role in reducing her infant's reactivity; studies do not appear to have been designed to test this, and instead generally chart the impact of maternal emotional engagement once physical contact has resumed, for instance as part of studies looking at development of preterm infants once they have left hospital (for example: Blair, 2002; Vanderveen *et al*., 2009). However given human neural plasticity, once the attachment process begins, emotional input from the mother will presumably go at least some way to counteracting deficits, acting to provide environmental stimuli conducive to lowering future reactivity. Interventions aimed at improving parenting, with an emphasis on maternal sensitivity, for instance the Infant Health Development Program which involves weekly visits from health workers who monitor and aid mother-infant interactions (Ramey *et al*., 1992), have been found to improve outcomes in preterm infants whose early life is characterised by maternal separation (Blair, 2002; Vanderveen *et al*., 2009). It then seems plausible that the *timing* of maternal emotional investment (independent of physical investment and *degree* of emotional investment) is a conditional adaptation dependent on environmental circumstance and has limited impact on infant development until later through the first year.

-Reproductive success and the results of emotional investment – attachment

The life history approaches to neural plasticity and developmental differences in reactivity discussed above deal largely with the development of phenotypes that will enable a child to survive in its given environment. Belsky (1997a) extends the attachment remit to encompass reproductive success in his work on attachment and mating strategies. He suggests that secure attachment in adults has benefits in terms of enhanced quality of long-term relationships, enabling high investment parenting. Less secure attachment, characterised by being avoidant/dismissing is thought to encourage short-term mating strategies and low parental investment (Belsky, 1997a;

Schmitt, 2005), whilst resistant/preoccupied attachment may benefit inclusive fitness by producing ‘help at the nest’ behaviour (Belsky, 1997a).

This approach is further developed by Del-Giudice (2009) who brings together research that indicates there are sex differences in attachment style to develop an “integrated evolutionary model of the development of attachment and human reproductive strategies” (2009: 1). Del-Giudice argues that insecure females tend to adopt resistant/preoccupied attachment, with attachment becoming avoidant when the environment is most risky, while males are most likely to be avoidant/dismissing in their insecure attachment styles. It is suggested that a resistant/preoccupied strategy in females may maximise investment from mates and kin, while an avoidant strategy in males is associated with aggression and competitiveness and is likely to benefit status. However, it must be noted that the evidence for sex-specific attachment styles is presently ambiguous (Ein-Dor *et al*., 2010).

While insecure attachment is often viewed as producing maladaptive behaviour by evolutionary psychologists (Schmitt, 2005), Ein-Dor *et al*. (2010) conclude that too many people are found to be insecurely attached for it not to have adaptive benefits; in every age group almost half of people score as insecurely attached. In addition, insecure attachment is observed at higher levels in disadvantaged populations; for instance a cross-cultural study of adult romantic attachment styles in 62 cultural regions found that avoidant attachment is most prevalent in African countries in the sample (Schmitt *et al*., 2004). Social defence theory, underpinned by group-selection and inclusive fitness perspectives, explains the evolution and persistence of different attachment styles as being the result of heterogenous advantage in groups (Ein-Dor *et al*., 2010); preliminary experimental evidence supports the case that individuals with secure attachment make for better leaders while the insecure are more likely to survive in times of extreme risk. Thus, notwithstanding the complexities contributing to adult attachment (Waters *et al*., 2000), conditional maternal emotional investment may enhance intergenerational reproductive success by guiding the development of optimal mating strategies in a given environment (Belsky, 1997a).

-Reproductive success and the results of emotional investment – personality

Reproductive success and survival have, so far, been discussed in relation to reactivity and attachment as measured separately, whilst acknowledging their related developmental path. Also sharing elements of this developmental path are the attributes measured by personality scales. Adult attachment styles have been found to share a theoretically predictable relationship with the Big Five personality traits and a number of their subscales (Shaver and Brennan, 1992). Many personality factors covary, suggesting that there are a limited number of contributors at a biological level affecting variation (DeYoung *et al*., 2010). Whilst personality factors have been shown to display heritability (Nettle, 2006), they are also thought to be proximately controlled by neurological features that appear developmentally plastic and responsive to environment (Schore, 2001a). For example, factors influencing dopamine pathways are implicated in the expression of the personality factors *Extraversion* (Depue and Collins, 1999) and *Openness/Intellect* (DeYoung, Peterson, and Higgins, 2005). *Neuroticism* is associated with negative affect reactivity (Nettle, 2006), and developmentally tied to stress exposure (DeYoung *et al*., 2010). Finally, the volumes of various brain areas, influenced by selective pruning in development, have been found to be related to *Agreeableness* and *Conscientiousness* (DeYoung *et al*., 2010).

Nettle (2006) suggests that variation in personality is maintained as a product of trade-offs between different costs and benefits to fitness in variable environments. Extraverts benefit by tending to have more sexual partners and extra-pair copulations, they also start more social interactions and have more social support. On the costs side they expose themselves, and their offspring, to more risk. High neuroticism, and the stress it entails, has costs in terms of physical and mental health; however it may provide benefits in times of risk resulting from hypervigilance. It also correlates positively with competitiveness (Nettle, 2006) and those who cope with the negative effects of neuroticism, as a result of being in protective environments (Boyce and Ellis, 2005), have the potential to thrive (Nettle, 2006). Very low neuroticism has also been found to be associated with extreme risk takers (Nettle, 2006). High neuroticism also reduces female fertility in the West whilst in high fertility populations it increases offspring quantity and reduces their quality (Jokela *et al*., 2009). Openness/Intellect is linked to creativity and has been found to provide benefits in terms of attracting mates (Nettle, 2006). However Openness/Intellect also presents costs in being linked to schizotypy, psychosis, and depression; the trait would seem to be very dependent on context or condition although the triggers, environmental or otherwise, resulting in pathology are currently poorly comprehended (Nettle, 2006). Conscientiousness is positively correlated with pursuing health behaviours (Alvergne, Jokela, and Lummaa, 2010) and life expectancy (Nettle, 2006) and negatively with short-term mating, and individuals possessing high levels forego short-term gains for those in the long-term; the costs and benefits of such a strategy will be context dependant. Agreeableness measures an individual's empathy and trustfulness, and high levels are likely to provide benefits in terms of social functioning yet costs in terms of being inattentive to personal fitness opportunities and open to exploitation. The cost-benefit trade-offs implicated the expression of the various personality factors, combined with neuroscientific evidence concluding that their expression is partially developmentally contingent and correlates with attachment styles, is indicative of personality being part conditional adaptation, enabled by environmentally sensitive developmental neuroplasticity, analogous to Boyce and Ellis's (2005) conception of stress reactivity.

An alternative explanatory model of personality variation, social niche specialisation, also cites phenotypic plasticity linked to life history strategies as the reason for the existence and retention of variation (Montiglio, Ferrari and Réale, 2013). Supported by game theory, this approach suggests that, because individuals vary in the section of the whole ecological niche occupied by their population, "the coevolution of habitat-specific performance and habitat preference can theoretically lead to the evolution of multiple, locally adapted, specialists" (2013: 1). If individuals are capable of choosing particular social conditions and avoiding others, populations will display social niche variation and individuals' social niche specialisation. Variations in personality in a social context are suggested to reflect and/or influence an individual's social specialisation. Social niche specialisation is predicted to result from trade-offs, therefore the authors conclude a relationship between social niche specialisation, personality, and life history strategies should be anticipated.

Large scale studies by Buss and colleagues have found significant support for the idea that preference for particular personalities affects mate choice (Botwin, Buss and Shakelford, 1997; Buss *et al*., 1990; Buss *et al*., 2001). In stable affluent environments people favour mates high on emotional stability (low *Neuroticism*), *Agreeability* and *Openness/Intellect*, and these characteristics rank above those linked to current targets for embodied capital theory (‘education and intelligence’, ‘good financial prospect’, ‘favourable social status or rating’, and ‘similar education’), while less value is placed on these personality variables by individuals from the less affluent, arguably more high risk environments surveyed. Taken together, the work of Buss *et al*., amongst others, highlights the reproductive advantages gained by the displaying of the “positive affect” dimensions of personality in the largely low mortality environment of WEIRD populations, and is suggestive of their costs in more risky environments.

It is plausible that maternal investment plays a role in life history trade-offs governing personality; high levels of maternal emotional investment are likely to create a low stress environment which encourages the development of low *Neuroticism*. High levels of maternal emotional investment also exercise the dopamine-reward systems, thus encouraging the development of high *Agreeableness, Extraversion,* and *Openness/Intellect*. In relatively stable, low risk environments, these personality traits then provide benefits for both survival and reproduction. Thus, in making emotional investments in their infant’s, mothers are investing in the future embodied emotional capital of their offspring by guiding the development of their attachment styles and personality attributes.

Section C – The potential costs of maternal investment

While a vast corpus of literature exists extolling the benefits of maternal investment, both from the point of view of the mother and of the infant, only a small number of authors have approached maternal behaviour in WEIRD contexts from a *cost-benefit* perspective[8]. This is understandable as the great majority of studies into the effects of maternal behaviour have not been carried out with evolution in mind, and thus make the implicit, or occasionally explicit, assumption that positive maternal behaviour can only be of benefit to all involved. However, the paradigm of evolutionary life history theory holds that any behaviour which entails the expenditure of energy or time, no matter how beneficial, incurs a cost because it is energy not being spent on something else. Those authors who have discussed maternal investment as “costly” have unfortunately remained vague as to what the actual costs to a mother might be. For instance, in an analysis of night time parenting strategies as life history trade-offs, Volpe (2010) limits her definition of cost to parent-infant conflict. Burgess and Drais (1999) are elaborate, if non-specific, in their life-history driven hypothesis of child maltreatment, stating that “a high-investment parenting strategy in modem industrial societies involves a multitude of costly and coordinated activities, including feeling and expressing love towards one's child; possessing a strong emotional attachment to one's child; talking to the child often; reading to the child; playing with the child; actively listening to the child; having empathy for the child; providing emotional support for the child; imparting values such as cooperativeness, honesty, and self-control; monitoring the child's behavior; enforcing rules in a consistent but flexible manner; providing for the child's nourishment and physical health; and attempting to shield the child from harm” (1999: 388). The closest definitions of specific costs come from Monnot (1999), who simply states that infant-directed speech is slow and energetically expensive, without giving any supporting evidence, and Meehan (2009) who goes so far as to say high-investment behaviours are those which “require intimate contact or direct attention to the infant…[thus] require caregivers to expend energy and/or divert their attention away from other activities” (2009: 383).

[8] Behavioural ecologists have conducted studies into the cost-benefit studies of maternal behaviour such as breastfeeding and weaning in small-scale society settings (for example Quinlan, 2007).

In his parental investment theory, Trivers (1974) posited that altruistic behaviour towards kin is of reproductive value to the altruist if the benefit-to-cost ratio is greater than the inverse of the degree of relatedness. Given that, on average, the relatedness coefficient of biological mother-infant dyads is one-half (Hamilton, 1964), the perceived costs to the mother must be one-half of the perceived benefits (i.e. benefits-to-costs ratio ≥ 2) to result in high maternal investment. However, this curvilinear relationship is individually determined and liable to fluctuate overtime on the basis of personal and ecological factors (Burgess and Drais, 1999), a point that is important to keep in mind when considering the emotional capital hypothesis, and the embodied capital hypothesis more generally. Under the present thesis, a mother's emotional capital at a given time, in combination with ecological factors such as social support and perceptions of 'good parenting', determine the 'acceptability' threshold of benefit-to-cost ratios.

In their life-history hypothesis of child maltreatment, Burgess and Drais (1999) propose that perceived costs of parental investment are actually more influential than perceived benefits in governing thresholds of acceptability due to their being more likely to vary, and to vary in short time spans. As shown in Figure 4.3a, when costs remain constant and perceived benefits decrease, parental investment decreases. Figure 4.3b demonstrates, in contrast, that when benefits remain constant, a comparable rise in perceived costs results in a greater decrease in parental investment. They suggest that one reason for this differential contribution may be a general perceptual tendency to track alterations in costs more judiciously than alterations in benefits. The awareness of costs is possibly more variable and open to more influences than that of benefits; as Trivers (1974) concluded, the costs of a parental behaviour are reliant in part on the parent's condition, whereas the benefits of a given behaviour are reliant in part on the condition of the offspring. Many things impact the condition of a mother and thus her perception of the costs of her behaviour, whilst, assuming the infant is healthy, her perception of the benefits of her behaviour isn't likely to vary much (Burgess and Drais, 1999). Thus, the perceived costs of maternal emotional investment to the mother are likely to be more salient in determining whether the cost-benefit ratio is acceptable than the benefits of such investment. Costs may be, therefore, more influential than benefits in determining an individual’s threshold for high emotional investment; what then of the costs themselves?

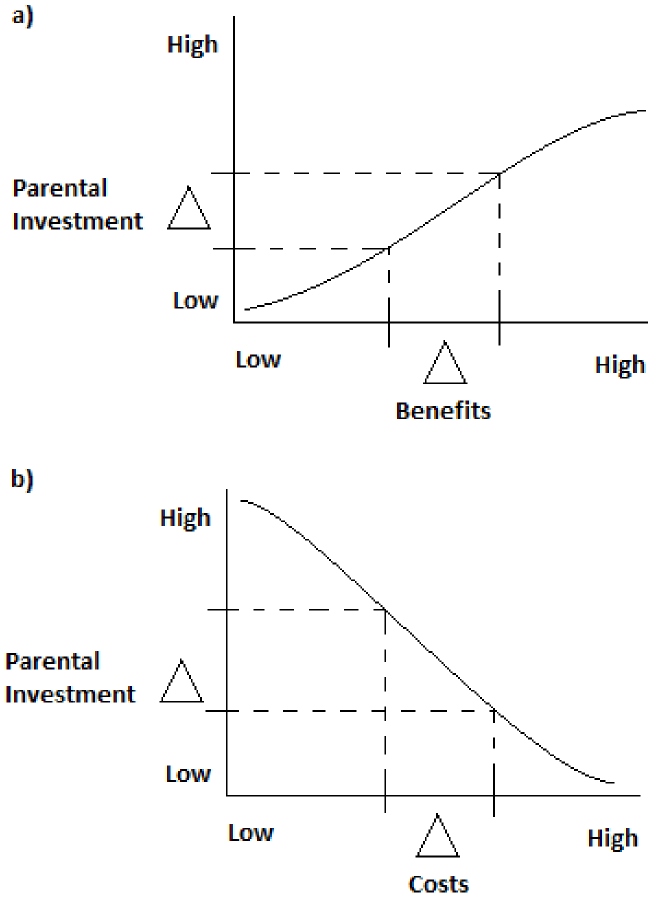

Figure 4.3 “Parental investment (PI) as a function of (a) benefits when costs are held constant and (b) costs when benefits are held constant. The conclusion to be drawn is that equivalent changes in the predictor (i.e., Δ B = Δ C) does not result in equivalent changes in the outcome (i.e., $\Delta PI_a \neq \Delta PI_b$). In fact, the change in parental investment given a change in benefits is less than the change in parental investment given an equivalent change in costs (i.e., $\Delta PI_a < \Delta PI_b$)” (Burgess and Drais, 1999: 386). Graphs reproduced from Burgess and Drais (1999: 386).

-Universal costs – motherese

Monnot (1999) states that infant-directed speech, also referred to as motherese, is energetically expensive and slow and, therefore, is costly for mothers. This stems from it having a heightened pitch contour (Bannan, 2008) which requires more energy to generate (Shinozaki, Ostendorf, and Atlas, 2009), and also greater vowel (Bannan, 2008) and consonant clarity slowing the speaking rate (Shinozaki, Ostendorf, and Atlas, 2009), which absorbs more time. In a study of British women and their infants, Monnot (1999) found that infant-directed speech positively correlates with infant weight gain in the early postnatal period. Infant-directed speech, whilst used from birth, is generally employed most intensively between 3-5 months postnatally, and differs from other-directed speech in that it signals complete attention to the infant and is noted for its prosodic intensity, or its conveyance of positive emotions – indeed motherese is often classed as a 'bonding' behaviour (Feldman *et al*., 2007). Quality and intensity of infant-directed speech, and infant weight gain were not found to correlate with maternal verbal intelligence, sociodemographic factors, or depression, and parents do not appear to use it in response to signs of infant health or well-being (Monnot, 1999). However, quality and intensity of infant-directed speech was found to negatively correlate with marital conflict, delivery problems, parity and maternal responsivity. It would appear that the quality/intensity of infant directed speech acts as an indicator to the infant of parental solicitude, therefore allowing infants to decide how much energy to expend on growth vs. survival, although Monnot is not so explicit, proposing no reasons for the observed relationship. Indeed, she does not bring trade-offs into her discussion, and only suggests that mothers experiencing marital conflict are preoccupied. It may be that mothers displaying low quality/low intensity motherese are not expending the energy and time required to generate prosodic intensity. It seems likely that infant-directed speech reflects an emotional investment; in support of this, a comparison by Trainor, Austin, and Desjardins (2000) of adult-directed and infant-directed speech concluded that what is special about infant-directed speech is the widespread expression of emotion towards infants, as opposed to the emotionally inhibited interactions between adults. Thus the energy required to produce it, and the time taken in doing so, may represent a, albeit small, component of the cost of emotional investment.

-Universal costs – emotional energy

Emotions themselves involve alterations to multiple systems: subjective, behavioural, physiological and relational (Gross, 2008). An individual's emotional reactivity is determined by their threshold, peak intensity, and rise and recovery times in reaction to emotional stimulation and is linked to personality dimensions (Baglioni *et al*., 2010). The ensuing neurological changes then result in autonomic changes including alterations to blood pressure, heart rate, muscle tension and electrodermal activity (Baglioni *et al*., 2010); all of which require energy. If long term activation of these systems is required to achieve the level of emotional investment thought necessary by an individual to achieve pay-offs in terms of offspring reproductive success, whilst at the same time the same systems are being activated by stimulation coming from a detrimental sociocultural environment, the energy expenditure may prove too costly. That 'emotional bonding' is not instantaneous in all women, and that many women report that it is a process taking weeks or months to develop (Figueiredo *et al*., 2009; Robson and Moss, 1970; Taylor *et al*., 2005), as outlined in Chapter 1, is suggestive of emotional investment being a costly process – the acceptability threshold for which is crossed at different times in different women.

That emotional engagement entails an energetic cost also finds support in research into self-control by psychologists. Self-control is necessary to adjust negative affect and cope with stress, and subsequent endeavours at self-control, after a previous effort, have a higher likelihood of failure (Muraven and Baumeister, 2000). Individuals with high self-control have been found to exhibit fewer issues with impulse control, have higher self-esteem and greater adjustment psychologically, as indicated by their having lower levels of anxiety, depression, anger, obsessive-compulsive patterns, paranoia, psychosis, and somatisation (Tangney, Baumeister, and Boone, 2004). Growing evidence indicates that the self has some form of limited resource, expended whenever it is required to actively alter, override, or regulate responses, and which is slow to replenish (Muraven, Tice, and Baumeister, 1998; Muraven, Shmueli, and Burkley, 2006; Schmeichel, Vohs, and Baumeister, 2003); with research indicating that this resource is glucose (Gailliot *et al*., 2007). Experimental evidence implicates this resource in acts of self-control such as the control of emotions, maintaining physical stamina, impulse inhibition, and persistence in spite of failure or obstruction, and acts of complex social behaviour, such as helping others, blocking out prejudice, and dealing with thoughts of mortality (Gailliot *et al*., 2007; Muraven, Tice, and Baumeister, 1998;

Muraven, Shmueli, and Burkley, 2006; Schmeichel, Vohs, and Baumeister, 2003). For instance, experiments have found that participants required to actively control their emotions perform significantly worse on subsequent tasks requiring complex thinking (Schmeichel, Vohs, and Baumeister, 2003), and that the expression of self-control in an initial task impairs willingness to help a stranger in a following task (Gailliot *et al*., 2007). Investigations have indicated that individuals have a desire to conserve their resources and thus partake in trade-offs, with participants anticipating the need of future self-control performing worse on interim tasks requiring self-control (Muraven, Shmueli, and Burkley, 2006), or simply withdrawing their efforts when the costs of continuing control become too high (De Bono, Shmueli, and Muraven, 2011). As anticipated by the law of diminishing marginal utilities in economics, it would appear that the fewer resources one has, the more value one places in what is left (Muraven, Shmueli, and Burkley, 2006). Even relatively small displays of self-control are ample to diminish the available store of glucose and produce noticeable effects on thought and behaviour (Gailliot *et al*., 2007).

Premenstrual syndrome (PMS), characterised by a loss of self-control, has been recently suggested to result from the link between glucose and self-control, with the increased metabolic demands of the luteal phase of the menstrual cycle thought to divert energy to the ovaries and away from the brain (Gailliot *et al*., 2010). The limited nature of cognitive resources have recently been proposed to underlie the relationship between poverty and counterproductive behaviour (Mani *et al*., 2013), and potentially explain, amongst other things, common findings of inconsistent parenting in socioeconomically disadvantaged populations (McLoyd, 1998). Mani *et al*. (2013) found that the complex thinking required of those in disadvantaged circumstances to manage expenses and deal with irregular income reduced their capacity to deal with choices and actions in other areas of their life. Their study was based on subjective needs rather than absolute poverty, suggesting the reach of this effect is widespread. Also potentially telling for maternal investment is the finding that display rules, i.e. expected behaviour in a given social context, that act on surface-level emotion regulation, have an energy depleting effect (Goldberg and Grandey, 2007). De Bono, Shmueli, and Muraven (2011) have also concluded that normative behaviour necessitates self-control. This suggests that adhering to social norms regarding emotions surrounding motherhood, if at odds with emotions actually experienced, will be energetically costly and detrimental to functioning in other respects. This effect is likely to be amplified by acute social exclusion, which has been found to trigger emotion regulation that acts to increase positive affect (DeWall *et al*., 2011). This is thought to be protective in terms of mental health, yet it is also likely to utilise energy supplies causing impairments in other areas of self-regulation (Baumeister *et al*., 2005). The counter balancing effect of increased positive affect may result in emotional numbness and manifest as emotional detachment (DeWall *et al*., 2011), which whilst beneficial in terms of lessening suffering and distress to enable coping, may be costly due to inappropriate social decisions made during this state (DeWall and Baumeister, 2006).

-Universal costs – empathy and inflammation

Another cost associated with the regulation of emotion is inflammation, with individuals who engage more frequently in emotion suppression showing higher levels of inflammatory markers (Appleton *et al*., 2013). Emotion regulation is required for empathy, which may necessitate not reacting to what is encountered by transcending one's own feelings (Larson and Yao, 2005). A recent study of the effects of parental empathy towards teenage offspring by Manczak *et al*. (2015) found that, while teenagers benefited, in terms of improved emotion regulation and lower systemic inflammation, from having empathetic parents, the empathetic parents suffered. Parents who expressed higher levels of empathy towards their offspring had higher levels of inflammation, as measured by elevated interleukin 1 receptor anatagonist (IL-1 ra) and IL-6, indicating chronic, low-grade inflammation. Such inflammation is physiologically costly in terms of energy (Raison and Miller, 2013) and presents morbidity and mortality risks (Harlow *et al*., 2003; Keicolt-Glaser and Glaser, 2002; Mykletun *et al*., 2009; Vliegen, Casalin, and Luyten, 2014; Young *et al*., 2000).

-Universal costs – infant development

Official diagnostic criteria define PND as having its onset within four to six weeks (APA, 2013; WHO, 1992), however multiple studies have found that symptoms may present beyond this time (Stowe, Hostetter, and Newport, 2005). Stowe, Hostetter, and Newport (2005) represent perhaps the only team to have carried out detailed analysis into PND onset times and their results, represented in Figure 6.4, are illuminating with respect to the present research. In a study of 209 American women with PND, they found that 11.5% reported onset during pregnancy, 66.5% within 6 weeks of delivery, and 22.0% after 6 weeks from delivery. 99% of cases had occurred by 27 weeks (7 months) from delivery, and 100% by 40 weeks (10 months) from delivery. Those whose onset occurred prenatally were more likely to be unmarried, and those in the late onset group (onset post 6 weeks), were less likely to have a history of PND. The authors suggest that perinatal and early PND may be distinct from later PND, although they note that there is little evidence to support this. Looking at these results within the context of maternal investment, with PND acting as a proxy for lack of/withdrawal of investment (Beaulieu and Bugental, 2008), shifts in the likelihood of PND occurring over time may reflect alterations to the cost-benefit ratio of investment.

Of potential relevance to early onset PND, are changes relating to the development of interpersonal skills in infants, which may signal infant viability. Prior to 5 weeks of age, full-term birth infants seldom maintain face-to-face interaction (Trevarthen, 1981), which mothers, seeking reassurance from the infant that investment is beneficial, may find inhibitive. This tallies with Robson and Moss's (1970) findings that mothers only begin to view their infants as people around 4-6 weeks; a period prior to which most women don't experience intense 'emotional bonding'. After this time there is a distinct increase in the attention infants pay to their mother's face and voice, and by 2 months infants are actively seeking face-to-face communication with their mothers (Trevarthen, 1981), which may play a role in the drop-off of PND risk at 6 weeks (Figure 4.4) (Stowe, Hostetter, and Newport, 2005). Lower 'emotional bonding' to high risk infants also suggests that women seek cues from their infants to gauge their worthiness of emotional investment. Very low birth weight

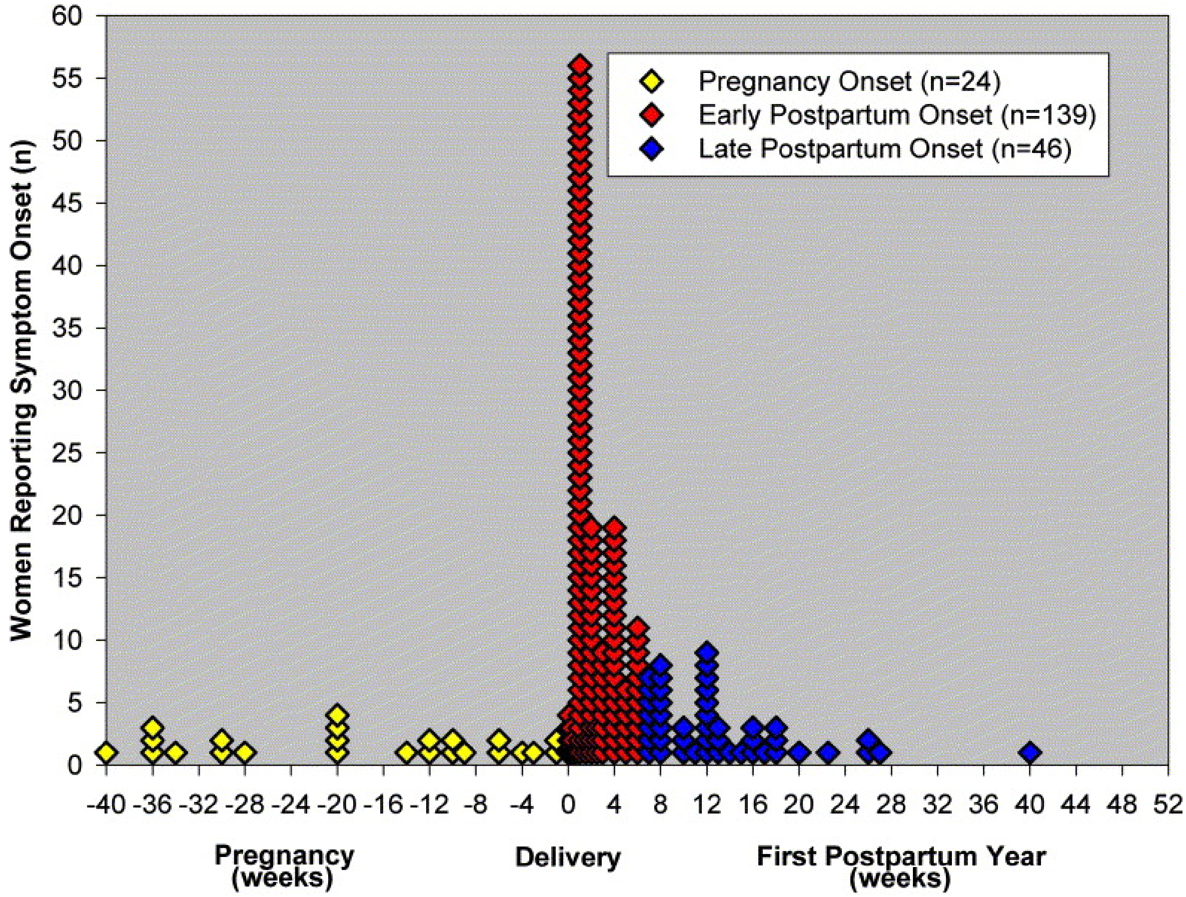

Figure 4.4 "Results of a scatterplot of the frequency of the onset of illness for women presenting for evaluation of postpartum depression across pregnancy and the first postpartum year" (Stowe, Hostetter, and Newport, 2005: 524). Graph reproduced from Stowe, Hostetter, and Newport (2005: 524).

infants display significantly reduced social responsiveness (Eckerman *et al*., 1999), and this is thought to be the cause of diminished 'emotional bonding' behaviour observed in mothers of such infants (Bereczkei, 2001; Mann, 1992). Bereczkei (2001) contends that the failure of the bonding process mediates a trade-off in these mothers, who also display shortened durations of breastfeeding and reduced interbirth intervals compared to mothers of infants with better survival prospects (Bereczkei, Hofer, and Ivan, 2000).

There is a further cognitive change between 3 to 4 months when infants become more interested in the environment around them, and responses to attempts at face-to-face contact from the mother are increasingly "disinterested, avoiding or even aggressive…[which] leads the mother to use a more exciting, surprising or arousing way of speaking…negative behavior in the baby may cause the mother to withdraw communication and just watch her infant, or she may switch to a caretaking form of behavior to which the infant has learned submission" (Trevarthen, 1981: 158). Stowe, Hostetter, and Newport's (2005) sample size is small, but there is a suggestion of a small peak in late onset PND between 3 and 4 months (Figure 4.4) which correlates with this shift in infant behaviour. That very few cases of PND arise in the second half of the first year may be linked to the onset of the attachment process at this time, again marked by developments in an infant's cognitive abilities. For instance, from around 6 months infants begin to deliberately imitate facial expressions, vocalisations and hand movements (Trevarthen, 1981) and by 9 months are much more focussed in their attention (Frank, Vul, and Johnson, 2009). Schaffer (1966) claimed that the beginnings of infant social development could be thought of in terms of two generalised behavioural tendencies, those of proximity seeking and proximity avoidance. The former is thought to provide the basis for social attachments (Bowlby, 1969), and brief separations from attachment figures are met with distress by 9 months (Gunnar *et al*., 1992). The latter has been labelled fear of strangers, or eight-months' anxiety, after its approximate time of onset (Schaffer, 1966). Another advanced behaviour which 7 month old infants have been found to display is that of theory of mind – creating beliefs regarding the beliefs of other agents and expressing surprise at violation of these beliefs, with infants expressing surprise by the amount of attention they pay to an event (Kovács, Téglás, and Endress, 2010). Mothers are in a unique position to observe the development of such complex behaviours and may subconsciously react to them, using them as a guide to the benefits versus costs of emotional investment.

-Universal costs – infant feeding

Another candidate for affecting a shift in cost-benefit ratios midway through an infant's first year is the ability of breastfeeding mothers to begin supplementing their infant's diet with other food. On average, humans completely wean their children at around 2.5 years (Kennedy, 2005), but data from the Human Relations Area File (Kennedy, 2005), contemporary cross-cultural studies

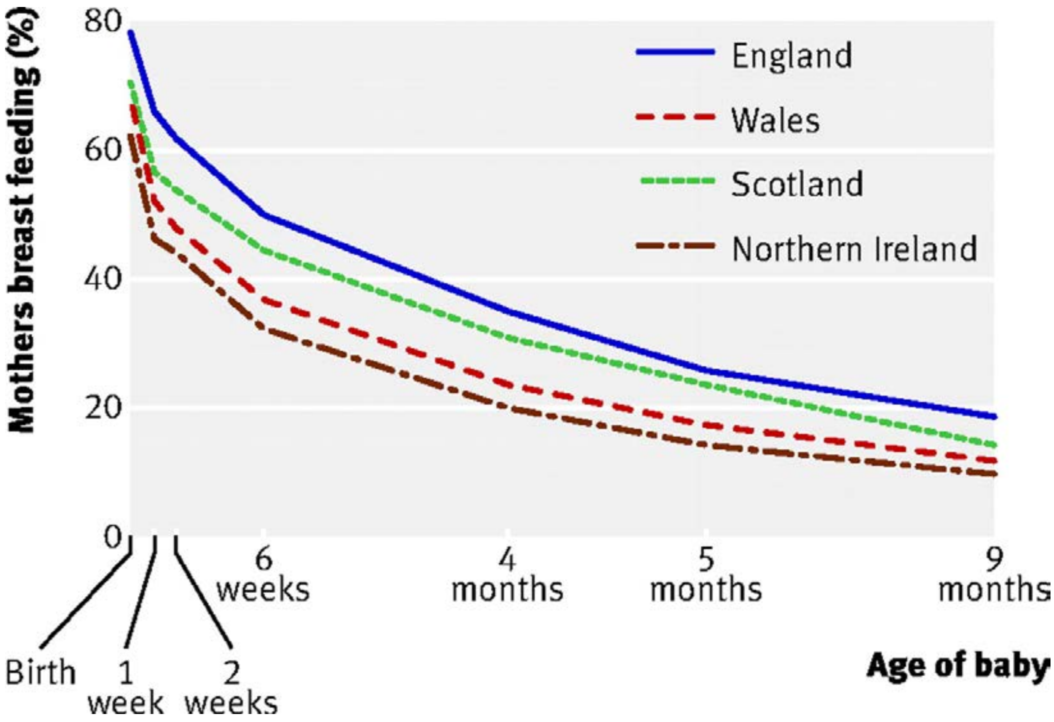

Figure 4.5 Prevalence of breastfeeding in the UK up to the age of 9 months in 2005 (Hoddinott, 2008: 881). Graph reproduced from Hoddinott (2008: 881).

(Michaelsen, 1998), and the archaeological record (Katzenberg, Herring, and Saunders, 1996) indicate that in general supplementation begins from around 6 months[9]. Lactation is incredibly energetically expensive, with a healthy and exclusively breastfeeding woman expending approximately 625-670 kcal per day (Butte and King, 2005; Dewey, 1997). Little evidence has been found to suggest that humans possess energy-saving adaptations in basal metabolic rate or dietary-induced thermogenesis whilst lactating, although there may be some early postpartum reduction in physical activity (Dewey, 1997). Whilst breastfeeding is widely recommended for ‘emotional bonding’ (NHS, 2012), it does not ensure it (Scheper-Hughes, 1985); a systematic review of the literature on the role of breastfeeding in mother-infant relations indicates that, while physiological mechanisms exist in humans to support a theoretical relationship, empirical studies do not demonstrate convincing support (Jansen, de Weerth, and Riksen-Walraven, 2008). Regardless of whether breastfeeding plays a positive role in the early stages of mother-infant

[9] We appear to share a similar pattern with our closest relatives the Neanderthals, *Homo neanderthalensis*, with research using barium deposits in teeth indicating they breastfed exclusively for seven months, then supplemented for another seven (Austin *et al*., 2013).

relations, given the high breastfeeding drop-off rates in the UK, as seen in Figure 4.5, it seems unfeasible to suggest that prolonged breastfeeding is necessary to *maintain* maternal emotional investment; in 2005 just 7% of UK mothers exclusively breastfed until 4 months (Hoddinott, 2008). The decision to breastfeed in contemporary societies with female workforce participation is not just a physical or emotional one, it is a political one (Kitzinger, 1990) due to the availability of supplementary feeding methods, and is tied up with notion of ‘intensive mothering’ (Lee, 2008). Tully and Ball (2013) have conceived of it as it as a trade-off between maternal perceptions of health benefits to the child vs. the physical and social experiences of her doing it. In her study of maternal identity and infant feeding, Lee (2008) documents the emotional turmoil women in the UK go through when making feeding decisions, while Ryan, Bissell, and Alexander (2010) contend that women perform moral work in their narratives of breastfeeding. Many women experience feelings of failure and guilt when deciding to supplement or give up entirely (Lee, 2008), and combined with the resultant fall in oxytocin, this may explain findings that PND is sometimes associated with ending breastfeeding. However, a recent study by Brown, Rance, and Bennett (2016) found that the experience of breastfeeding, rather than the duration, predicted symptoms of PND; only ceasing to breastfeed due to physical difficulty and pain positively predicted PND, women who chose to stop for other reasons were not at increased risk. If emotional investment in infants is energetically expensive, then it is possible that both the energy expended in the physical and the emotional act of breastfeeding (if negatively experienced) plays into maternal emotional investment trade-offs.

-Culturally specific costs

The previous examples may be said to be examples of species specific pressures which affect all human mothers: the pattern of infant cognitive development is universal even if the timing varies a little by individual; food supplementation beginning in the second half of the first year is a good candidate for a ubiquitous behaviour on the basis of cross-cultural and archaeological data, and the energy expended in lactation remains relatively constant although the toll it takes on a woman varies due to her physical and nutritional state; that emotions require energy to generate is biologically grounded, and although the context of the expression of infant-directed speech may be culturally (Trehub and Trainor, 1998) and individually variable, it has been argued that the behaviour itself is a species specific trait (Fernald, 1992). Other pressures influencing the cost-benefit ratio of investment decision making, on the other hand, are a product of sociocultural environments, and thus some women are more exposed to them than others.

-Culturally specific costs – infant sleeping arrangements

Sleeping practices are one such culturally entwined behaviour which may exert varying physical and emotional costs on mothers dependent on their sociocultural environment. The co-sleeping of infants with parents has been discussed in terms of being a species-wide pattern of behaviour and is seen almost universally outside of the West (McKenna, 1996; Volpe, 2010). In the West however, co-sleeping is presently the site of much controversy which arguably attaches an emotional cost to the behaviour. The traditional orthodoxy of medicine, with its emphasis on risk, has been to campaign against bed sharing on the grounds of danger of infant suffocation, a stance dating back to medieval times in England (Kitzinger, 1989). The twentieth century saw psychologists compound this risk, adding to it the notion that it is both psychologically damaging to the infant and threatening to the relationship between parents (McKenna, 1996). Together these risks were espoused by doctors and parenting manuals alike until in the 1980s an anthropologically led backlash began. Two popular, ethnographically informed books aimed at parents, Sheila Kitzinger's (1989) *The Crying Baby* and Jean Liedloff's (1986) *The Continuum Concept*, were published, highlighting the fact that such behaviour was not the worldwide norm, and nor was it necessarily the best way for anyone to get a good night's sleep (Kitzinger, 1989; Liedloff, 1989). Medical anthropologists also began to suggest that co-sleeping conveys health benefits. For instance, having analysed cross-cultural data in combination with lab research on sudden infant death syndrome (SIDS), McKenna (1996) found "where infant-parent cosleeping and breastfeeding are practiced in tandem in non-smoking households, and are practised by parents specifically to promote infant health, the chances of an infant dying from SIDS should be reduced" (1996: 201). However, in a recent widely publicised paper (for instance: Roberts, 2013) research found conversely that such conditions raised the risk of SIDS by fivefold (Carpenter *et al.*, 2013).

Volpe (2010) has applied a life history perspective to night-time parenting strategies, concluding they are behaviours subject to cost-benefit trade-offs. The strategies of teenage mothers were compared with those of adult mothers, on the grounds that life history theory predicts that teenage mothers will employ cost-cutting measures due to their need to meet their own growth and development requirements, as well as those of their infant, whilst adult mothers, who are free of such somatic costs, should provide more maternal investment relative to self-investment. Infants in both groups woke their mothers on numerous occasions intermittently throughout the night, and required pacification through feeding, representing a cost in terms of energy expended in pacification and lost energy generation from sleep. It was found that teenage mothers achieved a cost-reduction strategy by sharing a bed with their infant, and that the increased proximity and involvement that this enabled reduced the costs of caring for their infants during the night. Adult mothers on the other hand, practised the received wisdom of sleeping separately and were thus subject to greater costs in the form of "increased expenditures required to prepare separate sleep spaces for infants, promote early settling behaviours…and tend to infants that are at greater distances during the night" (Volpe 2010: 38). Mothers following the prescribed medical orthodoxy of separate sleeping are then subjecting themselves to greater energetic costs. They may also be exposed to greater costs in the form of prolonged emotional stimulation, as infants separated through the night engage in more prolonged bouts of crying to which mothers respond both emotionally and physically (Kitzinger, 1989).

Loss of sleep may also play a role in negatively skewing a mother's perceptions of the costs versus benefits of her investments. It is thought that areas of the brain's prefrontal cortex integrate and modulate the interaction of affect regulatory systems and sleep (Baglioni *et al.*, 2010). Sleep deprivation reduces the influence of the prefrontal cortex over other areas of the brain, causing changes in goal-directed behaviour, resulting in decreased modulation of emotions, impulses and drives. The cognitive-energy model posits that sleep loss affects cognitive-energy resources needed to cope with goal-obstructing events or to capitalise on goal-enhancing events, and the availability of which influences perception of goal oriented progression (Zohar *et al*., 2005). Positive emotions are thought to be promoted when enough cognitive-energy to reach a goal is anticipated and, when a lack of resources is perceived, negative emotions arise. The increased levels of parent-offspring conflict and the greater loss of sleep adult mothers experience relative to teenage mothers, as observed by Volpe (2010), may then elevate negative emotions and make the benefits of emotional investment seem less obtainable.

-Culturally specific costs – parental preoccupation

The extreme levels to which mothers from a clinically normal, largely middle to upper-middle class, US population are emotionally or simply cognitively engaged by their infants is demonstrated by Leckman *et al*. (1999). Their research led them to note the similarities and associations between early parental preoccupations and obsessive-compulsive disorder. Documenting the behaviour of new parents, they found it to be characterised by care giving, relationship building, and anxious intrusive thoughts associated with harm avoidant behaviour. At two weeks postnatally mothers report that their thoughts are concentrated on their infant for an average of 14 hours per day, which only declined slightly over time, to 9 hours at 3 months and 7 hours at 8 months. The research period of this study spanned from the 8th month of pregnancy to 8 months postpartum, and found that depression peaked before birth and subsequently fell, whilst both state and trait anxiety over this period didn’t vary. The results of interviews with mothers conducted in the 8th month of pregnancy, at 2-3 weeks, and 3-4 months postpartum are presented in Table 4.1 (fathers were also interviewed and their scores were, almost uniformly, notably lower). In addition to the findings presented below it was also found that 39% of breastfeeding mothers described feeling anxious about their ability to feed whilst breastfeeding. Such high levels of emotional engagement may represent a cost in terms of energy consumed by the continual activation of emotion pathways in the brain and their physiological consequences, and also in their distracting nature, disrupting mothers from performing other tasks.

Characteristic	**8th month of pregnancy**	**2-3 weeks postpartum**	**3-4 months postpartum**
Thoughts of harming child	34%	22%	32%
Found unpleasant thoughts to be a source of moderate/severe distress	22%*	15%	12%
Performing some form of response to distressing/anxious thoughts	73%	-	-
Need to check on infant even though they knew it was ok	71% (b)	75% (b)	75% (b)
Worried about things not being 'just right'	84%	68%	73%
Recurrent thoughts about infant's well-being	-	95%	-
Worried about something 'bad' occurring	-	80%	80%
Feel guilty if they slept through the night	-	59%	-
Feel panicky if they slept through the night	-	37%	-
Concerns about the health of the father	60% (b)	56%	66%

Table 4.1 Percentage of mothers displaying various characteristics in late pregnancy or postpartum reported by Leckman *et al*. (1999). (b) Indicates where the percentage includes both mothers and fathers. * Severity of distress wasn't rated.

Such levels of emotional engagement may be universal, or arguably more plausibly, they may be a product of the particular cultural milieu in which mothers in contemporary, developed societies find themselves, where sources of perceived risk abound (Royal College of Obstetricians and Gynaecologists, 2013) and mothers are perhaps uniquely isolated (Morgan, 1996). Morgan (1996) concludes that Western children, and the mothers who raise them, have become relegated to ghettos; "…True, they are not herded together in one place. This ghetto is splintered into thousands of individual homes" (1996: 114). In a survey of 1400 mothers from the UK and Australia with an infant aged 9 months or under, Kitzinger (1989) found that 38% of women were on their own for between 8 to 12 hours a day during the week, and another 34% were alone for 4 to 8 hours. In this light, Leckman *et al.*'s (1999) findings regarding preoccupation are understandable – by the second week postpartum fathers were spending on average 40 hours away from the infant, whilst women were spending just 3 hours away. Additionally, whilst mothers at this time were spending 14 hours per day with their thoughts concentrated on their infant, fathers were spending 7 hours, declining to 5 hours at 3 months. In recent decades, evolutionary anthropologists have been amassing evidence to support the view that humans evolved as cooperative breeders (for instance: Alvarez, 2004; Hrdy, 2009; Kennedy, 2005). Hrdy (2009) maintains "…Around the world, wherever traditional ways of life persist – that is, communities where mothers have not yet begun to live in compartmentalized families and started to worry about not exposing their babies to germs – shared care is the rule" (2009: 77-78). It seems reasonable to presume that access to comprehensive alloparenting would reduce maternal preoccupation with their infants, in much the same way that leaving for work reduces a father's, and that WEIRD women mother in relative vacuums undoubtedly amplifies any costs in the maternal investment decision making process.

-Culturally specific costs – pressure to 'emotionally bond'

The perceived level of investment required to reap the benefits of secure attachment might itself influence cost-benefit ratios. Pascoe found "disappointment with the 'bonding' experience" (1989: 452) to be a risk factor for delayed bonding. If 'emotional bonding' represents a process occurring over weeks and months, at differing rates in each woman potentially contingent of environmental circumstance, as research suggests, but cultural factors lead women to believe it should occur rapidly, then they may be trapped in a vicious cycle. Intensive mothering, the culturally dominant mothering paradigm in contemporary WEIRD settings, holds women should devote their whole beings to ensure the protection of their offspring. The costs of investment levels deemed necessary may be perceived as being too high by some women, and others may view the 'bond' they have achieved as not good enough, and withdraw it at a later date. The levels some mothers go to in the acquirement of embodied capital for themselves and their offspring is hinted at by Booth's (2002) study of the differences in mother-infant interaction between mother's caring for their infants on their own at home and those whose infants spent at least 30 hours per week in child care. The results indicated that the variation in the quality and quantity of interaction is less than generally anticipated. The women who stayed at home spent, on average, 38.13 hours focusing on their infant, whilst those who used child care spent 26.05 – which when added to at least 30 hours of work in paid employment becomes a significant expense of energy and time. The amount of time mothers using child care spent focusing on their infants was significantly and positively correlated with her level of separation anxiety and perception of the costs of employment to her infant. Maternal education has been found to have a much greater influence on the quality of mother-child interaction than other factors (NICHD, 1999). The American National Institute of Child Health and Human Development (NICHD) found that when interaction was measured at 6, 15, 24, and 36 months, there was a 12% relative difference in maternal sensitivity between mothers of high and low education, compared to approximately 2% differences attributable to usage of child care, maternal depressive symptoms, or child temperament. The quantity of time spent socially interacting with young children has also been found to be positively related to the level of education a mother has received (Hill and Stafford, 1980). These findings are indicative of cultural influences on the perceived levels of necessary emotional investment, and the time and energy required making them.

The above suggestions as to what might constitute costs associated with maternal emotional investment have been largely energy and time based. While time may be limited by other expectations such as paid employment, it should be noted that the energy budgets of most WEIRD women are high and not under threat of being exhausted, so they are, theoretically, more than capable of sustaining breastfeeding, infant carrying (which is as costly as lactation if not more so (Wall-Scheffler, Geiger, and Steudel-Numbers, 2007)), and other care giving behaviours. However, research linking glucose to a limited, exhaustible, reserve governing emotional control, which is slow to replenish, were conducted using participants from WEIRD settings (Gailliot *et al*., 2007;

Muraven, Tice, and Baumeister, 1998; Muraven, Shmueli, and Burkley, 2006; Schmeichel, Vohs, and Baumeister, 2003), suggesting that such systems are partly biologically constrained and independent of external resource availability.

-When a short-term investment is not a short-term cost

Life history theory is usually employed to explain trade-offs in investments acting over long periods of time. For instance, the timing of menarche is proposed to be a product of the switch from energy investment in childhood growth to reproductive potential (Hill and Kaplan, 1999), both of which are long-term investments relative to the human lifespan. Maternal emotional investment in the pre-attachment period, however, involves energy investment over only a matter of months, so the question ‘why not take the risk?’ must be posed. If the absolute levels of energy required to emotionally invest are relatively small, which they probably are, and the energy expenditure does not risk mortality, which certainly in the WEIRD populations it does not, why not endure the short-term costs for the long-term benefit of stacking the odds of reproductive success in your infant’s favour? The answer to this may be twofold; either the benefit is not real or significant, or the costs of investing and then failing are too high.

-Is the benefit real?

So far, it has been taken for granted that the benefit of emotional investment is real. A corpus of literature, as already noted, exists to attest to the benefits of ‘bonding’ and subsequent attachment. However, Chisholm (1996) has suggested that the different attachment styles in infants identified in Ainsworth’s Strange Situation Test represent life history trade-offs on the part of the infant, ensuring they make the best use of their available energy in the environment in which they find themselves, and a similar stance has been proposed by Main (1990). The ‘standard’ American distribution of test results is 20% avoidant (A), 70% secure (B), and 10% resistant (C) (van

IJzendoorn and Kroonenberg, 1988). As previously discussed, a number of explanations of this variation have been put forward using the framework of life history theory (for a review see Del-Giudice, 2009), however these works remain largely theoretical. Research also exists to suggest that the effects of different attachment styles may be culturally mediated rather than universal. Wang and Mallinckrodt (2006) asked a group of American and a group of Taiwanese students to complete an adult attachment measure as they "believed an 'an ideally emotionally and psychologically healthy person of your own gender in your culture' would respond" (2006: 192). More avoidant beliefs were endorsed about ideal attachment style by Taiwanese men and women than American men and women, and more anxiety was endorsed by Taiwanese men than American men.

Another cost beyond immediate energy expenditure is suggested by life history approaches to attachment that view cost-benefit trade-offs as contingent on environmental circumstances, explaining the observation of individual variation in stress reactivity, attachment, and personality. If maternal emotional investment plays a guiding role in the development of these traits, with maternal assessment of environmental conditions and resulting emotional responses acting to help appropriately calibrate the infant to its environment, then there may be costs in terms of the mother providing investment which leads to non-optimal affective behaviour in her offspring. The physical and the, arguably more important, social environment will influence her offspring's reproductive opportunities and success, so under this paradigm it should be expected that mothers pay attention to cues of both physical and social threat when making investment decisions.

Irrespective of whether a secure attachment style is always optimal for an infant or whether mothers actively mediate the attachment styles of their infants in response to environmental circumstance, evidence for a positive correlation between 'emotional bonding' and attachment security does not appear to be watertight. Sluckin (1998) states that "…Little is known about the prevalence, precipitants or nature of the interaction between 'non-bonded' mothers and their babies" (1998: 11), and what we do know stems from women who present with PND, which may confound findings. A study by Pearce and Ayers (2005) indicated that the mother-infant emotional ‘bond’ was affected by a mother’s expectations and perceptions of her infant during pregnancy, but that a mother’s expectations and perceptions were not affected by antenatal depression. Their results also suggest that, whilst antenatal depression was not related to the mother-infant bond, PND was, “suggesting that the relationship between depressed mood and a poor mother–baby bond is concomitant rather than causal” (2005: 99). As previously discussed, emotional bonding is a process which takes some women a considerable amount on time, however if ‘late attachers’, as Robson and Moss (1970) termed them (before the advent of bonding theory), or more appropriately ‘late investors’, manage without becoming depressed, the achievement of a secure attachment style once the second half of the first year arrives is by no means impossible. Secure attachments can be formed without the ‘bonding’ process; infants can securely attach to caretakers who are not their mothers and female caretakers can securely attach to unrelated infants they have not gone through the initial ‘bonding’ process with (Sagi *et al*., 1995). Therefore, mothers who are emotionally stable may well securely attach to their infant without having previously ‘bonded’ with them (or having only been ‘bonded’ for a couple of months rather than 6), in much the same way an adoptive mother would. An individual’s attachment style is also not set in stone; attachment styles over infancy are not stable, changing as often as not, shifting both from secure to insecure and from insecure to secure (Belsky *et al*., 1996), and styles from infancy to adulthood change in response to environmental circumstance (Waters *et al*., 2000). All of which goes to suggest that the negative consequences for offspring of initial low emotional investment are far from certain; thus mothers will place more emphasis on the costs when deciding whether to invest.

-The cost of grief

The costs of emotional investment mainly considered so far have been in the form of relatively immediate energy and time deficits incurred by the mother. However, the previous example highlighted another factor for consideration in the weighing of costs and benefits – the likelihood of investments paying off. When an offspring does not survive, any investment in that offspring is lost, but in humans, where emotional investments have been made, grief will also be experienced, bringing with it additional costs. Grief is an extremely sensitive subject and it is one from which social anthropologists have often shied, preferring to focus instead on its public expression rather than private experience, and whilst psychiatrists have looked at the experience, they have done so in almost wholly Western-centric conditions (Eisenbruch, 1984). Nonetheless, the literature which does exist is informative and suggestive of grief being a costly experience which is, at least partially, mediated by levels of embodied capital income lost as a result of the death and predictable along inclusive fitness lines.

Grief occurs after a loss, and may be defined as the "clusters of psychological and physiological responses that occur at the time of, and for a certain period after, the loss. These include shock, denial, depressive symptoms, guilt, anger, searching, yearning, hopelessness, tightness in the throat, sleep disturbance, lack of physical strength, and digestive problems" (Lin and Lasker, 1996: 262). Such responses incur energy costs and, unlike the costs discussed so far, those associated with grief have been found to pose significant risks in terms of morbidity and mortality, with the death of a child producing a heightened risk (Sanders, 1988). Grief has been found to be associated with nutritional problems, altered immune function, impaired memory and concentration, difficulties with work and relationships and decreased levels of social participation (Stroebe, Schut, and Stroebe, 2007). 'Normal grief', as defined in the psychiatric literature, begins with high levels of the aforementioned symptoms, and these levels then decline over time (Lin and Lasker, 1996), and is thought to be a natural reaction to the severing of an attachment relationship (Stroebe, Schut, and Stroebe, 2007). Yet the label 'normal grief' is somewhat misleading, especially when applied to perinatal death. In a study of American patterns of grief after pregnancy loss, Lin and Lasker (1996) found that only 41% of subjects exhibited a 'normal pattern', the rest displaying a combination of delayed grief (grief which hasn't diminished within a year), reversed grief (with grief lowest when measured 1 year post loss and highest at 2 years), and low, unchanged grief (mainly displayed by men). This study also found that grief hadn't disappeared for any subjects by 2 years after the loss. Indeed Rybarik (2000) concludes that perinatal loss does not appear to be something people get over at all, while Klass (2000) extends this to all child death. It is the prolonged nature of symptoms that leads to significant costs associated with child death. Li *et al*. (2005) found that mothers had an overall relative risk of being hospitalised for a first psychiatric disorder of 1.78 after the loss of a child – a risk that was highest in the first year after death but remained significantly elevated for 5 years at least. In a review of the health consequences of bereavement, Stroebe, Schut, and Stroebe (2007) report that, five years on from a child's death, 27.7% of mothers present with post-traumatic stress disorder and 18 months on from experiencing SIDS 58% of mothers meet the DSM 5 diagnostic criteria for complicated grief. Analysis of 69,224 bereaved mothers in the National Longitudinal Mortality Survey (NLMS) of the United States Census Bureau has found that maternal mortality was heightened by 133% after a death of child, and that this risk was greatest within the first 2 years (Espinosa and Evans, 2013). Grief may well then constitute a credible threat to future survival and reproduction, with selection acting to favour those who avoided emotional investment in infants until their survival was more assured. Alternatively, Volk and Atkinson (2008) have suggested it may be adaptive for the intensity of parental grief to be relative to the reproductive value of the child.

The reproductive value of a child was reported by Crawford, Salter, and Jang (1989) to be highly correlated with level of grief expressed at its hypothetical loss in both a sample from an industrialised population (Canada) and a pre-industrialised hunter-gatherer population (!Kung), although the relationship was more powerful in the !Kung which may indicate a moderating ecological effect. However actual grief in in relation to reproductive value in contemporary industrialised settings is less straightforward. Littlefield and Rushton (1986) tested an evolutionary model of grief on 263 bereaved Canadian parents. Whilst some of their predictions were supported, for instance, mothers grieved more intensely than fathers, and maternal grandmothers displayed greater grief intensity than maternal grandfathers and paternal grandmothers, who in turn grieved more intensely than paternal grandfathers, other hypotheses found no support. Notably, the predictions that older children, having received greater parental investment, should be grieved for more than younger children, that older parents should grieve more intensely than younger parents due to their reduced future reproductive potential, and that parents with fewer additional offspring should grieve more intensely than parents with more additional offspring, were not borne out. Similar findings have been found by other researchers, for example, research into neonatal death[10] has found that mothers grieve more that fathers, but that parental grief is not significantly related to duration of life, weight at birth, extent of parent-infant contact, parental age or previous perinatal loss (Benfield, Leib, and Vollman, 1978), and in mothers whose infant died of SIDS, levels of grief were the same whether they had surviving children or not (Ostfeld *et al*., 1993). However, Littlefield and Rushton (1986) did find in their sample that the pattern of grief intensity ran as such: "healthy male > healthy female = unhealthy female = unhealthy male" (1986: 797). An evolutionary approach to loss during pregnancy would expect that grief would be less relative to postnatal loss, would be greater in mothers than fathers, and that grief intensity should correlate positively with gestational age. The evidence to support this is variable; Goldbach *et al*. (1991) found that women expressed greater initial levels of grief than men, measured 6-8 weeks after loss, but that the differential decreased by 1-2 years, and that intensity was greater later in pregnancy, while other researchers have found that intense grief is experienced irrespective of gestational age (Wallerstedt, Lilley, and Baldwin, 2003). The experience of intense grief in relation to pregnancy loss appears to be a historically recent phenomenon; Cecil (1996) has studied literary depictions of loss as a means of determining the level of import attributed to it and finds little reference made to the subject by Western writers until the 20th century. Grief does not appear to be entirely related to reproductive value in studies of infant death in contemporary industrialised populations. This may reflect the low levels of fertility in such contexts rendering all infants of inherently greater reproductive value than those born into high fertility populations. Alternatively, the cultural emphasis on 'bonding' and attachment could be driving mothers to greater levels of emotional investment then they would otherwise make, enhancing losses.

Data does not appear to exist with which to explicitly test the hypothesis that mothers in WEIRD populations who are less 'emotionally bonded' to their infants grieve less intensely in the event of

[10] A neonate being defined as a newborn infant or one in its first 28 days of life (Benfield *et al*., 1978).

death than those who are highly bonded, but indirect evidence suggests this is the case. Littlefield and Rushton (1986) found that, in a late twentieth century Canadian sample, unhealthy children were grieved for less than healthy male children and, as previously noted, maternal 'bonding' and attachment to unhealthy children is often reduced compared to healthy ones. Analysis of the NLMS is also suggestive, indicating that the health costs of grief were less for mothers of lower SES, as measured by education, ethnicity and marital status (Espinosa and Evans, 2013). The NLMS did not measure grief intensity, but it is possible that the findings were the result of attenuated grief, resulting from lower 'bonding' scores which have been observed in such groups (Figueiredo *et al*., 2009). Conversely, perceived social support has also been found to ameliorate the effects of grief at infant death (Engler and Lasker, 2000), possibly enabling mothers to take the risk of investing, although this finding is questioned by others (Stroebe, Schut, and Stroebe, 2007). Surprisingly little work has been done on the interactions between personality and grief but "available studies support the view that robust individuals adjust to bereavement better than people who are fragile" (Stroebe, Schut, and Stroebe, 2007: 1967).

That reduced emotional investment is protective against grief also finds support from ethnographic data. In in the high mortality environment of a Brazilian favela Scheper-Hughes (1985) found a mother's "grief is as attenuated as her attachment" (1985: 306) and women only grieved intensely for infants they thought would survive. Scheper-Hughes observed many children born to the 72 women she worked with to die from 'selective neglect'; "the cause of death is seen as a deficiency of the child" (1985: 305).The situation is aided by the belief that a child is less human than an adult, and of the 585 live births these women had between them, 13% of the infants were allowed to die this way. Scheper-Hughes reports that intense grief was expressed by mothers of the favela only at the loss of children who had shown promise of survival, to whom they had allowed themselves to become emotionally attached, and it may be that this reflects their greater reproductive potential. A similar situation was documented by Maclean (1971 in Cecil, 1996) also working in a high mortality population, this time in Nigeria. Sickly infants were thought 'born to die'; referred to as *abiku* these were infants for whom not even mothers might mourn. In a classic study of burial rites in the Nuer of South Sudan, Evans-Pritchard (1949) also reported “People do not mourn for a small child. “A small child is not a person (*ran*). When he tethers the cattle and herds the goats he is a person. When he cleans the byres and spreads dung out to dry and collect it and carry it to the fires he is a person”. A man will not say that he has a son till the child is about six years of age. A small child is buried by old women without sacrifice” (1949: 58). Quinlan’s (2007) exploration of the relationship between maternal care and extrinsic mortality risk in the societies listed in the Standard Cross-Cultural Sample (SCCS) suggests that low maternal physical and, possibly, emotional investment were the norm for traditional societies. The SCCS database is composed of ethnographic information collected from culturally independent, largely pre-industrial societies (Murdoch and White, 1969). Quinlan (2007) defined maternal care as a composite measure of the proximity of mother and infant sleeping, their degree of bodily contact in early infancy, and mothers’ responses to infants when they cry; the first two measures reflect physical investment, the latter may have an element of emotional investment. Warfare and famine were found to be negatively correlated with level of maternal care, whilst mothers show increasing levels of maternal care as pathogen stress increases to moderate levels, after which it decreases to low levels as pathogen stress levels become high. This suggests that parenting can affect outcome at low to moderate levels of stress, but at high levels pathogens become an extrinsic mortality risk causing investments to gain no return. Wiley and Carlin (1999) proposed to use analogous measures derived from the Human Resource Area Files, a database similar to the SCCS, as proximate measures of mother-infant attachment until they found the data availability insufficient. They predicted the model of attachment seen in Table 4.2 on the basis of fertility and mortality schedules and present a range of ethnographic examples, albeit limited and qualitative, to back it up.

High Fertility/High Mortality I	Low Fertility/High Mortality II
• many potential kin caretakers or 'attachment figures' • exclusive attention to any given infant unlikely • mothers under stress; unavailable/unwilling to engage in attachment behaviors • infants often sick; unable to elicit responses from mother	• lack of potential kin caretakers • not likely to be many societies; perhaps !Kung pattern? • mothers under stress; unavailable for attachment, but close mother-infant bond possible due to lack of other caregivers • infants often sick; unable to elicit responses from mother • 'environment of evolutionary adaptedness'?
High Fertility/Low Mortality III	**Low Fertility/Low Mortality IV**
• many potential kin caretakers or 'attachment figures' • diffuse pattern of caretaking, esp. use of sibling care • exclusive attention to any one infant/child unlikely • mother's attention fragmented among many children • most subsistent agriculture societies	• post-demographic transition societies • high degree of association between mothers and infants • intensive investment (material & emotional) in few offspring • exclusive, monotropic bond; mother's attention likely • reverse effect of maternal employment – i.e., daycare by non-kin

Table 4.2 Wiley and Carlin's predicted attachment outcomes based on fertility and mortality schedules (1999: 146).

Historically, infant mortality rates have been high, and they remain so outside the Western world. Indeed Volk and Atkinson (2008) have contended that child death is the 'crucible of human evolution' and presently underappreciated by scholars interested in human evolution. An analysis of infant mortality in historical and hunter-gatherer populations has led them to propose that approximately 27% of infants died within their first year prior to industrialisation (Volk and Atkinson, 2013). Child mortality is currently most likely to occur in the first four weeks after birth (the neonatal period) (Lawn, Cousens, Zupan, 2005), and presumably this has always been the case. In the year 2000, deaths during the first four weeks amounted to 38% of child deaths under the age of five globally. Even though the infant mortality is very low in high income countries, the first four weeks still represent a period of elevated risk, with 63% of child deaths occurring within this timeframe in the 39 for which mortality data exists of 54 countries with a gross national income per person of over US$9386 (Lawn, Cousens, Zupan, 2005). Despite the medical advances of the 20th century, neonatal mortality rates (NMR) remain high in large swathes of the world, see

Table 4.3. Three-quarters of deaths in the first month occur within the first week, with the risk greatest in the first two days, see Figure 4.6. Sixty to eighty percent of those dying in the neonatal period are born with low birthweight. Given the high risks of early infant death, and the high costs of grief associated with the severing of strong emotional attachments, it certainly seems to make sense, from an evolutionary perspective, that emotional investment be limited until the period of highest mortality risk has passed.

WHO regions	**NMR per 1000 live births (range across countries)**
Africa	44 (9-70)
Americas	12 (4-34)
Eastern Mediterranean	40 (4-63)
Europe	11 (2-38)
Southeast Asia	38 (11-43)
Western Pacific	19 (1-40)

Table 4.3 Regional variations in neonatal mortality rates (NMRs) (Lawn, Cousens, Zupan, 2005).

If one accepts that WEIRD mothers exist within a culture of risk, then it is perhaps reasonable to suggest that some perceive infant mortality risks to be higher than they really are, and thus hold back on emotionally investing in infants until they have greater proof of their survival prospects so as to protect themselves from the risk of intense grief and the costs that come with it. And if emotional investment represents an additional energetic cost, on top of those already incurred from physical investments like lactation, then perceived costs may well accumulate to outweigh perceived benefits. The levels of additional energy required for emotional investment may be tiny, but as Lindblom (2000) points out in his discussion of the energy trade-offs potentially involved in the evolution of speech, “being both a tinkerer and a miser, evolution tends to be parsimonious, which suggests that the same rules ought to apply for small and for big movements” (2000: 199), or for small or large investments. Therefore, it seems reasonable to propose real costs of maternal emotional investment, which result in a life history trade-off being made in relation to the level and timing of emotional investment a mother makes in her infant. This being the case, and keeping in mind the following caveat made by Chisholm (1996) in his life history analysis of attachment, “at the risk of explaining something that doesn’t exist!” (1996: 17), a model will now be outlined for predicting both the levels of maternal emotional investment in infants under different environmental conditions and the likelihood that PND will occur as a result of social stress related to investment decisions in such conditions.

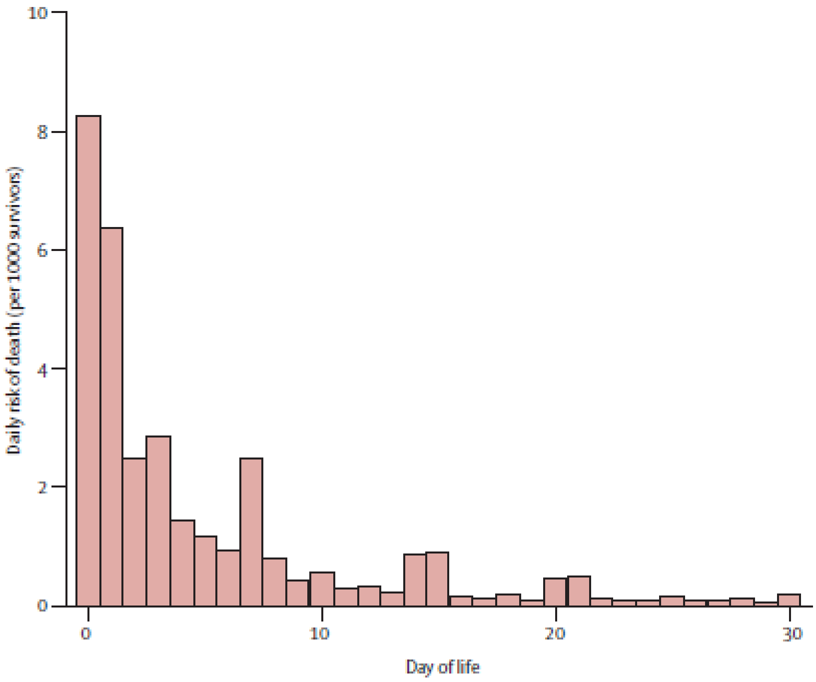

Figure 4.6 “Daily risk of death during first month of life based on analysis of 47 DHS datasets (1995–2003) with 10,048 neonatal deaths” (Lawn, Cousens, Zupan, 2005: 13).

Section D – A model predicting maternal emotional investments and resultant PND

Taking inspiration from Wiley and Carlin’s (1999) model predicting attachment outcomes based on fertility and mortality schedules (Table 4.2), incorporating the results from Chapter 5 supporting a social stress pathway to PND and an embodied capital theory of life history investments, the following model (Table 4.4) was developed to predict maternal emotional investments and PND likelihood based on mortality and characteristics of the sociocultural mothering environment. Under this model low or non-existent levels of maternal emotional investment are caused by inadequate pay- offs to the mother, and emotional investments are viewed as stemming from and contributing to embodied capital, which for the purposes of simplification is held as being composed of either somatic capital or emotional capital. The depression experienced by women with PND is hypothesised to result when a lack of maternal emotional investment clashes with

High Mortality Environment		**Low Mortality Environment**	
Investment Strategy 1 *Individual level factors:* Maternal somatic investment costs = HIGH Maternal emotional investment costs = HIGH *Population level factors:* Social costs of not investing = HIGH *Outcomes:* Emotional investment = LOW PND = YES	**Investment Strategy 2** *Individual level factors:* Maternal somatic investment costs = HIGH Maternal emotional investment costs = HIGH *Population level factors:* Social costs of not investing = LOW *Outcomes:* Emotional investment = LOW PND = NO	**Investment Strategy 3** *Individual level factors:* Maternal somatic investment costs = LOW Maternal emotional investment costs = LOW *Population level factors:* Social costs of not investing = HIGH *Outcomes:* Emotional investment = HIGH PND = NO	**Investment Strategy 4** *Individual level factors:* Maternal somatic investment costs = LOW Maternal emotional investment costs = HIGH *Population level factors:* Social costs of not investing = HIGH *Outcomes:* Emotional investment = LOW PND = YES
Investment Strategy 5 *Individual level factors:* Maternal somatic investment costs = HIGH Maternal emotional investment costs = LOW *Population level factors:* Social costs of not investing = HIGH *Outcomes:* Emotional investment = HIGH PND = NO	**Investment Strategy 6** *Individual level factors:* Maternal somatic investment costs = HIGH Maternal emotional investment costs = LOW *Population level factors:* Social costs of not investing = LOW *Outcomes:* Emotional investment = LOW PND = NO	**Investment Strategy 7** *Individual level factors:* Maternal somatic investment costs = LOW Maternal emotional investment costs = LOW *Population level factors:* Social costs of not investing = LOW *Outcomes:* Emotional investment = HIGH PND = NO	**Investment Strategy 8** *Individual level factors:* Maternal somatic investment costs = LOW Maternal emotional investment costs = HIGH *Population level factors:* Social costs of not investing = LOW *Outcomes:* Emotional investment = LOW PND = NO

Table 4.4 A model to predict maternal emotional investments and postnatal depression (PND) likelihood based on mortality and characteristics of the sociocultural mothering environment.

social and cultural norms stigmatising low levels of such investment by mothers. Using this framework the model predicts the existence of eight theoretical investment strategies based on the further simplifying assumptions that only high or low mortality environments exist, mortality correlates positively with somatic investment costs (in terms of likelihood of investment loss), and low emotional investment in conjunction with high social costs of not investing always results in PND.

-Investment strategies under low mortality

It is suggested that contemporary WEIRD society creates the conditions under which *investment strategies 3, 4, 7* and *8* (Table 4.4) will be present. For the most part, maternal investment costs are low in terms of both somatic and emotional costs as a result of low adult and infant mortality leading the majority of women to employ *investment strategy 3*. Yet actual or perceived insufficiency in emotional capital, in combination with, and possibly a result of, social and cultural conditions, lead to the costs in terms of emotional investment to be too high for some, and produces a minority of women who opt for the low emotional investment of *strategy 4* and who will be at increased risk of experiencing PND. As stated, the terms of this model are simplified, in reality there are also likely to be women who consider the emotional costs of investing to be too high, and thus pursue a low emotional investment strategy, and yet have the emotional fortitude to withstand the associated social stigma, and thus do not go on to develop PND. This is supported by the results of moderation analysis presented in Chapter 3 which were suggestive of shame moderating the relationship between emotional investments in the infant and PND, with emotional investments only predicting PND when shame is also experienced.

Work by Mann (1992) who observed discriminative investment behaviour in mothers of extremely low birth weight (ELBW) twins suggests that the latter point is the case. The seven American mothers who formed the focus of Mann's study were observed to consistently display more positive maternal behaviour, in the form of affection, play, talking etc. to the healthier of the pair relative to the sicker, a relationship that held even after controlling for socioeconomic status. The chances of raising two ELBW twins to be physically and/or cognitively ‘normal’ are low, even with Western medicine, thus these women conform to Mann’s hypothesis of discretionary ‘psychosocial investment’ based on reproductive value. Mann did not test for PND, but given the methodology of the study it seems highly improbable that it would have been missed, in addition to which PND would be expected to affect interactions with both twins equally, therefore depression was not the cause of a lack of investment. It may be that having had ELBW infants these mothers are not subject to the same social pressures as mothers who have healthy babies, and thus they are at liberty to employ a dual investment strategy “shame free”, with *strategy 8* applying to the sicker twin and *strategy 7* applying to the healthier twin. Additional support for the existence of investment *strategy 8* comes from studies of maternal bonding to premature babies. Bereczkei (2001) reported varying levels of maternal investment in relation to infant viability without associated depression in a developed context, suggesting it is possible that the social norms associated with acceptable behaviour towards morbidly ill infants are relaxed.

-Investment strategies under high mortality

It is presumably the case that the costs of emotionally investing in an infant in high mortality environments are always high, due to the risk of their death (although the model also allows the costs to be low). Thus investment *strategy 2* (Table 4.4) is suggested to encompass the majority of traditional and historical populations in which both somatic and emotional investment costs have been high due to high levels of mortality. While the model only deals with varying emotional investment, it is probable that physical levels of investment will also vary, for instance, Scheper-Hughes (1985) documents the lack of breastfeeding by nutritionally stressed women in the high mortality environment of North Eastern Brazil where women deem their bodies to be wasted and milk to be no good, a situation she labels ‘selective neglect’. In her case study Scheper-Hughes derides the bonding model (with its emotional connotations) as having “neither relevance to, nor resonance with, the experiences of the women of the O Cruzeiro for whom the life history of attachment follows a torturous path marked by many interruptions, separations, rejections, and loses reflecting the precariousness of their own existence and survival" (1985: 314). In this society the physiological markers of 'bonding' are all there, prolonged skin-to-skin contact, co-sleeping, breastfeeding in the initial weeks etc, but the emotional markers are lacking in a way that is described as "often muted and *protectively distanced*" (1985: 311). Infants who show no fight for life are left to die and "…A mother speaks of having 'pity' for such a child, but her grief is as attenuated as her attachment" (1985: 306).

Scheper-Hughes (1985) reports that 13% of the infants in the Brazilian favela died from selective neglect and the mother "does not hold herself responsible…nor is she blamed by the immediate female community (men seem to have little knowledge of the matter); the cause of death is seen as a deficiency of the child" (1985: 305), and the situation is aided by the belief that a child is less human than an adult. Under high mortality conditions, where quantity is a better strategy in the quantity versus quality trade-off (Lawson, Alvergne, and Gibson, 2012), cultural evolution (Mesoudi, 2008) of social costs attached to low investment seems unlikely as such costs would be counterproductive in terms of reproductive fitness. Where low maternal emotional investment is not socially prohibited it is likely to be common in the face of high mortality, as supported by a number of ethnographic studies, and under this model, it will not be associated with PND. However, this is not to say that PND will be absent from high mortality environments, indeed under a social genome approach to depression it is predicted to result from an immune response to pathogens (Raison and Miller, 2013). As noted, PND appears present in the Tsimane (Myers *et al*., 2016), and is likely to be the result of inflammatory responses to pathogen exposure (Stieglitz *et al*., 2015).

There is a corpus of studies demonstrating the presence of PND in contemporary societies in which adult and infant mortality rates are higher than those in the West, brought together in a meta-analysis by Halbreich and Karkun (2006). These studies are almost exclusively based in societies in which women are exposed to some degree of Western medicine, with subjects selected on the basis of their receiving some form of pre- and postnatal medical care. Under the framework of the present thesis the medicalisation of childbirth and, in particular, childrearing is thought to be a major component in the emotional stresses attached to mothering in the West (Lee, Macvarish, and Bristow, 2010). It is therefore suggested that some of the women suffering from PND in these societies may exhibit *investment strategy 1* (Table 4.4), where the influence of Western sociocultural values, perhaps in combination with falling mortality rates, has caused the development of high social costs attached to lack of emotional investment. Wiley and Carlin's (1999) review of the ethnographic literature indicates the *investment strategy 2* (Table 4.4) is the norm in parts of the world today. Indeed, Schepher-Hughes (1985) vociferously contends that 'maternal thinking' of a vast number of women living in the Third World reflects this pattern. Finally, *investment strategies 5 and 6* are thought unlikely to exist.

Next steps

Maternal investment in infants is part of the suite of human fertility behaviours, and as such it should be subjected to a risk-sensitive, adaptive investigation on the grounds that it satisfies the conditions of a) the outcomes being to some degree unpredictable and b) the relationship between outcomes and their fitness or utility value being nonlinear (Winterhalder and Leslie, 2002). *Part 1* of this chapter has outlined a framework for understanding the emotional relationships which mothers have with their infants as an emotional investment in offspring embodied capital, and argued that this emotional investment appears risk-sensitive in both the degree of investments made and the timing of such investments. *Part 2* will present further results from the study of pregnant/postpartum women, first introduced in Chapter 3, testing hypotheses derived from the emotional capital theory.

Part 2

Defining emotional capital

The emotional capital hypothesis is heavily influenced by embodied capital theory, and proposes that emotional investments from mothers to infants are a form of capital invested in offspring income-related embodied capital. As an embodied capital approach, being grounded in life history theory, this entails conceiving of emotional resources as energy related (Hill and Kaplan, 1999). In its original conception, Kaplan (1996) uses education as an example to illustrate embodied capital; education is not a tangible form of energy *per se*, rather is it an *extra-somatic* form of embodied capital that is related to energy via its being financially expensive and time consuming to obtain. Thus, when parents invest in an offspring's education, they are not constrained from having more offspring in which they can also make educational investments because their own level of education diminishes; instead it is their finite financial resources and time availability that are the limiting factors influencing reproductive trade-offs. As discussed in *Part 1*, the expression of emotion requires energy (Baglioni *et al*., 2010) and a limited resource, linked to glucose (Gailliot *et al*., 2007), that is expended whenever it is needed to actively alter, override, or regulate responses, and which is slow to replenish has been implicated in emotional self-control (Muraven, Tice, and Baumeister, 1998; Muraven, Shmueli, and Burkley, 2006; Schmeichel, Vohs, and Baumeister, 2003). This suggests that emotional investments are more directly linked to energy, akin to *somatic capital* (Kaplan *et al*., 1995) or *energy capital* (Wells, 2010) forms of embodied capital investment, and that emotional capital is fairly 'liquid' capital (Wells, 2010) which can be gained and lost over time spans that are relatively short. Thus under the emotional capital hypothesis, decisions are made as to whether to invest emotionally in the current offspring or retain 'emotional energy' to either maintain own emotional stability or store for emotional investment in future offspring. The emotional capital of women who decide to emotionally invest in their infant should fall (with a concomitant rise in their infant's emotional capital) and that of women who decide to invest in themselves or future offspring remain the same. The 'emotional energy' conveyed to infants during emotional interactions with their mothers is postulated to come from the mother's 'reserve' of emotional capital.

Findings supporting the role of energy in emotions indicate that emotional capital may be considered as something beyond the metaphorical and that an attempt to quantify and measure it is a valid pursuit with the potential to inform life history perspectives on maternal investment. Again research relating to the self-control of emotion provides a useful framework to begin to quantify emotional capital. The development of the self-control of emotion is influenced both by factors which are intrinsic (such as temperament, inhibitory control, and attention) and extrinsic (such as social relationships and caregiving environment) (Fox and Calkins, 2003). A similar dichotomy exists in the concept of *reserves* or *reserve capacity* employed in life-span psychology (Staudinger, Marsiske, and Baltes, 1995); an individual's reserves are a reflection of plasticity, i.e. their ability to adapt to and recover from change, and "constituted by internal (e.g., cognitive capacity, physical health) and external (e.g., social network, financial status) resources available to the individual at any given time" (Staudinger, Marsiske, and Baltes, 1995: 807). The concept of reserve capacity overlaps with that of *resilience* stemming from the field of developmental psychopathology and is usually discussed in relation to children and adolescents. Resilience may be viewed as a subtype of plasticity, and deals with an individual's ability to exhibit adaptive responses to stressful situations, to which individuals who lack resilience respond maladaptively. Adaptive responses can be separated into two kinds: 1) maintaining normal development trajectories despite exposure to threats or risks (which may be internal or external), and 2) recovery from traumatic experience. Both reserve capacity and resilience imply the existence of latent resources that can be mobilised; yet "unlike resilience, reserve capacity is not only relevant to maintaining or regaining *normal* levels of adaptation. Reserve capacity also refers to factors and resources that promote *growth beyond* the current and normal level of functioning" (Staudinger, Marsiske, and Baltes, 1995: 808). Fox and Calkins argue "the development of self-control of emotion will be most fruitful if investigations examine the interplay, over time, among these internal and external factors" (2003: 7). The following proposals for what constitutes emotional capital are necessarily speculative;

however a similar framework, in which emotional capital is viewed as being composed of intrinsic and extrinsic facets, may be productive and enables the interplay between these facets to be explored.

Quantifying emotional investments

Existing embodied capital studies have sought to quantify measures of capital, for instance by measuring level of education attained or income earned (Kaplan *et al*. 1995), and to begin to test the emotional capital hypothesis an attempt at quantifying emotional capital must also be made. Emotional capital, as used by sociologists, is inferred on the basis of a mother's desire and resources enabling her to invest time interacting emotionally with her child (generally, but not exclusively, in a positive manner), and measured using qualitative interview techniques (Reay, 2000). It is proposed that emotional capital investments in infants during the initial postnatal period, the six months of an infant's life before attachment begins (Chisholm, 1996), are made via and reflected in the maternal behaviours which psychologists label 'bonding', or more specifically 'emotional bonding'. As such the degree of emotional investment during this time can be assessed using mother-infant bonding measures, and the timing of investment onset measured by observation of mother-infant interactions or maternal self-report of their feelings during the postnatal period. While maternal emotional investment in the early postnatal period is of particular interest to the present study, maternal emotional investment continues throughout the life course and may be partially (allowing for influences external to the mother-infant dyad) reflected in attachment security once an infant's cognitive development enables reciprocal interaction, and mother-offspring relationship quality later in life. Maternal emotional investment during an offspring's development, playing a role in attachment security and personality formation, contributes to an offspring's intrinsic emotional capital (see below) and plays a role in its own reproductive trade-offs.

Intrinsic emotional capital

Following Fox and Calkins (2003), who propose the self-control of emotion is made up of intrinsic and extrinsic factors, the following factors are suggested to contribute to *intrinsic* emotional capital. Income-related embodied capital is capital used to obtain resources for reproduction (Kaplan, 1996); the attraction of mating partners falls under this umbrella, as does the ability to maintain (or regain quickly) self-control whilst emotionally investing in others. As discussed in *Part 1*, personality is related to reproductive success in a range of ways (Alvergne, Jokela, and Lummaa, 2010; Buss *et al*., 1990; Jokela *et al*., 2009; Nettle, 2006). Temperament is a factor in the development of self-control (Fox and Calkins, 2003), and is intertwined with personality (Rothbart, 2007). Personality also affects an individual's emotional reactivity - their threshold, peak intensity, and rise and recovery times in reaction to emotional stimulation (Baglioni *et al*., 2010). It is therefore suggested that a measure of personality be used in quantifying intrinsic emotional capital.

As discussed in Chapter 1, the field of affective neuroscience posits seven mammalian 'subcortical emotion systems', reflecting emotional endophenotypes (Panksepp, 2006). The seven subcortical emotion systems are thought to be an important foundation of personality (Davies and Panksepp, 2011). Personality is widely assessed using the Five Factor Model (FFM) (Digman, 1990), which regards personality as comprising five dimensions, often labelled *Agreeableness*, *Conscientiousness*, *Extraversion* or *Surgency*, *Emotional Stability*, and *Intellect* or *Openness to Experience*. Davis and Panksepp devised the Affective Neuroscience Personality Scales (ANPS) as a way of measuring the affective underpinnings of the FFM and have gathered data to support a strong relationship between the two measures (Davies and Panksepp, 2011). They contend that "individual differences in such higher affective as well as lower primary-process aversive affective brain systems (*rage*, *fear*, and *sadness*) along with the positive affect systems of *play*, *caring*, and *seeking* are foundational for personality expression as well as the emergence of mental anguish and pathology. Individuals with different levels of responsiveness in these primary brain systems not only react differently to the same stimuli, they will experience these stimuli differently and develop different conditioned response tendencies and ongoing personal preferences." (Davies and

Panksepp, 2011: 1954, italics were capitals in original). Behaviours produced by the *play* affect system promote positive affective experiences, involve competition and the facilitation of social interaction via non-harmful physical contact, and are associated with the FFM measure *Extraversion* (Barrett, Robins, and Janata, 2013). *Care* behaviours are nurturing and loving, they promote social bonding, regulate distress, and manage pain, and are associated with *Agreeableness*. The expression of basic appetitive drive – the hunting of reward and other experiences which are pleasurable – is reflected in *seek* behaviours which are associated with *Openness to Experience*. Behaviours produced by the *anger* system are aggressive, reflect 'fight' as opposed to 'flight' responses, and are associated with *Neuroticism* and low *Agreeableness*. The *fear* system produces anxiety, worry, and freezing or fleeing reactions, and is associated with *Neuroticism*. Finally, the *sadness* system is activated in response to separation distress, loss, and broken social bonds, it may involve grief, and is also associated with *Neuroticism*.

Trait emotional intelligence may be defined as "a constellation of emotion-related self-perceptions and dispositions" (Petrides and Furnham, 2003:40) which influence a person's ability to successfully cope with environmental pressures (Bar-On, 1997), and thus is another good candidate for measuring intrinsic emotional capital. Emotional intelligence is currently a relatively new area of study and there is great interest surrounding it within psychology and the field of individual differences research (Austin, Saklofske, and Egan, 2005). Significant correlations between personality and trait emotional intelligence have been found; however they also appear to have different predictive powers, with emotional intelligence having stronger correlations to social network size while a neurotic personality is more closely related to social network quality (Austin, Saklofske, and Egan, 2005). Employing both measures as part of a composite measure of emotional capital will, therefore, also add to the knowledge in this area.

Finally, mental or emotional wellbeing should also be considered part of intrinsic emotional capital. Emotional wellbeing has well documented effects on social functioning (Hirschfeld *et al*., 2000) and ability to self-care (Manning Jr, and Wells, 1992), and when viewing emotional resources as a form of energy, is a logical factor for determining an individual's ability to invest energy away from the self.

Extrinsic emotional capital

Social support and social networks are already extensively studied within capital based frameworks in relation to *social capital* (Portes, 2000). Links between emotional wellbeing and social support are well evidenced (Chu, Saucier, and Hafner, 2010) and, in the context of maternal emotional wellbeing, access to social networks has been found to play a role in mitigating PND (Dennis *et al*., 2009). Access to emotional support from their social network seems likely to form part of an individual's extrinsic emotional capital, by elevating emotional wellbeing and perhaps acting as an external resource buffering against losses in energy resulting from investment of emotional energy outside of the self.

Emotions as resources

It is suggested that emotional capital is 'liquid' (Wells, 2010), and that emotional investment in another, at least temporarily, diminishes an individual's emotional energy reserve. Of the factors proposed to make up the *intrinsic* element of emotional capital, two are responsive to environmental change: emotional wellbeing varies in response to alterations in circumstance (Nes *et al*., 2006) and longitudinal studies of personality have found that personalities may exhibit changes in adulthood and that patterns of change may relate to specific life events (Roberts and Mroczek, 2008). Trait emotional intelligence is, by definition, a trait and should not vary; however, as it is a measure of self-perception it would seem open to influence from external pressures such as access to resources and social pressure which may alter feelings regarding the self and thus have the potential to vary through time. The experience of birth is a major life event which may cause changes to both emotional personality and emotional intelligence of women, in much the same way as it can affect emotional wellbeing, altering a woman’s emotional capital. Alternatively, the act of emotionally investing may use up energy which might otherwise be spent on maintaining emotional stability, i.e. maintaining pre-birth levels of emotional wellbeing, emotional personality, and emotional intelligence. The hypothesis that intrinsic emotional capital is liquid and diminished by emotional investment will form part of the following analysis.

Emotional intelligence and postnatal depression

People with high levels of emotional intelligence have been found to show low levels of depression (Dawda and Hart, 2000; Petrides and Furnham, 2001) and it is thought that the ability to understand emotions which emotional intelligence confers protects against negative emotions taking over (Bar-On, 1997). However, the only study relating to postnatal women found that Norwegian mothers of high emotional intelligence were more likely to suffer from PND (Akerjordet and Severinsson, 2009). If an embodied capital theory does hold for emotional investment in offspring, then this may make sense. The higher a mother’s emotional capital, the higher emotional capital investment she should deem necessary in her infant, and the higher the investment, the higher the required returns to make it worthwhile. If women of high emotional intelligence are also more susceptible to the sociocultural messaging regarding the risks of mothering and importance of infant emotional development in Western society, this may cause them to judge their available capital as inadequate and the likelihood of failure too high, leading them to withdraw their emotional investment. At the same time by virtue of their being more inclined to value the emotional capital of their infant and see themselves as key to its development, they are perhaps more susceptible to social stigma attached to ‘bad mothering’ and suffer PND in response to perceived or actual social rejection.

Emotional investments and risk

An embodied capital approach to parental investment, falling within the framework of parental investment theory (Trivers, 1972), predicts that investments are made in the expectation of pay-offs in terms of income from offspring reproductive success. Thus parental investments are risk sensitive, and investments should be reduced, withheld, or withdrawn when the potential benefits of investments are outweighed by costs of wasted investment when failure is anticipated, for example as a result of being in a high mortality environment. Maternal emotional investments in offspring emotional capital are similarly hypothesised to be subject to risk sensitive cost-benefit analyses, as reflected in the model for predicting maternal emotional investments and PND likelihood based on mortality and characteristics of the sociocultural mothering environment (full version Table 4.4, abbreviated version Table 4.5). As discussed in *Part 1*, in the majority of traditional and historical populations in which both somatic and emotional investments carry a high likelihood of producing insufficient pay-offs, due to high levels of mortality, low emotional investment strategies (*strategy 2*) are hypothesised to be the norm.

High Mortality Environment		**Low Mortality Environment**	
Investment Strategy 1 *Individual level factors:* MSIC = HIGH MEIC = HIGH *Population level factors:* SCNI = HIGH *Outcomes:* EI = LOW PND = YES	**Investment Strategy 2** *Individual level factors:* MSIC = HIGH MEIC = HIGH *Population level factors:* SCNI = LOW *Outcomes:* EI = LOW PND = NO	**Investment Strategy 3** *Individual level factors:* MSIC = LOW MEIC = LOW *Population level factors:* SCNI = HIGH *Outcomes:* EI = HIGH PND = NO	**Investment Strategy 4** *Individual level factors:* MSIC = LOW MEIC = HIGH *Population level factors:* SCNI = HIGH *Outcomes:* EI = LOW PND = YES
Investment Strategy 5 *Individual level factors:* MSIC = HIGH MEIC = LOW *Population level factors:* SCNI = HIGH *Outcomes:* EI = HIGH PND = NO	**Investment Strategy 6** *Individual level factors:* MSIC = HIGH MEIC = LOW *Population level factors:* SCNI = LOW *Outcomes:* EI = LOW PND = NO	**Investment Strategy 7** *Individual level factors:* MSIC = LOW MEIC = LOW *Population level factors:* SCNI = LOW *Outcomes:* EI = HIGH PND = NO	**Investment Strategy 8** *Individual level factors:* MSIC = LOW MEIC = HIGH *Population level factors:* SCNI = LOW *Outcomes:* EI = LOW PND = NO

Table 4.5 A model to predict maternal emotional investments and PND likelihood based on mortality and characteristics of the sociocultural mothering environment. Key: Maternal Somatic Investment Costs (MSIC), Maternal Emotional Investment Costs (MEIC), Social Costs of Not Investing (SCNI), Emotional Investment (EI), and Postnatal Depression (PND).

Burgess and Drais (1999) propose that perceived costs of parental investment are actually more influential than perceived benefits in governing acceptability thresholds of benefit-to-cost ratios, due to their being more likely to vary, and to vary in short time spans, and suggest there is a perceptual bias towards tracking alterations in costs more judiciously than alterations in benefits. In Chapter 3 the contemporary emphasis on risk surrounding mothering in WEIRD populations was discussed, and results, showing that the awareness of stigma attached to maternal behaviour positively predicts a woman's level of risk perception, indicate that risk can originate from the sociocultural environment. Risk, in the context of the WEIRD mothering environment, has become divorced from probability (Lee, 2014b); thus, while the 'objective' likelihood of insufficient pay-offs to maternal emotional investments is largely very small, subjective perceptions of the likelihood of insufficient pay-offs may be high. In particular, an emphasis on the damage inappropriate maternal emotional relationships with infants can have on infant neurological development (Faircloth, 2014b), maternal emotion and love having become medicalised (Kanieski, 2009), may make maternal emotional investment liable to very high acceptability thresholds in benefit-to-cost ratios, leading to investment *strategies 4* (Table 4.4-5).

Research questions

Can maternal emotions be understood as forms of embodied capital investment in offspring?

If so, what influences trade-offs in relation to maternal emotional investment?

From these questions a range of hypotheses broadly relating to 'bonding', risk, and emotional capital (for a summary see Table 4.6) can be derived using the framework of an emotional capital theory of maternal emotional investments presented in *Part 1* of this chapter.

Hypotheses

-Bonding (B)

Bi) *Emotional bonding will be highly valued by women from WEIRD populations*

Embodied capital investments are predicated on their being of benefit to an offspring's fitness in a given environmental context (Kaplan, 1996). Thus the emotional capital hypothesis relies on women placing value in emotional investments. In low mortality environments where reproductive success is enhanced by secure attachment and personality traits linked to early maternal sensitivity (see *Part 1*), and particularly in WEIRD contexts where emotional stability and awareness are touted as key to employment success (Gendron, 2004), mothers should be expected to uniformly view emotional investments in their offspring as important.

Bii) *Emotional investment will conform to the predictions of parental investment theory and be stronger when maternal emotional capital is greater*

If 'emotional bonding' reflects an investment of emotional capital, akin to an embodied capital investment, then it should positively correlate with a mother's available emotional capital before the birth of her child.

Biii) *The time it takes to emotionally invest will conform to the predictions of parental investment theory and be shorter when maternal emotional capital is greater*

If emotional bonding with an infant reflects an investment of emotional capital from the mother, and bonding is a process that accrues over time, then the time it takes to feel strongly bonded to an infant should be negatively related to the level of available emotional capital.

Biv) *Emotional investment will be better predicted by measures of emotional capital than measures of practical support and other measures of maternal resources*

If emotional bonding reflects an emotional investment of emotional capital then it should be better predicted by measures of emotional capital, which directly influence investment ability, than by

Hypothesis	Dependent variable	Independent variable(s)	Statistical approach
Bonding			
Bi. Emotional bonding will be highly valued by women from WEIRD populations	**Bi.** Importance of emotional bonding		**Bi.** Percentage distributions
Bii. Emotional investment will conform to the predictions of parental investment theory and be stronger when maternal emotional capital is greater	**Bii.** Bonding	**Bii.** *Emotional capital*, current PND	**Bii.** Linear regression
Biii. The time it takes to emotionally invest will conform to the predictions of parental investment theory and be shorter when maternal emotional capital is greater	**Biii.** Time to bond	**Biii.** *Emotional capital*, PND ever	**Biii.** Linear regression
Biv. Emotional investment will be better predicted by measures of emotional capital than measures of practical support and other measures of maternal resources	**Biv.** Bonding or time to bond	**Biv.** *Practical support* or *maternal resources*, current PND or PND ever	**Biv.** Linear regression; comparison of resulting AICc, BIC, and adjusted R^2's with these measures from Bii-iii.
Bv. Emotional investment will predict PND	**Bv.** Depressive symptom severity or PND ever	**Bv.** *Bonding* and/or *bonding confidence*, antenatal depression	**Bv.** Linear and binary logistic regression
Bvi. Emotional capital will predict emotional investment better than it predicts PND, while other maternal resources will predict PND better than they predict emotional investment	**Bvi.** Bonding or depressive symptom severity, and time to bond or PND ever	**Bvi.** *Emotional capital* or *maternal resources*, antenatal depression	**Bvi.** Linear and binary logistic regression; adjusted R^2 and pseudo R^2 comparison
Risk			
Ri. The perception of risk surrounding mothering will predict bonding, confidence in bonding, and time taken to bond	**Ri.** Bonding, bonding confidence, or time to bond	**Ri.** *Perception of risk*	**Ri.** Linear regression
Emotional capital			
ECi. Factors affecting a mother's resources will predict shifts in intrinsic emotional capital	**ECi.** Shift in intrinsic emotional capital	**ECi.** *Extrinsic emotional capital*, *overall practical support*, *time spent alone* or *SES*, PND ever	**ECi.** Linear regression
ECii. Emotional investment in an offspring will result in a fall in maternal intrinsic emotional capital	**ECii.** Shift in intrinsic emotional capital	**ECii.** *Bonding*, PND ever	**ECii.** Linear regression

Table 4.6 Hypotheses tested in Chapter 4 and the measures and methods used to test them. Measures in *italics* denote the variable of interest, measures underlined denote moderator variables in moderation analyses. Abbreviations: postnatal depression (PND), socioeconomic status (SES), Western educated industrialised rich democratic (WEIRD), Bayesian information criterion (BIC), bias corrected Akaike information criterion (AICc).

Hypothesis	Dependent variable	Independent variable(s)	Statistical approach
ECiii. The relationship between emotional investment and shifts in intrinsic emotional capital will be moderated by extrinsic emotional capital	**ECiii.** Shift in intrinsic emotional capital	**ECiii.** *Extrinsic emotional capital*, <u>bonding,</u> PND ever	**ECiii.** Moderation analysis
ECiv. All women will be susceptible to sociocultural pressures surrounding mothering and thus maternal shame	**ECiv.** Maternal shame	**ECiv.** *Stigma consciousness*, or *perception of social pressure*, <u>emotional capital</u>	**ECiv.** Moderation analysis
ECv. All women will withdraw emotional investment in response to perceived risk	**ECv.** Perception of risk	**ECv.** *Bonding*, *bonding confidence*, or *time to bond*, <u>emotional capital</u>	**ECv.** Moderation analysis
Predicting PND – a comprehensive psychosocial stress model			
Antenatal depression, recognised PND risk factors, maternal shame, and social isolation will all positively predict PND	PND ever	*Antenatal depression*, *recognised risks*, *maternal shame*, *time spent alone*	Binary logistic regression

Table 4.6 (continued) Hypotheses tested in Chapter 4 and the measures and methods used to test them. Measures in *italics* denote the variable of interest, measures <u>underlined</u> denote moderator variables in moderation analyses. Abbreviations: postnatal depression (PND), socioeconomic status (SES), Western educated industrialised rich democratic (WEIRD), Bayesian information criterion (BIC), bias corrected Akaike information criterion (AICc).

other measures of a mother's resources, which will only indirectly influence investment ability.

Bv) *Emotional investment will predict PND*

Under a social genome approach to depression, PND is hypothesised to be the result of an inflammatory response to psychosocial stress. Due to the pressures mothers experience in WEIRD contexts in relation to emotional bonding, low emotional bonding and low confidence in emotional bonds are hypothesised to predict PND.

Bvi) *Emotional capital will predict emotional investment better than it predicts PND, while other maternal resources will predict PND better than they predict emotional investment*

As PND is held to be the product of an inflammatory stress response there are multiple pathways by which it can develop. Kendall-Tackett (2007) proposes that many of the commonly recognised risk factors for PND, reflected in the *maternal resources* variable, produce an inflammatory response resulting from psychosocial stress leading to PND. Maternal emotional investment trade-offs based in part on emotional capital availability is hypothesised to indirectly lead to PND via a psychosocial induced stress response to emotional investment experiences, requiring the added element of shame. Not all women will experience shame in relation to low emotional investment, as was shown in Chapter 3, and thus emotional capital will better predict emotional investment than it predicts PND.

Common PND risk factors have been previously found to predict delayed emotional investment (see Chapter 1); sociologists using the notion of emotional capital suggest that things like poor finances can constrain the capacity of mothers to emotionally invest in children (Reay, 2000), possibly as a result of requiring emotional energy being spent on self-maintenance to enable functioning in other areas of life (Mani *et al*., 2013). Maternal resources are, therefore, hypothesised to predict emotional investment; however because maternal resources may act directly on PND as well as indirectly, by lowering emotional investment leading to further psychosocial stress, maternal resources are predicted to account for more variance in PND than emotional investment.

-Risk (R)

Ri) The perception of risk surrounding mothering will predict bonding, confidence in bonding, and time taken to bond

Parental investment theory predicts that investment in an infant should be withheld or withdrawn when the fitness benefits are outweighed by the costs. The perception of environmental risk which reduces the likelihood of investments paying-off will lead to investment being redirected to the self for the purposes of maintenance and future reproduction. As such the perception of environmental risk should negatively predict emotional investments and confidence in those investments.

-Emotional capital (EC)

ECi) Factors affecting a mother's resources will predict shifts in intrinsic emotional capital

Rather than being viewed as fixed, intrinsic emotional capital (emotional wellbeing, emotional intelligence, and emotional personality) is conceptualised as a limited resource, and therefore liable to changes. Extrinsic factors affecting a mother's resources will, therefore, predict shifts in intrinsic emotional capital from before birth to 6 months postpartum. These shifts will be independent of PND and thus not simply reflect a reduction in emotional wellbeing.

ECii) Emotional investment in an offspring will result in a fall in maternal intrinsic emotional capital

Emotional investment is costly, in terms of emotional capital being invested in the infant (reflected in bonding strength) rather than being retained by the mother for self-maintenance for future reproduction. 'Emotional bonding' will thus predict shifts in intrinsic emotional capital with stronger bonds resulting in declines in capital.

ECiii) The relationship between emotional investment and shifts in intrinsic emotional capital will be moderated by extrinsic emotional capital

‘Emotional bonding’ will only result in declines in intrinsic emotional capital when emotional support from the mother’s social network is not available to replenish the ‘emotional energy’ spent on the infant.

ECiv) *All women will be susceptible to sociocultural pressures surrounding mothering and, thus, maternal shame*

While women of varying emotional capital may differ in their susceptibility to sociocultural pressures surrounding mothering, given the nature of these pressures all women who perceive high levels of pressure will experience maternal shame, irrespective of their emotional capital.

ECv) *All women will withdraw emotional investment in response to perceived risk*

While women of differing emotional capital may vary in their perception of risk when faced with the same environment, when they do perceive risk, all women will trade-off current emotional investment for self-maintenance and future investment opportunities and withdraw emotional investment.

Materials and methods

-Data collection

The experiences of women were collected using a multi-wave questionnaire. Participants were recruited for the first wave during the second and third trimester of pregnancy (wave 1), and they then took part in follow-up questionnaires at approximately 1 month after birth (wave 2) and 6 months after birth (wave 3). For full details see Chapter 3.

-Questionnaires

For the full questionnaires, along with rationales behind each question and relevant references see Appendix E.

-Measures

The following measures were used in addition to those introduced in Chapter 3 (see Table 4.7 for a summary).

Variable	Description	Type
Depression measures		
Depressive symptom severity	Depressive symptoms at 1 month postnatally – higher score = higher severity	Continuous
Current PND	PND at 1 month postnatally	Binary categorical
PND ever	PND experienced at any point within 6 months of giving birth	Binary categorical
Antenatal depression	Antenatal depression during pregnancy	Binary categorical
The mothering environment		
Stigma consciousness	Awareness of stigma surrounding mothering during pregnancy – higher score = higher awareness	Continuous
Perception of social pressure	Perception of social pressure surrounding mothering during pregnancy – higher score = higher perception of pressure	Continuous
Perception of risk	Perception of risk surrounding infant during pregnancy and at approximately 6 months postnatally – higher score = higher risk	Continuous
Maternal shame	Experience of shame surrounding maternal behaviour and emotions during pregnancy and at approximately 1 and 6 months postnatally – higher score = higher shame	Continuous
Emotional investment		
Bonding	Strength of bonding at approximately 1 and 6 months postnatally – higher score = lower bonding	Continuous
Bonding confidence	Confidence in bonding relationship at approximately 1 and 6 months postnatally – higher score = higher confidence	Continuous
Time to bond	Time taken to feel strongly bonded, measured at approximately 6 months postnatally – higher score = longer time	Continuous
Social isolation		
Time spent alone	Hours spent alone with infant without the company of another adult on weekdays	Binary categorical
Demographics		
SES	Social class based on occupation; high ('Professional'), medium ('Managerial and technical'), and low ('Skilled non-manual – unskilled')	Categorical
Education	Highest level of education attained	Categorical
Maternal age	Age during pregnancy	Continuous

Table 4.7 A summary of the variables introduced in Chapter 3.

-Emotional capital measures

Intrinsic emotional capital was measured in the following ways: *Emotional personality* was measured using the Brief Affective Neuroscience Personality Scale (BANPS) (Barret, Robins, and Janata, 2013), developed from Davies and Panksepp's (2011) Affective Neuroscience Personality Scales (ANPS). The scale consists of 6 subscales assessing the positive subcortical emotion systems *play* (6 questions), *seek* (6 questions), *care* (4 questions) and the negative subcortical emotion systems *anger* (6 questions), *fear* (5 questions), and *sadness* (6 questions), with scoring on a scale of 1 'Strongly disagree', 2 'Disagree', 3 'Neither agree nor disagree', 4 'Agree', 5 'Strongly agree'. The BANPS may be used as a composite scale, however Barret, Robins, and Janata (2013) recommend employing the subscales individually as they reflect neurobiologically distinct systems. Here both the composite score (created by reverse scoring the negative subscales before summing all scale scores) is used as part of the measure *overall emotional capital* (see below for details) and the individual subscales to measure *emotional personality – X* where the higher the score the greater the disposition to express the given emotion, and use the latter both altogether and separately in regression analyses. Measures were taken during pregnancy (wave 1), to assess whether scores influenced maternal emotional investment, and approximately 6 months postnatal (wave 3), to assess whether scores shifted from pre-birth levels.

Emotional intelligence was measured using Petrides's Trait Emotional Intelligence Short-form (TEIQue-SF) (Petrides and Furnham, 2006). The TEIQue-SF consists of 30 statements and participants are requested to rate the degree to which they apply to them of a scale of 1 'Completely disagree' to 7 'Completely agree', providing a continuous measure of *emotional intelligence* with higher scores indicating higher intelligence. Measures were taken during pregnancy (wave 1), to assess whether scores influenced maternal emotional investment, and approximately 6 months postnatal (wave 3), to assess whether scores shifted from pre-birth levels.

Emotional wellbeing was measured using Bradburn's Affect Balance Scale (ABS) (van Schuur and Kruijtbosch, 1995). The ABS consists of 10 statements of positive or negative affect and participants are requested to answer whether they have felt that way in the last few weeks. The scale is scored 0 ‘Yes’ or 1 ‘No’, with lower scores indicating higher wellbeing. Measures were taken during pregnancy (wave 1), to assess whether scores influenced maternal emotional investment, and approximately 6 months postnatal (wave 3), to assess whether scores shifted from pre-birth levels.

A composite measure of *intrinsic emotional capital* was created by summing the BANPS subscale scores (after reverse scoring *anger, fear*, and *sadness*), the TEIQue-SF score, and the ABS score (after reverse scoring), where a higher score indicated higher capital. Calculated for during pregnancy (wave 1), to assess whether scores influenced maternal emotional investment, and approximately 6 months postnatal (wave 3), to assess whether scores shifted from pre-birth levels.

Extrinsic emotional capital was assessed in terms of availability of emotional support. Participants were asked to rate the level of emotional support they received from the following sources: the offspring’s father, their family, the father’s family, their friends, their GP, and their health workers. The original scale of 1 ‘Very low’, 2 ‘Low’, 3 ‘Moderate’, 4 ‘High’, and 5 ‘Very high’ was condensed to 1 ‘Low’, 2 ‘Moderate’, and 3 ‘High’. For the purposes of analysis both the effect of *individual sources of emotional support* and *extrinsic emotional capital* (the sum of the individual sources) were used as continuous measures. Measured during pregnancy (wave 1) and approximately 6 months postnatal (wave 3).

A composite measure of *overall emotional capital* was created by summing *intrinsic* and *extrinsic emotional capital* scores, with higher scores indicating higher capital. As noted, these measures reflect a first attempt at quantifying emotional capital and as such their use is partly speculative; however, they have all been implicated in maternal investment, emotional stability, or emotional reactivity. Employing the variety of measures both separately and in conjunction will be the most informative strategy in terms of providing a base for future research. For reference purposes an overview of the different measures can be found in Table 4.8.

Variable	Description
Intrinsic measures	
Individual measures of intrinsic capital	Emotional personality subscales (play, seek, care, anger, fear, sadness) – higher score = higher disposition; emotional intelligence – higher score = higher intelligence, emotional wellbeing – higher score = lower wellbeing
Intrinsic emotional capital	Composite measure based on the individual measures – higher score = higher capital
Extrinsic measures	
Individual sources of emotional support	Emotional support available from the offspring's father, the mother's family, the father's family, the mother's friends, the mother's GP, and the mother's health workers – higher score = higher support
Extrinsic emotional capital	Sum of individual sources of emotional support
Overall measure	
Overall emotional capital	Sum of intrinsic and extrinsic emotional capital

Table 4.8 Overview of the emotional capital measures.

-Other maternal resources

To investigate the distinction between types of support available to mothers' available practical support was also assessed. Participants were asked to rate the level of practical support they received from the following sources: the offspring's father, their family, the father's family, their friends, their GP, and their health workers. The original scale of 1 'Very low', 2 'Low', 3 'Moderate', 4 'High', and 5 'Very high' was condensed to 1 'Low', 2 'Moderate', and 3 'High'. For the purposes of analysis both the effect of *individual sources of practical support* and *overall practical support* (the sum of the individual sources) were used as continuous measures. Measured during pregnancy (wave 1) and approximately 6 months postnatal (wave 3).

The amount of time women spent alone with their infants without the company of another adult was measured following Kitsinger's (1989) study of baby crying in which it was found that a large proportion of mothers were alone for long periods, and those that were found crying infants harder to deal with. The question and response options were taken from Kitsinger (1989); participants were asked 'On weekdays, how long are you usually alone at home without another adult?' with the response scale 1 'Less than 2 hours', 2 '2-4 hours', 3 ' 4-8 hours', 4 ' 8-12 hours', and 5 '12-24 hours'. The scale was used a continuous measure of *time spent alone*. Measured at approximately 6 months postnatal (wave 3).

A large body of literature, on which current adaptationist explanations of PND are based, has documented the relationship between PND and indicators of poor environmental circumstance (Beck, 2001) and many of the standard risk factors for PND mirror those associated with long bonding times (see Chapter 1 for a review). To assess how the emotional capital based hypothesis for predicting emotional investment and PND performs against the standard recognised risk factors a measure of *maternal resources* was created as a composite measure of the following variables: SES determined by the Social Class Based on Occupation method (CeLSIUS, 2007: see Chapter 2 for more details), scored 0 ‘Skilled non-manual, skilled manual, partially skilled, unskilled’, 1 ‘Managerial and technical’, and 2 ‘Professional’; highest level of education attained, scored 0 ‘Less than a bachelor’s degree’, 1 ‘Bachelor’s degree’, and 2 ‘Postgraduate degree’; relationship stability, scored 0 ‘Unstable’, 1 ‘Moderately stable, and 2 ‘Stable’; financial means to access local mother and baby groups, scored 0 ‘No’ and 1 ‘Yes’, and; transport access to local mother and baby groups, scored 0 ‘No’ and 1 ‘Yes’. Scores were summed to create a continuous measure of *maternal resources* where a higher score indicates higher resources. A composite measure was used, similar to the ‘maternal circumstance’ measure in Myers, Burger, and Johns (2016) (also see Chapter 2), because the sample size prevented the entering of all these variables into models at once. Measures taken during pregnancy (wave 1), with the exception of education which was measured at approximately 6 months postnatal (wave 3).

-Importance of emotional investments

Embodied capital investments are predicated on their being of benefit to an offspring’s fitness (Kaplan, 1996); emotional investments in infants should therefore be valued by mothers. The importance mothers placed on ‘emotional bonding’ (reflecting terminology commonly in use) was assessed in two ways: Participants were requested to rate how important they felt emotional bonding was for mothers in general, to them personally, to an infant’s and to a child’s long-term emotional, educational, and physical development. Scores were rated on a scale of 1 ‘Not at all’, 2 ‘A little’, 3 ‘Moderately’, 4 ‘Very’, and 5 ‘Extremely’. Participants were also requested to rank in order of importance to them the ‘physical’, ‘emotional’, and ‘educational’ development of their child. Measured during pregnancy (wave 1).

-Sample characteristics

See Chapter 3.

-Modelling approach and data handling

Bias-corrected and accelerated (BCa) bootstrapping was performed on some models to counter heteroscedasticity indicated by analysis of the residuals; this is a robust procedure and avoids potential complications associated with data transformation (Field, 2013). Where bootstrapping is applied the number of samples used is indicated in the relevant results table and any bootstrapped significance values reported in the text are preceded by the notation BCa.

Multicollinearity between variables was assessed via inspection of variance inflation factors (VIF) and tolerance statistics. In all models presented no VIFs were found to be greater than 10, the average VIF was never noticeably greater than 1, and no tolerance statistics were less than 0.2 (Field, 2013); thus no variables were deemed to be problematically correlated.

-Statistical approach

Bi) *Emotional bonding will be highly valued by women from WEIRD populations*

The percentage distributions of responses to the various questions regarding the importance of emotional bonding were calculated.

Bii) *Emotional investment will conform to the predictions of parental investment theory and be stronger when maternal emotional capital is greater*

Linear regression models were run with *bonding* (wave 2) acting as the dependent variable and measures of *emotional capital* (wave 1) as the predictor variable, while controlling for *current PND* (wave 2). *Emotional capital* was entered into the models in the form of: *intrinsic emotional capital*; the individual measures constituting *intrinsic emotional capital – emotional wellbeing,* *emotional intelligence*, the individual subscales of *emotional personality – play*, *seek*, *care*, *anger*, *fear*, and *sadness*; *extrinsic emotional capital*, and; the *individual sources of emotional support*, and; *overall emotional capital*. BCa bootstrapping was performed on some models to counter heteroscedasticity (Field, 2013).

Biii) *The time it takes to emotionally invest will conform to the predictions of parental investment theory and be shorter when maternal emotional capital is greater*

Linear regression models were run with *time to bond* (a retrospective measure taken at wave 3) acting as the dependent variable and measures of *emotional capital* (wave 1) as the predictor variable, while controlling for *PND ever* (wave 3). *Emotional capital* was entered into the models in the form of: *intrinsic emotional capital*; the individual measures constituting *intrinsic emotional capital – emotional wellbeing*, *emotional intelligence*, the individual subscales of *emotional personality – play*, *seek*, *care*, *anger*, *fear*, and *sadness*; *extrinsic emotional capital*, and; the *individual sources of emotional support*, and; *overall emotional capital*. BCa bootstrapping was performed on each model to counter heteroscedasticity.

Biv) *Emotional investment will be better predicted by measures of emotional capital than measures of practical support and other measures of maternal resources*

Linear regression models were run with *bonding* (wave 2) or *time to bond* (wave 3) acting as the dependent variable and either *overall practical support* (wave 1), *individual sources of practical support* (wave 1), or *maternal resources* (wave 1) acting as predictors, controlling for either *current PND* or *PND ever*. Bias-accelerated and corrected bootstrapping was performed on each model to counter heteroscedasticity and aid robusticity. The Bayesian information criterion (BIC) scores, bias corrected Akaike information criterion (AICc) scores, and adjusted R^2's of resulting from these models were compared with those from hypotheses *Bii-iii*. The sample size for which the *maternal resources* measure exists is smaller than the other predictor variables, which exploratory analysis showed had a noticeable effect on resultant measures used for model comparison and so all the models were re-run using this restricted sample to enable comparison.

Bv) *Emotional investment will predict PND*

Linear regression models were run with *depressive symptom severity* at approximately 1 month postnatal (stage 2) as the dependent variable and *bonding*, *bonding confidence*, or both (stage 2) as the predictor variable, also controlling for *antenatal depression* (stage 1), and binary logistic regression models with *PND ever* (stage 3) as the dependent variable and *bonding*, *bonding confidence*, or both (stage 2) as the predictor variable, controlling for *antenatal depression* (stage 1).

Bvi) *Emotional capital will predict emotional investment better than it predicts PND, while other maternal resources will predict PND better than they predict emotional investment*

Two sets of analysis were run with the purpose of generating estimates of how much variance in the dependent variable (either emotional investment or PND) was captured by the models for comparison. The first set compared the adjusted R^2 for *bonding* (wave 2) with the adjusted R^2 for *depressive symptom severity* (wave 2), generated by linear regression models in which either the individual measures of *intrinsic emotional capital*, *individual measures of extrinsic emotional capital*, or *maternal resources* (wave 1) acted as the predictor variables, *antenatal depression* (stage 1) acted as a control variable. The second set compared the adjusted R^2 for *time to bond* (wave 3) with the pseudo R^2's for *PND ever* (wave 3), generated by linear and binary regression models in which either the individual measures of *intrinsic emotional capital*, *individual measures of extrinsic emotional capital*, or *maternal resources* (wave 1) acted as the predictor variables, *antenatal depression* (stage 1) and *depressive symptom severity* (wave 2) acted as a control variable. Bias-accelerated and corrected bootstrapping was performed on each model to counter heteroscedasticity.

Ri) The perception of risk surrounding mothering will predict bonding, confidence in bonding, and time taken to bond

Linear regression models were run in which *bonding* (wave 2-3), *bonding confidence* (wave 2-3), or *time to bond* (wave 3) acted as the dependent variable and the *perception of risk* (wave 1 and 3) acted as the predictor variable. Bias-accelerated and corrected bootstrapping was performed to counter heteroscedasticity.

ECi) *Factors affecting a mother's resources will predict shifts in intrinsic emotional capital*

Linear regression models were run in which the *shift in intrinsic emotional capital* (the difference between score reported during pregnancy and the score reported at approximately 6 months postnatal), for overall *intrinsic emotional capital* and the *individual measures,* acted as the dependent variable, and extrinsic maternal resources (*extrinsic emotional capital* and *overall practical support* during pregnancy and at approximately 6 months postnatal, *time spent alone* with the infant on weekdays, and *SES*) as the predictor variables, whilst also controlling for the occurrence of *PND ever* within approximately 6 months postnatal. BCa bootstrapping was performed on some models to account for heteroscedasticity.

ECii) Emotional investment in an offspring will result in a fall in maternal intrinsic emotional capital

Linear regression models were run in which the *shift in intrinsic emotional capital*, for *intrinsic emotional capital* and the *individual measures*, acted as the dependent variable, and *bonding* at approximately 1 month (wave 2) acted as the predictor variable, while also controlling for *PND ever* within approximately 6 months postnatal (wave 3). Bias-accelerated and corrected bootstrapping was performed on some models to account for heteroscedasticity.

ECiii) The relationship between emotional investment and shifts in intrinsic emotional capital will be moderated by extrinsic emotional capital

Moderation analysis was conducted using the Process tool in SPSS (Hayes, 2013) to test whether the level of *extrinsic emotional capital* a mother received (wave 1 and 3) moderated the relationship between *bonding* (wave 2) and *shifts in intrinsic emotional capital*, controlling for *PND ever* within approximately 6 months postnatal (wave 3). Bias corrected bootstrapping was applied.

ECiv) *All women will be susceptible to sociocultural pressures surrounding mothering and, thus, maternal shame*

Moderation analysis was conducted using the Process tool in SPSS (Hayes, 2013) to test whether the level of *emotional capital* (wave 1) moderated the relationship between *stigma consciousness* or *perception of social pressures* (wave 1) and *maternal shame* (wave 1-2). Bias corrected bootstrapping was applied.

ECv) *All women will withdraw emotional investment in response to perceived risk*

Moderation analysis was conducted using the Process tool in SPSS (Hayes, 2013) to test whether the level of available *emotional capital* (stage 1) moderated the relationship between the *perception of risk* (stage 1) and *bonding* (stage 2), *bonding confidence* (stage 2), or *time to bond* (stage 3). Bias corrected bootstrapping was applied.

Results

Bi) *Emotional bonding will be highly valued by women from WEIRD populations*

The percentage distribution of responses shows women to attach high importance to emotional bonding (Table 4.9). 97.1% of women rated a mother emotionally bonding with her baby as with 'very or extremely' important, and 98.5% rated emotional bonding as 'very or extremely' important personally. The majority of women rated the importance of emotional bonding as 'very or extremely' in response to all questions as to how important bonding was to various aspects of child development, in the first year and long-term respectively: emotional 98.5%, 94.2%; educational 90.0%, 84.2%; physical 72.9%, 67.1%.

When asked what was most important to them, 84.3% of women chose their child's emotional development; while 12.9% chose educational development and 2.9% chose physical development (Table 4.10).

Question	Percentage distribution of responses (95% CI)				
	Not at all	A little	Moderately	Very	Extremely
How important do you think it is for a mother to emotionally bond with her baby?	0.0	0.0	2.9 (-1.1 – 6.8)	27.1 (16.7 – 37.5)	70.0 (59.3 – 80.74)
How important is it to you that you emotionally bond with your baby?	0.0	0.0	1.4 (-1.4 – 4.2)	11.4 (4.0 – 18.8)	87.1 (79.3 – 95.0)
How important do you think emotional bonding is to a baby's emotional development in the first year?	0.0	0.0	1.4 (-1.4 – 4.2)	21.4 (11.8 – 31.0)	77.1 (67.3 – 86.9)
How important do you think emotional bonding is to a baby's educational development in the first year?	0.0	0.0	10.0 (3.0 – 17.0)	34.3 (23.2 – 45.4)	55.7 (44.1 – 67.3)
How important do you think emotional bonding is to a baby's physical development in the first year?	0.0	5.7 (0.3 – 11.1)	21.4 (11.8 – 31.0)	34.3 (23.2 – 45.4)	38.6 (27.2 – 50.0)
How important do you think emotional bonding in infancy is to a child's long-term emotional development?	0.0	0.0	5.7 (0.3 – 11.1)	27.1 (16.7 – 37.5)	67.1 (56.1 – 78.1)
How important do you think emotional bonding in infancy is to a child's long-term educational development?	0.0	0.0	15.7 (7.2 – 24.2)	37.1 (25.8 – 48.4)	47.1 (35.4 – 58.8)
How important do you think emotional bonding in infancy is to a child's long-term physical development?	0.0	11.4 (4.0 – 18.9)	21.4 (11.8 – 31.0)	31.4 (20.5 – 42.3)	35.7 (24.5 – 46.9)

Table 4.9 Percentage distributions of the importance attached to emotional bonding by mothers.

Trait	Percentage distribution of responses (95% CI)		
	1st	2nd	3rd
Physical development	2.9 (-1.0 – 6.8)	42.9 (31.3 – 54.5)	54.3 (42.6 – 66.0)
Emotional development	84.3 (75.8 – 92.8)	12.9 (5.1 – 20.8)	2.9 (-1.0 – 6.8)
Educational development	12.9 (5.1 – 20.8)	44.3 (32.7 – 55.9)	42.9 (31.3 – 54.5)

Table 4.10 Percentage distributions of the ranking of importance of developmental traits by mothers.

Bii) *Emotional investment will conform to the predictions of parental investment theory and be stronger when maternal emotional capital is greater*

There was a general trend for level of emotional investment (*bonding*) to be greater (lower MIBS score = stronger *bonding*) when maternal *emotional capital* was greater as measured by both *intrinsic* and *extrinsic emotional capital* (Table 4.11), after controlling for *current PND*.

When the individual measures constituting *intrinsic emotional capital* were entered separately into the same model the *emotional personality – sadness* subscale was found to positively predict *bonding* approaching significance (BCa $p = 0.064$) indicating women with greater disposition towards sadness made greater emotional investments (Table 4.11).

The strength of *bonding* increased as *extrinsic emotional capital* increased ($p = 0.027$), and when *individual sources of emotional support* were entered separately into the same model support from the mother's family at a level approaching significance (BCa $p = 0.094$) positively predicted *bonding* (Table 4.11). However, contrary to the hypothesis emotional support from the father of the infant was found to negatively predict *bonding* (BCa $p = 0.012$) (Table 4.11).

Extrinsic emotional capital was found to be a better predictor of *bonding* than *intrinsic emotional capital*, accounting for 5% more variance (Table 4.11). When individual measures were assessed *individual sources of emotional support* accounted for 12% more variance than *emotional wellbeing*, *emotional intelligence*, and the *emotional personality subscales* (Table 4.11). Finally, when *intrinsic* and *extrinsic emotional capital* were both entered into the same model only *extrinsic emotional capital* a significant predictor at a level approaching significance (Table 4.11).

Biii) *The time it takes to emotionally invest will conform to the predictions of parental investment theory and be shorter when maternal emotional capital is greater*

While as predicted measures of *intrinsic emotional capital* generally negatively predicted *time to bond*, after controlling for the experience of PND at any point during approximately the first six months, *extrinsic emotional capital* did not (Table 4.12).

Time to bond was faster in women of higher *intrinsic emotional capital* at a level approaching significance (BCa $p = 0.086$) (Table 4.12). When the measures of *intrinsic emotional capital* were entered individually into the same model, women lower on *emotional wellbeing* (BCa $p = 0.003$) and higher on the *emotional personality – play* (BCa $p = 0.009$) subscale were found to take longer to bond, while women higher on the *sadness* subscale (BCa $p = 0.068$) bonded in a reduced period of time at a level approaching significance (Table 4.12).

Variable	Unstandardised coefficient		Standardised coefficient	*p*	95% CI for *b*	
	b	**SE**	***β***		**Lower**	**Upper**
Intrinsic emotional capital						
Constant	5.642	2.477		*0.025*	*0.969*	*9.920*
Current PND (no = ref)	1.384	0.884	0.219	*0.225*	*-0.867*	*3.696*
Intrinsic emotional capital	-0.013	0.010	-0.189	*0.146*	*-0.030*	*0.006*
Adjusted R2						0.083
BIC						271.020
Individual measures of intrinsic emotional capital						
Constant	8.198	5.174		*0.093*	*0.077*	*16.624*
Current PND (no = ref)	1.520	0.878	0.241	*0.163*	*-0.617*	*3.552*
Emotional wellbeing	0.076	0.229	0.068	*0.725*	*-0.385*	*0.609*
Emotional intelligence	-0.054	0.028	-0.475	*0.104*	*-0.119*	*0.031*
Emotional personality - play	0.094	0.148	0.092	*0.591*	*-0.189*	*0.318*
Emotional personality - seek	0.091	0.120	0.132	*0.592*	*-0.226*	*0.511*
Emotional personality - care	0.007	0.146	0.009	*0.978*	*-0.366*	*0.352*
Emotional personality - anger	-0.046	0.093	-0.082	*0.696*	*-0.286*	*0.170*
Emotional personality - fear	0.119	0.109	0.183	*0.309*	*-0.143*	*0.402*
Emotional personality - sadness	-0.197	0.093	-0.415	***0.064***	*-0.406*	*-0.002*
Adjusted R2						0.147
BIC						287.181
Extrinsic emotional capital						
Constant	6.369	1.810		0.001	2.739	9.998
Current PND (no = ref)	1.590	0.799	0.252	**0.052**	-0.012	3.193
Extrinsic emotional capital	-0.291	0.128	-0.288	**0.027**	-0.547	0.034
Adjusted R2						0.136
BIC						267.705
Individual sources of emotional support						
Constant	4.974	1.900		*.010*[a]	*.930*[a]	*8.264*[a]
Current PND (no = ref)	1.401	0.769	0.222	*.107*[a]	*-.297*[a]	*2.994*[a]
Emotional support from the father	1.260	0.577	0.276	***.012***[a]	*.325*[a,b]	*2.345*[a]
Emotional support from family	-0.983	0.428	-0.287	***.094***[a]	*-2.054*[a]	*.110*[a]
Emotional support from father's family	-0.026	0.403	-0.008	*.945*[a]	*-.922*[a]	*1.127*[a]
Emotional support from friends	-0.865	0.463	-0.244	*.125*[a]	*-2.128*[a]	*.181*[a]
Emotional support from GP	-0.167	0.439	-0.050	*.632*[a]	*-.830*[a]	*.593*[a]
Emotional support from health workers	-0.544	0.445	-0.163	*.193*[a]	*-1.291*[a]	*.499*[a]
Adjusted R2						0.266
BIC						273.160

Table 4.11 Results on linear regression models assessing the hypothesis that emotional investment (measured by strength of *bonding* – lower score = higher strength) will conform to the predictions of parental investment theory and be stronger when maternal emotional capital is greater. Significance and 95% CIs in *italics* indicate results of bias corrected and accelerated (BCa) bootstrapping based on 1000 samples unless otherwise noted to counter heteroscedasticity: a=999 samples; b=Some results could not be computed from jackknife samples, so this confidence interval is computed by the percentile method rather than the BCa method.

Variable	Unstandardised coefficient		Standardised coefficient	*p*	95% CI for *b*	
	b	**SE**	***β***		**Lower**	**Upper**
Intrinsic and extrinsic emotional capital						
Constant	7.281	2.578		*0.007*	*2.231*	*11.453*
Current PND (no = ref)	1.431	0.865	0.227	*0.129*	*-0.494*	*3.160*
Intrinsic emotional capital	-0.005	0.011	-0.075	*0.558*	*-0.024*	*0.012*
Extrinsic emotional capital	-0.262	0.141	-0.259	***0.076***	*-0.569*	*0.168*
Adjusted R2						0.123
BIC						271.462
Overall emotional capital						
Constant	6.007	2.523		*0.017*	*1.521*	*9.672*
Current PND (no = ref)	1.347	0.881	0.214	*0.224*	*-0.991*	*3.678*
Overall emotional capital	-0.014	0.009	-0.205	*0.106*	*-0.030*	*0.006*
Adjusted R2						0.089
BIC						270.672

Table 4.11 (continued) Results on linear regression models assessing the hypothesis that emotional investment (measured by strength of *bonding* – lower score = higher strength) will conform to the predictions of parental investment theory and be stronger when maternal emotional capital is greater. Significance and 95% CIs in *italics* indicate results of bias corrected and accelerated (BCa) bootstrapping based on 1000 samples unless otherwise noted to counter heteroscedasticity.

No relationship was found between *time to bond* and *extrinsic emotional support* as a result of the counteracting influences of *emotional support* from the father of the infant's family and the mother's friends (Table 4.12). As hypothesised, women receiving higher levels of *emotional support* from their friends showed a general trend to form a faster bond with their infants (BCa p = 0.155), yet higher levels of *emotional support* from the father's family increased *time to bond* (BCa p = 0.005) (Table 4.12).

Measures composing *intrinsic emotional capital* were found to be a better predictor of the number of months it took mothers to feel strongly bonded than *individual sources of emotional support*, accounting for 13% more variance, and when *intrinsic* and *extrinsic emotional capital* were both controlled for only *intrinsic emotional capital* remained a significant predictor at a level approaching significance (Table 4.12).

Variable	Unstandardised coefficients		Standardised coefficients	*p*	95% CI for *b*	
	b	SE	*β*		Lower	Upper
Intrinsic emotional capital						
Constant	3.375	1.170		*0.006*	*1.390*	*5.670*
PND ever (no = ref)	-0.063	0.358	-0.029	*0.880*	*-0.838*	*0.725*
Intrinsic emotional capital	-0.007	0.005	-0.258	***0.086***	*-0.015*	*0.000*
Adjusted R2						0.017
BIC						145.425
Individual intrinsic emotional capital measures						
Constant	-0.256	1.719		*0.881*	*-3.900*	*3.280*
PND ever (no = ref)	-0.368	0.317	-0.172	*0.339*	*-1.163*	*0.300*
Emotional wellbeing	0.318	0.080	0.792	***0.003***	*0.136*	*0.459*
Emotional intelligence	-0.004	0.011	-0.097	*0.699*	*-0.026*	*0.014*
Emotional personality - play	0.134	0.051	0.409	***0.009***	*0.037*	*0.210*
Emotional personality - seek	0.011	0.043	0.041	*0.823*	*-0.088*	*0.110*
Emotional personality - care	-0.042	0.055	-0.150	*0.471*	*-0.154*	*0.090*
Emotional personality - anger	-0.027	0.034	-0.123	*0.497*	*-0.111*	*0.071*
Emotional personality - fear	0.047	0.041	0.198	*0.195*	*-0.024*	*0.133*
Emotional personality - sadness	-0.068	0.040	-0.358	***0.068***	*-0.146*	*0.008*
Adjusted R2						0.301
BIC						148.219
Extrinsic emotional capital						
Constant	1.412	0.783		*0.096*	*0.018*	*2.885*
PND ever (no = ref)	0.225	0.330	0.106	*0.542*	*-0.535*	*1.136*
Extrinsic emotional capital	0.013	0.054	0.037	*0.796*	*-0.113*	*0.134*
Adjusted R2						-0.034
BIC						147.830
Individual sources of emotional support						
Constant	0.945	0.951		*0.390*	*-1.323*	*5.300*
PND ever (no = ref)	0.289	0.304	0.135	*0.405*	*-0.395*	*0.960*
Emotional support from the father	0.054	0.312	0.026	*0.850*	*-0.593*	*0.523*
Emotional support from family	0.095	0.206	0.074	*0.649*	*-0.251*	*0.352*
Emotional support from father's family	0.739	0.200	0.549	***0.005***	*0.390*	*1.108*
Emotional support from friends	-0.409	0.230	-0.303	*0.155*	*-1.008*	*0.148*
Emotional support from GP	-0.221	0.227	-0.185	*0.513*	*-0.851*	*0.495*
Emotional support from health workers	0.105	0.247	0.084	*0.754*	*-0.527*	*0.620*
Adjusted R2						0.176
BIC						150.744

Table 4.12 Results on linear regression models assessing the hypothesis that emotional investment (measured by time taken to strongly bond) will conform to the predictions of parental investment theory and be shorter when maternal emotional capital is greater. Significance and 95% CIs in *italics* indicate results of bias corrected and accelerated (BCa) bootstrapping based on 1000 samples unless otherwise noted to counter heteroscedasticity.

Variable	Unstandardised coefficients		Standardised coefficients	*p*	95% CI for *b*	
	b	SE	*β*		Lower	Upper
Intrinsic and extrinsic emotional capital						
Constant	3.068	1.256		***0.025***	*0.649*	*5.967*
PND ever (no = ref)	-0.042	0.361	-0.020	*0.911*	*-0.801*	*0.690*
Intrinsic emotional capital	-0.008	0.005	-0.292	***0.067***	*-0.018*	*-0.001*
Extrinsic emotional capital	0.039	0.056	0.111	*0.509*	*-0.073*	*0.154*
Adjusted R2						0.006
BIC						148.741
Overall emotional capital						
Constant	3.350	1.204		*0.006*	*1.209*	*5.835*
PND ever (no = ref)	-0.055	0.359	-0.026	*0.889*	*-0.850*	*0.733*
Overall emotional capital	-0.007	0.004	-0.248	***0.087***	*-0.015*	*0.000*
Adjusted R2						0.013
BIC						141.800

Table 4.12 (continued) Results on linear regression models assessing the hypothesis that emotional investment (measured by time taken to strongly bond) will conform to the predictions of parental investment theory and be shorter when maternal emotional capital is greater. Significance and 95% CIs in *italics* indicate results of bias corrected and accelerated (BCa) bootstrapping based on 1000 samples unless otherwise noted to counter heteroscedasticity.

Biv) Emotional investment will be better predicted by measures of emotional capital than measures of practical support and other measures of maternal resources

Models containing measures of *emotional capital* all accounted to more variance in the strength of *bonding* than models containing other resources when comparing adjusted R^2 scores (Table 4.13). With the exception of the model containing *individual sources of practical support*, which ranked third, the pattern was the same when accounting for variance in *time to bond* (Table 4.13).

At small sample sizes both the BIC and AICc penalise complex models, and this is generally the case with the exception of the model containing *individual sources of emotional support* predicting *time to bond* which lost the least information according to the AICc (Table 4.13). Both information criterions were in agreement regarding models predicting *bonding* (Table 4.13); ranking 1st) *extrinsic emotional capital*, 2nd) *overall emotional capital*, and 3rd) *intrinsic emotional capital*. For models predicting *time to bond*, the BIC ranked 1st) *intrinsic emotional capital*, 2nd) *overall emotional capital*, and 3rd) *extrinsic emotional capital*, while the AICc ranked 1st) *individual* *sources of emotional support*, 2nd) *intrinsic emotional capital*, and 3rd) *overall emotional capital* (Table 4.13).

Model	Bonding			Time to bond		
	Adjusted R^2 (rank)	BIC (rank)	AICc (rank)	Adjusted R^2 (rank)	BIC (rank)	AICc (rank)
Intrinsic emotional capital	0.086 (5)	**169.369 (3)**	**164.812 (3)**	0.001 (4)	**115.590 (1)**	**109.721 (2)**
Individual measures of intrinsic emotional capital	**0.201 (2)**	180.645 (7)	176.754 (7)	**0.194 (2)**	124.414 (8)	114.100 (8)
Extrinsic emotional capital	**0.107 (3)**	**168.579 (1)**	**164.022 (1)**	-0.038 (6)	**117.193 (3)**	111.323 (4)
Individual sources of emotional support	**0.208 (1)**	176.089 (6)	170.446 (6)	**0.196 (1)**	119.364 (6)	**109.350 (1)**
Overall emotional capital	0.094 (4)	**169.056 (2)**	**164.499 (2)**	-0.006 (5)	**115.858 (2)**	**109.988 (3)**
Overall practical support	0.031 (7)	171.294 (5)	166.737 (5)	-0.046 (8)	117.512 (5)	111.642 (7)
Individual sources of practical support	0.029 (8)	182.815 (8)	177.172 (8)	**0.156 (3)**	121.412 (7)	111.398 (5)
Maternal resources	0.036 (6)	171.104 (4)	166.547 (4)	-0.044 (7)	117.421 (4)	111.551 (6)

Table 4.13 Scores for various measures enabling the comparison of models predicting maternal emotional investment. Abbreviations: Bayesian information criterion (BIC), bias corrected Akaike information criterion (AICc).

Bv) *Emotional investment will predict PND*

As strength of *bonding* at approximately 1 month postnatally decreased, postnatal depressive symptoms at this time increased at a level approaching significance (p = 0.093) and the odds of experiencing PND (*PND ever*) within approximately the first 6 months postnatally increased (OR 1.475, p = 0.008) (Table 4.14).

As the confidence women had in their emotional investments (*bonding confidence*) at approximately 1 month postnatally increased, postnatal depressive symptoms at this time decreased (p = 0.011) and the odds of experiencing PND (*PND ever*) within approximately the first 6 months postnatally decreased (OR 0.207, p = 0.007) (Table 4.14).

When assessed together, only *bonding confidence* predicted postnatal depressive symptoms at approximately 1 month (p = 0.044) and both *bonding* at a level approaching significance (OR 1.341, p = 0.075) and *bonding confidence* (OR 0.306, p = 0.050) predicted the experience of PND (*PND ever*) within approximately the first 6 months postnatally (Table 4.14).

Variable	Postnatal Depressive Symptoms at 1 month			Postnatal Depression by 6 months		
	Standardised coefficient *β*	*p*	Adjusted R^2	Odds ratio	*p*	Pseudo R^2's C&S/N
Bonding only						
Constant		0.000	0.116	0.041	0.000	0.269/0.393
Antenatal depression	0.330	**0.011**		12.991	**0.002**	
Bonding	0.215	**0.093**		1.475	**0.008**	
Bonding confidence only						
Constant		0.000	0.174	127.605	0.041	0.286/0.418
Antenatal depression	0.318	**0.011**		13.235	**0.002**	
Bonding confidence	-0.319	**0.011**		0.207	**0.007**	
Both						
Constant		0.002	0.166	8.679	0.430	0.324/0.474
Antenatal depression	0.323	**0.011**		18.004	**0.002**	
Bonding	0.094	0.489		1.341	**0.075**	
Bonding confidence	-0.279	**0.044**		0.306	**0.050**	

Table 4.14 Results of linear and binary logistic regression models assessing whether emotional investment predicts PND. Abbreviations: Cox & Snell (C&S), Nagelkerke (N).

Bvi) *Emotional capital will predict emotional investment better than it predicts PND, while other maternal resources will predict PND better than they predict emotional investment*

At approximately 1 month postnatally, measures of *intrinsic* and *extrinsic emotional capital* accounted for more variance in strength of *bonding* than they accounted for in *depressive symptom severity*, while *maternal resources* accounted for more variance in *depressive symptom severity* than *bonding* (Table 4.15).

At approximately 6 months postnatally, measures of *intrinsic* and *extrinsic emotional capital* accounted for a similar amount of variance in *time to bond* as experience of *PND ever*, while *maternal resources* accounted for more variance in the experience of *PND ever* than *time to bond* (Table 4.15).

Ri) The perception of risk surrounding mothering will predict bonding, confidence in bonding, and time taken to bond

The *perception of risk* during pregnancy negatively predicted *bonding* strength at a level approaching significance (BCa $p = 0.052$) and *bonding confidence* (BCa $p = 0.005$) at approximately 1 month postnatally, and *bonding confidence* at approximately 6 months postnatally (BCa $p = 0.017$) (Table 4.16). The *perception of risk* at approximately 6 months postnatally negatively predicted *bonding confidence* at a level approaching significance (BCa p = 0.072) (Table 4.16). The *perception of risk* during pregnancy positively predicted *time to bond* at a level approaching significance (BCa p = 0.078) (Table 4.16).

Variable	Bonding			Postnatal Depressive Symptoms		
	Standardized Coefficients *β*	***p***	**Adjusted R^2**	**Standardized Coefficients *β***	***p***	**Adjusted R^2**
Individual intrinsic emotional capital measures						
Constant		*0.051*	**0.145**		*0.381*	0.139
Antenatal depression	-0.198	*0.218*		0.129	*0.525*	
Emotional wellbeing	0.112	*0.629*		0.194	*0.413*	
Emotional intelligence	-0.504	*0.116*		-0.032	*0.938*	
Emotional personality - play	0.122	*0.470*		0.066	*0.695*	
Emotional personality - seek	0.101	*0.629*		-0.003	*0.986*	
Emotional personality - care	-0.062	*0.765*		-0.281	*0.255*	
Emotional personality - anger	-0.121	*0.555*		-0.113	*0.637*	
Emotional personality - fear	0.240	*0.246*		0.040	*0.842*	
Emotional personality - sadness	-0.311	*0.128*		0.176	*0.382*	
Individual sources of emotional support						
Constant		*0.002*	**0.274**		*0.025*	0.104
Antenatal depression	-0.219	*0.077*		0.220	*0.212*	
Emotional support from the father	0.291	*0.026*		-0.009	*0.934*	
Emotional support from family	-0.310	*0.062*		-0.172	*0.303*	
Emotional support from father's family	-0.034	*0.741*		-0.090	*0.579*	
Emotional support from friends	-0.380	*0.013*		-0.229	*0.241*	
Emotional support from GP	-0.026	*0.845*		0.198	*0.158*	
Emotional support from health workers	-0.127	*0.349*		0.066	*0.654*	
Maternal resources						
Constant		0.035	-0.038		0.042	**0.099**
Antenatal depression	0.004	0.982		0.351	0.025	
Maternal resources	-0.165	0.375		-0.251	0.152	

Table 4.15 Results of linear and binary logistic regression models and their resulting R^2's for comparing their relative ability to predict maternal emotional investment vs. PND. Significance values in *italics* indicate results of bias corrected and accelerated bootstrapping based on 1000 samples unless otherwise noted to counter heteroscedasticity.

Variable	Unstandardised coefficient		Standardised coefficient	p	95% CI		Adjusted R^2
	b	SE	β		Lower	Upper	
Risk perception during pregnancy and bonding at approximately 1 month postnatally							
Constant	0.339	1.481		0.787	-1.821	2.703	0.027
Perception of risk	0.229	0.143	0.211	**0.052**	-0.023	0.459	
Risk perception during pregnancy and bonding at approximately 6 months postnatally							
Constant	1.490	1.227		0.196	-0.845	4.182	0.011
Perception of risk	0.140	0.114	0.178	0.203	-0.062	0.332	
Risk perception and bonding at approximately 6 months postnatally							
Constant	1.674	0.894		0.022	0.340	3.083	0.026
Perception of risk	0.185	0.122	0.217	0.117	-0.045	0.446	
Risk perception during pregnancy and bonding confidence at approximately 1 month postnatally							
Constant	5.737	0.383		0.001	4.910	6.604	0.165
Perception of risk	-0.129	0.037	-0.424	**0.005**	-0.210	-0.050	
Risk perception during pregnancy and bonding confidence at approximately 6 months postnatally							
Constant	5.922	0.390		0.001	5.172	6.624	0.179
Perception of risk	-0.122	0.036	-0.443	**0.017**	-0.202	-0.034	
Risk perception and bonding confidence at approximately 6 months postnatally							
Constant	5.076	0.313		0.001	4.681	5.577	0.023
Perception of risk	-0.062	0.043	-0.208	**0.072**	-0.138	-0.014	
Risk perception during pregnancy and time to bond							
Constant	0.386	0.637		0.562	-0.933	1.727	0.065
Perception of risk	0.122	0.060	0.292	**0.078**	-0.002	0.254	

Table 4.16 Results of linear regression models assessing the hypothesis that risk perception will negatively predict maternal emotional investment. Significance and 95% CIs reflect the results of bias corrected and accelerated bootstrapping based on 1000 samples to counter heteroscedasticity.

ECi) Factors affecting a mother's resources will predict shifts in intrinsic emotional capital

While *extrinsic emotional capital* during pregnancy did not predict *shifts* in any measure of *intrinsic emotional capital*, *extrinsic emotional capital* at approximately 6 months postnatally negatively predicted *shifts* in overall *intrinsic emotional capital* approaching significance (p = 0.054) and *emotional intelligence* (p = 0.021) (Table 4.17); low support predicted falls in capital.

Overall practical support during pregnancy negatively predicted *shifts* in the *emotional personality – play* subscale approaching significance (p = 0.070), and *overall practical support* at approximately 6 months negatively predicted *shifts* in *emotional intelligence* (p = 0.035) (Table 4.17); low support predicted falls in capital.

Time spent alone at approximately 6 months postnatal positively predicted *shifts* in the *emotional personality – play* (p = 0.047) and *care* (BCa p = 0.001) subscales, and negatively predicted *shifts*

Variable	Overall emotional support during pregnancy			Overall emotional support at approximately 6 months postnatal			Overall practical support during pregnancy			Overall practical support at approximately 6 months postnatal		
	b	***p***	**Adjusted R^2**	***b***	***p***	**Adjusted R^2**	***b***	***p***	**Adjusted R^2**	***b***	***p***	**Adjusted R^2**
Shift in extrinsic emotional capital	-1.032	0.416	0.027	-2.346	**0.054**	0.098	-1.657	0.150	0.061	-1.581	0.189	0.052
Shift in emotional intelligence	-0.735	0.367	-0.024	-1.779	**0.021**	0.081	-1.123	0.130	0.012	-1.599	**0.035**	0.062
Shift in emotional wellbeing	-0.092	0.454	-0.022	-0.030	0.806	-0.034	-0.001	0.996	-0.036	-0.137	0.256	-0.005
Shift in emotional personality - play	-0.115	0.297	0.007	-0.052	*0.651*	-0.014	-0.181	**0.070**	0.058	-0.050	0.632	-0.014
Shift in emotional personality - seek	0.064	*0.801*	0.024	0.059	*0.746*	0.023	0.093	*0.606*	0.029	0.170	0.270	0.048
Shift in emotional personality - care	-0.075	0.605	-0.031	-0.126	0.370	-0.018	-0.140	0.290	-0.010	-0.142	0.301	-0.012
Shift in emotional personality - anger	0.146	0.348	0.011	0.147	*0.391*	0.012	0.123	0.386	0.008	0.016	0.917	-0.011
Shift in emotional personality - fear	0.122	0.375	0.117	0.036	0.788	0.101	0.150	0.233	0.130	-0.073	0.577	0.106
Shift in emotional personality - sadness	0.027	0.889	0.186	0.310	**0.099**	0.237	0.044	0.808	0.187	0.201	0.279	0.208

Variable	Time spent alone on weekdays			SES				
				Medium vs high (ref)		Low vs high (ref)		
	b	***p***	**Adjusted R^2**	***b***	***p***	***b***	***p***	**Adjusted R^2**
Shift in extrinsic emotional capital	4.830	0.108	0.072	1.790	0.857	-6.515	0.551	-0.002
Shift in emotional intelligence	2.337	0.232	-0.008	3.981	0.533	-4.061	0.563	-0.046
Shift in emotional wellbeing	-0.183	*0.486*	-0.027	0.514	0.606	0.217	0.843	-0.053
Shift in emotional personality - play	0.518	**0.047**	0.074	0.350	0.684	0.921	0.333	-0.019
Shift in emotional personality - seek	0.315	0.420	0.035	-1.743	*0.141*[a]	-2.362	***0.087***[a]	0.093
Shift in emotional personality - care	0.963	***0.002***	0.153	1.212	0.270	-1.576	0.194	0.025
Shift in emotional personality - anger	-0.621	**0.091**	0.058	0.286	0.799	-3.277	**0.011**	0.133
Shift in emotional personality - fear	-0.077	0.817	0.101	1.495	0.156	1.674	0.150	0.151
Shift in emotional personality - sadness	0.037	0.937	0.196	-0.033	0.983	1.011	0.551	0.174

Table 4.17 Results of linear regression models predicting shifts in intrinsic emotional capital based on various measures of maternal resources. Significance values in *italics* indicate results of bias corrected and accelerated bootstrapping based on 1000 samples unless otherwise noted to counter heteroscedasticity: a = based on 997 samples.

Variable	Unstandardised coefficient		Standardised coefficient *β*	***p***	95% CI for *b*	
	b	**SE**			**Lower**	**Upper**
Shift in intrinsic emotional capital						
Constant	7.412	5.569		0.192	-3.198	18.742
PND within approximately 6 months postnatal (no = ref)	18.102	8.031	0.389	**0.031**	1.762	34.442
Bonding at approximately 1 month postnatal	-2.842	1.429	-0.343	**0.045**	-5.750	0.065
Adjusted R^2						0.115
Shift in emotional intelligence						
Constant	7.329	3.518		*0.115*	*-0.151*	*15.200*
PND within approximately 6 months postnatal (no = ref)	7.558	5.074	0.261	***0.054***	*-0.197*	*14.764*
Bonding at approximately 1 month postnatal	-1.992	0.903	-0.387	***0.020***	*-3.553*	*-0.362*
Adjusted R^2						0.087
Shift in emotional wellbeing						
Constant	0.012	0.608		0.984	-1.225	1.249
PND within approximately 6 months postnatal (no = ref)	-0.681	0.877	-0.145	0.443	-2.465	1.103
Bonding at approximately 1 month postnatal	-0.005	0.156	-0.006	0.974	-0.323	0.312
Adjusted R^2						-0.037
Shift in emotional personality – play						
Constant	0.394	0.532		*0.522*	*-0.724*	*1.664*
PND within approximately 6 months postnatal (no = ref)	0.983	0.767	0.234	*0.160*	*-0.267*	*2.287*
Bonding at approximately 1 month postnatal	-0.168	0.137	-0.225	*0.202*	*-0.439*	*0.109*
Adjusted R^2						0.008
Shift in emotional personality – seek						
Constant	0.537	0.687		*0.471*	*-0.610*	*1.588*
PND within approximately 6 months postnatal (no = ref)	1.348	0.990	0.248	*0.352*	*-1.141*	*3.373*
Bonding at approximately 1 month postnatal	-0.229	0.176	-0.237	*0.336*	*-0.699*	*0.299*
Adjusted R^2						0.015
Shift in emotional personality – care						
Constant	0.435	0.691		0.533	-0.970	1.841
PND within approximately 6 months postnatal (no = ref)	-0.161	0.997	-0.030	0.873	-2.188	1.867
Bonding at approximately 1 month postnatal	-0.111	0.177	-0.118	0.534	-0.472	0.249
Adjusted R^2						-0.042
Shift in emotional personality – anger						
Constant	-0.938	0.740		0.213	-2.443	0.566
PND within approximately 6 months postnatal (no = ref)	-1.490	1.067	-0.255	0.172	-3.660	0.680
Bonding at approximately 1 month postnatal	0.196	0.190	0.189	0.309	-0.190	0.582
Adjusted R^2						0.007

Table 4.18 Results of linear regression models assessing the shift in measures of intrinsic emotional capital based on strength of *bonding* after controlling for PND. Significance values and 95% CIs in *italics* indicate results of bias corrected and accelerated bootstrapping based on 1000 samples to counter heteroscedasticity.

Variable	Unstandardised coefficient		Standardised coefficient	*p*	95% CI for *b*	
	b	**SE**	***β***		**Lower**	**Upper**
Shift in emotional personality – fear						
Constant	0.138	0.653		*0.829*	*-1.357*	*1.353*
PND within approximately 6 months postnatal (no = ref)	-2.943	0.942	-0.517	***0.012***	*-4.935*	*-1.112*
Bonding at approximately 1 month postnatal	0.126	0.168	0.125	*0.597*	*-0.249*	*0.664*
Adjusted R^2						0.186
Shift in emotional personality – sadness						
Constant	0.072	0.911		0.937	-1.781	1.926
PND within approximately 6 months postnatal (no = ref)	-3.261	1.314	-0.426	**0.018**	-5.935	-0.588
Bonding at approximately 1 month postnatal	0.025	0.234	0.018	0.917	-0.451	0.500
Adjusted R^2						0.126

Table 4.18 (continued) Results of linear regression models assessing the shift in measures of intrinsic emotional capital based on strength of *bonding* after controlling for PND. Significance values and 95% CIs in *italics* indicate results of bias corrected and accelerated bootstrapping based on 1000 samples to counter heteroscedasticity.

in *anger* approaching significance ($p = 0.091$) (Table 4.17); as time spent alone increased, *intrinsic emotional capital*, *play*, and *care* fell and *anger* increased.

Being of *low* compared to *high SES* negatively predicted *shifts* in the subscales *seek* approaching significance (BCa $p = 0.087$) and *anger* ($p = 0.011$) (Table 4.17); being of higher SES predicted greater falls in the *seek* and *anger* subscales.

ECii) Emotional investment in an offspring will result in a fall in maternal intrinsic emotional capital

Bonding strength predicted *shifts* in *intrinsic emotional capital* ($p = 0.045$) and *emotional intelligence* (BCa $p = 0.020$) (Table 4.18); as strength of bonding increased level of capital decreased.

ECiii) The relationship between emotional investment and shifts in intrinsic emotional capital will be moderated by extrinsic emotional capital

Extrinsic emotional capital received at approximately 6 months postnatally (interaction $p = 0.045$) moderated the relationship between *bonding* and *shifts in intrinsic emotional capital*, such that women who received high levels of support showed little or no decline in their capital irrespective of their *bonding* strength, while in women with average and low support capital decreased between pregnancy and approximately 6 months postnatally as the strength of their bond with their infant increased, with women of low support experiencing the sharpest declines (Figure 4.7).

Extrinsic emotional capital received at approximately 6 months postnatally (interaction $p = 0.036$) moderated the relationship between *bonding* and *shifts in emotional intelligence*, such that women who received high levels of support showed little or no decline in their *emotional intelligence* irrespective of their *bonding* strength, while in women with average and low support *emotional intelligence* decreased between pregnancy and approximately 6 months postnatally as the strength of their bond with their infant increased, with women of low support experiencing the sharpest declines (Figure 4.8).

Extrinsic emotional capital received during pregnancy moderated the relationship between *bonding* and *shifts in emotional wellbeing* (interaction $p = 0.008$), such that at average levels of support there was a slight decrease in *emotional wellbeing* irrespective of *bonding*, while at high levels of support *emotional wellbeing* showed a slight increase when *bonding* was strong with *emotional wellbeing* then declining as *bonding* decreased, and at low levels of support *emotional wellbeing* showed a slight decline when *bonding* was strong then increased as *bonding* decreased (Figure 4.9).

Extrinsic emotional capital received during pregnancy moderated the relationship between *bonding* and shifts in the propensity to display play behaviour measured by the *emotional personality – play* subscale at a level approaching significance (interaction $p = 0.060$), such that women with high and average support experienced no shifts in their play scores irrespective of *bonding* strength, while women of low support experienced declines in their play scores as *bonding* strength increased (Figure 4.10). *Extrinsic emotional capital* received at approximately 6 months postnatally also moderated the relationship between *bonding* and *shifts in play* scores (interaction $p = 0.013$), such that women with high support experience no shifts in their play scores irrespective of *bonding* strength, while women of average and low support experienced declines in their play scores as their

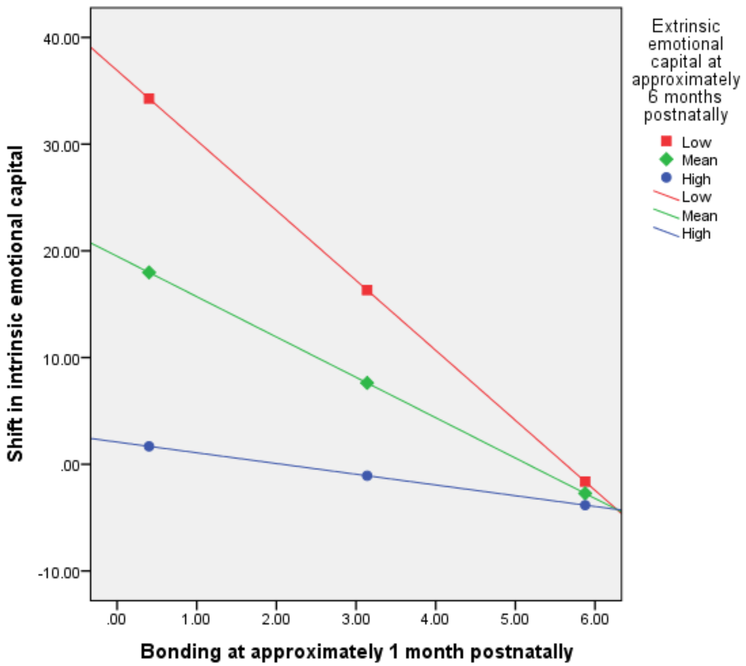

Figure 4.7 Simple slopes equations of the regression of strength of *bonding* (higher score = lower bonding) at approximately 1 month postnatally on the *shift in intrinsic emotional capital* (positive score = fall in capital) at three levels of *extrinsic emotional capital* at approximately 6 months postnatally. Values for *extrinsic emotional capital* are the mean and +/- one standard deviation of the mean.

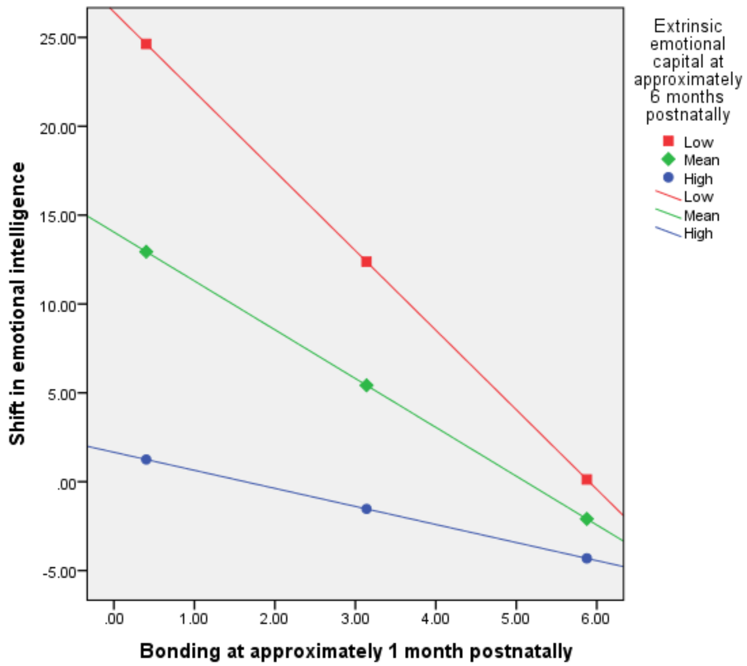

Figure 4.8 Simple slopes equations of the regression of strength of *bonding* (higher score = lower bonding) at approximately 1 month postnatally on the *shift in emotional intelligence* (positive score = fall in capital) at three levels of *extrinsic emotional capital* at approximately 6 months postnatally. Values for *extrinsic emotional capital* are the mean and +/- one standard deviation of the mean.

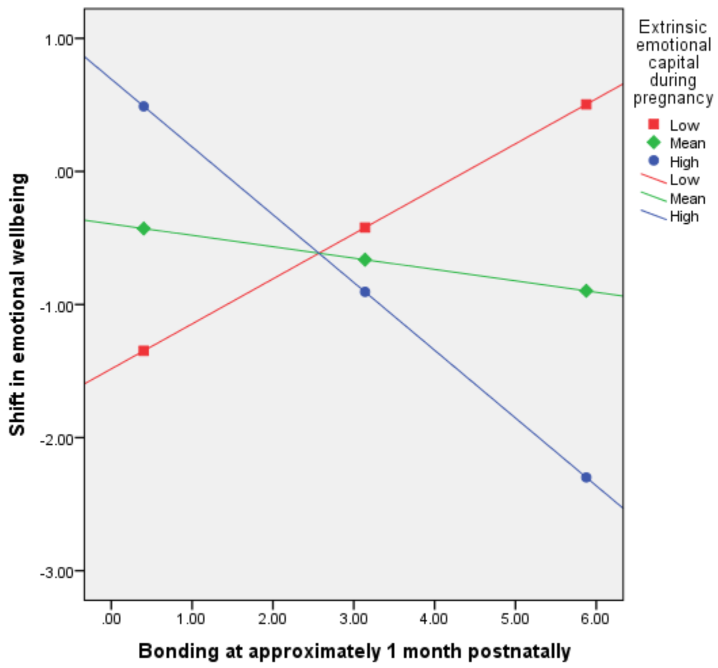

Figure 4.9 Simple slopes equations of the regression of strength of *bonding* (higher score = lower bonding) at approximately 1 month postnatally on the *shift in emotional wellbeing* (positive score = rise in capital) at three levels of *extrinsic emotional capital* during pregnancy. Values for *extrinsic emotional capital* are the mean and +/- one standard deviation of the mean.

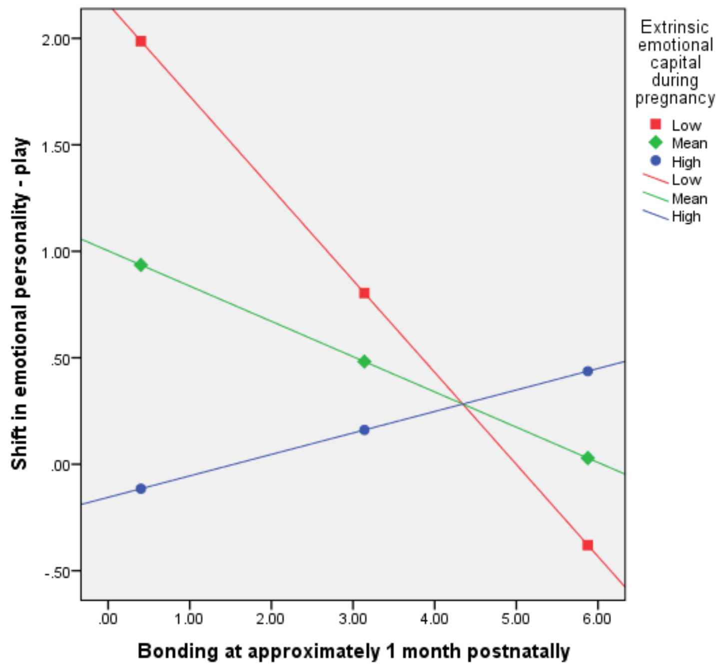

Figure 4.10 Simple slopes equations of the regression of strength of *bonding* (higher score = lower bonding) at approximately 1 month postnatally on the *shift in emotional personality - play* (positive score = fall in capital) at three levels of *extrinsic emotional capital* during pregnancy. Values for *extrinsic emotional capital* are the mean and +/- one standard deviation of the mean.

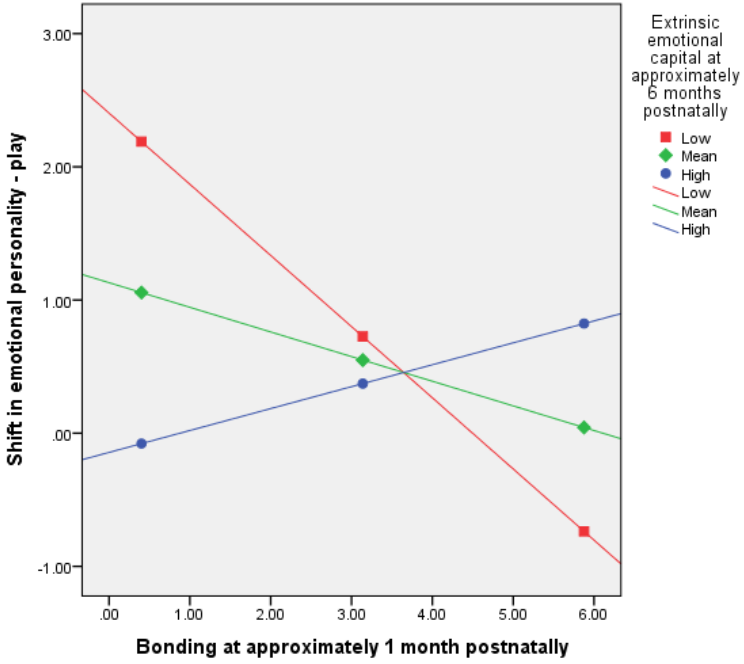

Figure 4.11 Simple slopes equations of the regression of strength of *bonding* (higher score = lower bonding) at approximately 1 month postnatally on the *shift in emotional personality - play* (positive score = fall in capital) at three levels of *extrinsic emotional capital* at approximately 6 months postnatally. Values for *extrinsic emotional capital* are the mean and +/- one standard deviation of the mean.

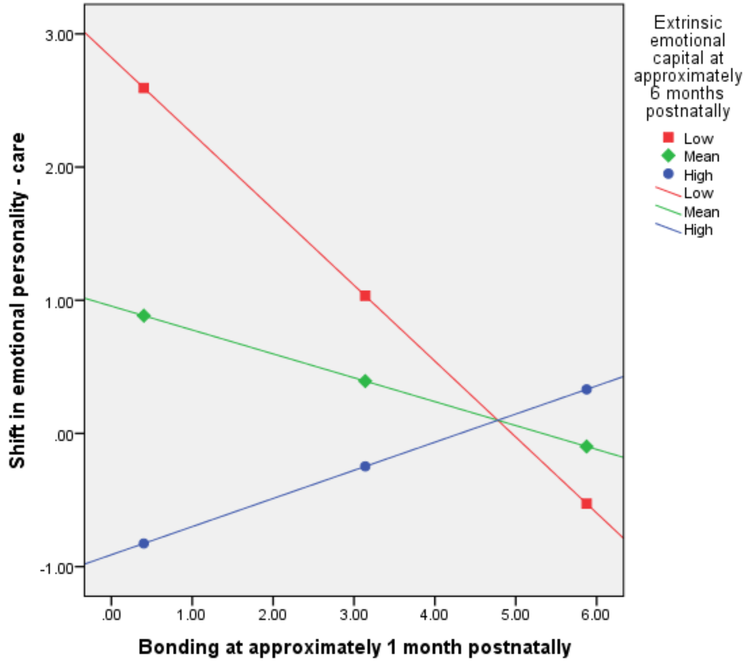

Figure 4.12 Simple slopes equations of the regression of strength of *bonding* (higher score = lower bonding) at approximately 1 month postnatally on the *shift in emotional personality - care* (positive score = fall in capital) at three levels of *extrinsic emotional capital* at approximately 6 months postnatally. Values for *extrinsic emotional capital* are the mean and +/- one standard deviation of the mean.

bonding strength increased, with women of low support experiencing the sharpest declines (Figure 4.11).

Extrinsic emotional capital received at approximately 6 months postnatally moderated the relationship between *bonding* and shifts in the propensity to display caring behaviour measured by the *emotional personality – care* subscale (interaction p = 0.030), such that women with high and average support experienced no shifts in their care scores irrespective of *bonding* strength, while women with low support experienced falls in their care scores as their *bonding* strength increased (Figure 4.12).

Variable	**Unstandardised coefficient *b***	**SE**	***p***	**95% CI for *b***		**R^2**
				Lower	**Upper**	
Outcome – shift in intrinsic emotional capital						
Constant	88.099	25.839	0.002	35.399	140.798	0.375
Extrinsic emotional capital (wave 3)	-5.836	1.842	**0.003**	-9.593	-2.079	
Bonding	-15.771	5.893	**0.012**	-27.791	-3.752	
Extrinsic emotional capital (wave 3)*bonding	**0.930**	**0.445**	**0.045**	**0.022**	**1.838**	
PND ever	18.302	7.326	**0.018**	3.359	33.244	
Outcome – shift in emotional intelligence						
Constant	64.925	15.346	0.000	33.626	96.223	0.430
Extrinsic emotional capital (wave 3)	-4.152	1.094	**0.001**	-6.383	-1.920	
Bonding	-10.220	3.500	**0.006**	-17.358	-3.081	
Extrinsic emotional capital (wave 3)*bonding	**0.580**	**0.264**	**0.036**	**0.041**	**1.119**	
PND ever	7.274	4.351	0.105	-1.600	16.149	
Outcome – shift in emotional wellbeing						
Constant	-5.349	3.145	0.099	-11.763	1.066	0.226
Extrinsic emotional capital (wave 1)	0.403	0.219	0.075	-0.044	0.850	
Bonding	2.043	0.743	0.010	0.528	3.558	
Extrinsic emotional capital (wave 1)*bonding	**-0.157**	**0.055**	**0.008**	**-0.270**	**-0.044**	
PND ever	-1.421	0.858	0.108	-3.171	0.329	
Outcome – shift in emotional personality – play						
Constant	6.374	2.875	0.034	0.509	12.238	0.192
Extrinsic emotional capital (wave 1)	-0.429	0.200	0.040	-0.838	-0.021	
Bonding	-1.505	0.679	0.034	-2.889	-0.120	
Extrinsic emotional capital (wave 1)*bonding	**0.099**	**0.051**	**0.060**	**-0.004**	**0.202**	
PND ever	1.233	0.784	0.126	-0.367	2.833	
Outcome – shift in emotional personality – play						
Constant	6.180	2.569	0.022	0.940	11.420	0.241
Extrinsic emotional capital (wave 3)	-0.427	0.183	0.026	-0.801	-0.053	
Bonding	-1.695	0.586	0.007	-2.890	-0.500	
Extrinsic emotional capital (wave 3)*bonding	**0.117**	**0.044**	**0.013**	**0.027**	**0.207**	
PND ever	1.252	0.728	0.096	-0.234	2.738	
Outcome – shift in emotional personality – care						
Constant	9.013	3.345	0.011	2.191	15.835	0.199
Extrinsic emotional capital (wave 3)	-0.626	0.238	0.013	-1.112	-0.139	
Bonding	-1.867	0.763	0.020	-3.423	-0.312	
Extrinsic emotional capital (wave 3)*bonding	**0.131**	**0.058**	**0.030**	**0.013**	**0.249**	
PND ever	0.023	0.948	0.981	-1.911	1.957	

Table 4.19 Significant moderation results from testing the hypothesis that extrinsic emotional capital will moderate the relationship between strength of *bonding* and shifts in measures on intrinsic emotional capital. Wave 1 = during pregnancy, wave 3 = approximately 6 months postnatally. Significance and 95% CIs are the result of bias corrected bootstrapping based on 1000 samples.

Full significant results from the moderation analysis can be seen in Table 4.19.

ECiv) *All women will be susceptible to sociocultural pressures surrounding mothering and, thus, maternal shame*

The relationship between *stigma consciousness* and *maternal shame* during pregnancy was not moderated by any measure of *emotional capital* during pregnancy.

The relationship between *stigma consciousness* and *maternal shame* at approximately 1 month postnatally was only moderated by the *emotional personality – fear* subscale during pregnancy at a level approaching significance (interaction $p = 0.075$), such that in women with low and average *fear* scores shame was relatively low and constant irrespective of *stigma consciousness*, while in women with high *fear* scores shame increased as consciousness increased (Figure 4.13).

The relationship between the *perception of social pressures* and *maternal shame* during pregnancy was only moderated by the *emotional personality – anger* subscale (interaction $p = 0.001$) such that while in all women perception positively predicted shame, women of low *anger* scores experienced less shame than high and mean score women at low perception and at high perception they experienced more shame than high and average score women, while conversely women of high *anger* scores experienced more shame than women of average and low scores at low perception and less shame than women of average and low scores at high perception, and women of mean scores fell between the two (Figure 4.14).

The relationship between the *perception of social pressure* and *maternal shame* at approximately 1 month postnatally was only moderated by the *emotional personality – play* subscale at a level approaching significance (interaction $p = 0.051$), such that women of high *play* scores experienced consistent and relatively moderate levels of shame irrespective of perception, while shame increased as perception increased in women of average and low *play* scores (Figure 4.15), and the *emotional personality – anger* subscale showed the same moderating relationship at a level approaching significance (interaction $p = 0.60$) as the *play* subscale (Figure 4.16).

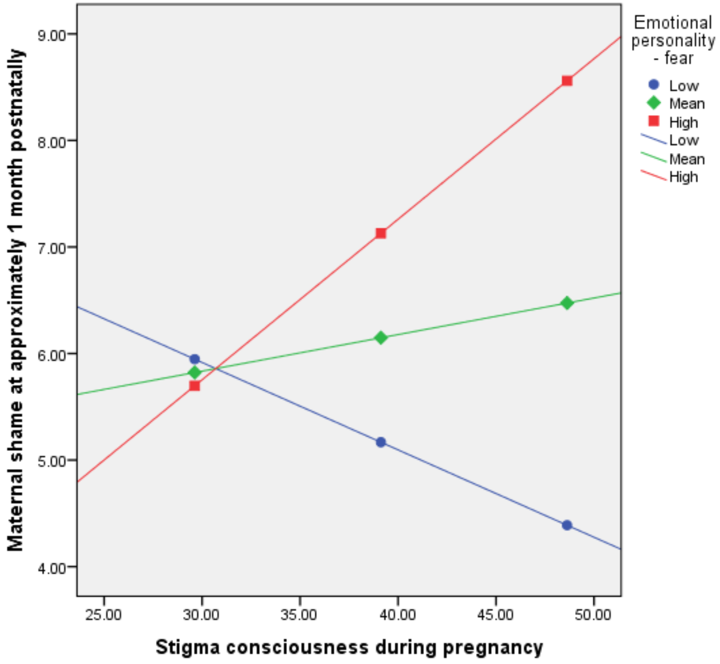

Figure 4.13 Simple slopes equations of the regression of *stigma consciousness* during pregnancy on the experience of *maternal shame* at approximately 1 month postnatally at three levels of *emotional personality - fear* during pregnancy. Values for *emotional personality - fear* are the mean and +/- one standard deviation of the mean.

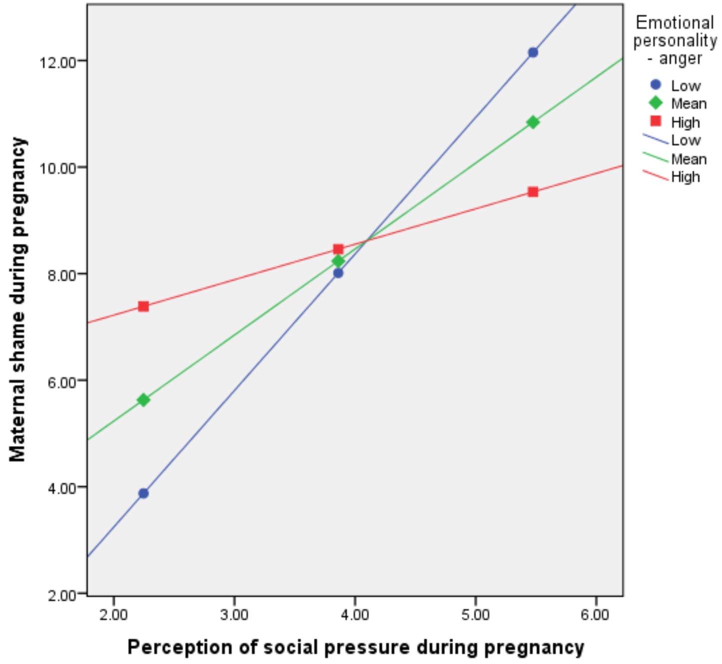

Figure 4.14 Simple slopes equations of the regression of *perception of social pressure* during pregnancy on the experience of *maternal shame* during pregnancy at three levels of *emotional personality - anger* during pregnancy. Values for *emotional personality - anger* are the mean and +/- one standard deviation of the mean.

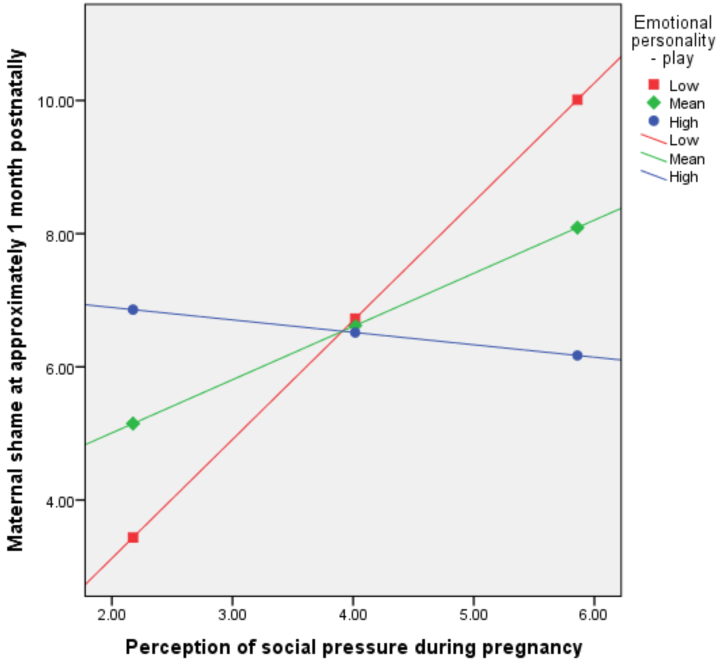

Figure 4.15 Simple slopes equations of the regression of *perception of social pressure* during pregnancy on the experience of *maternal shame* at approximately 1 month postnatally at three levels of *emotional personality - play* during pregnancy. Values for *emotional personality - play* are the mean and +/- one standard deviation of the mean.

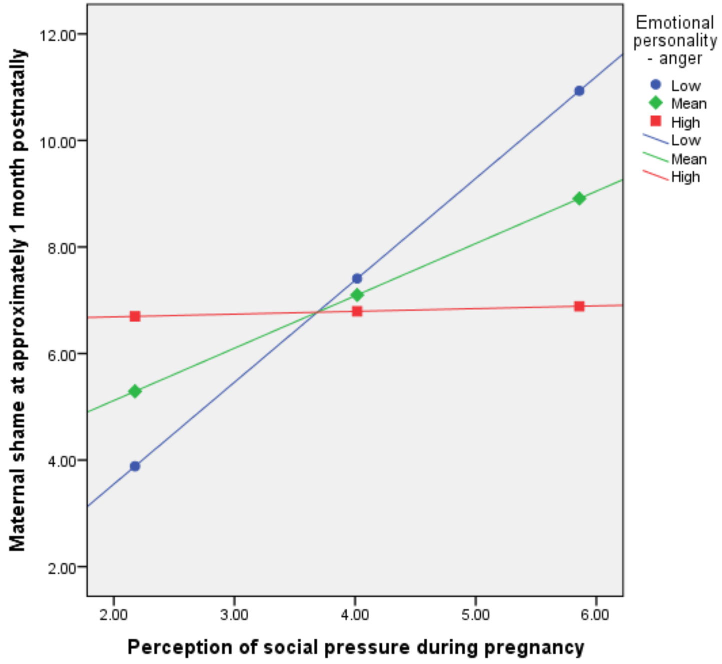

Figure 4.16 Simple slopes equations of the regression of *perception of social pressure* during pregnancy on the experience of *maternal shame* at approximately 1 month postnatally at three levels of *emotional personality - anger* during pregnancy. Values for *emotional personality - anger* are the mean and +/- one standard deviation of the mean.

Variable	Unstandardised coefficient *b*	SE	*p*	95% CI for *b*		R^2
				Lower	Upper	
Outcome – maternal shame wave 2						
Constant	18.897	10.791	0.086	-2.748	40.509	0.152
Emotional personality – fear	-0.876	0.634	0.173	-2.147	0.395	
Stigma consciousness	-0.425	0.277	0.131	-0.979	0.130	
Emotional personality – fear*stigma consciousness	**0.289**	**0.016**	**0.075**	**-0.003**	**0.060**	
Outcome – maternal shame wave 1						
Constant	-12.015	4.930	0.017	-21.802	-2.229	0.208
Emotional personality - anger	0.840	0.246	**0.001**	0.352	1.328	
Perception of social pressure	5.038	1.329	**0.000**	2.399	7.676	
Emotional personality – anger*perception of social pressure	**-0.205**	**0.062**	**0.001**	**-0.329**	**-0.081**	
Outcome – maternal shame at wave 2						
Constant	-30.240	17.997	0.099	-66.338	5.872	0.079
Emotional personality - play	1.576	0.791	**0.052**	-0.011	3.164	
Perception of social pressure	9.403	4.618	0.467	0.141	18.665	
Emotional personality – play*perception of social pressure	**-0.403**	**0.202**	**0.051**	**-0.808**	**0.002**	
Outcome – maternal shame wave 2						
Constant	-9.572	8.228	0.250	-26.074	6.931	0.073
Emotional personality – anger	0.755	0.416	**0.076**	-0.081	1.590	
Perception of social pressure	4.434	2.215	**0.050**	-0.009	8.877	
Emotional personality – anger*perception of social pressure	**-0.205**	**0.106**	**0.060**	**-0.418**	**0.009**	

Table 4.20 Significant moderation results from testing the hypothesis that all women will be susceptible to maternal shame in response to *stigma consciousness* and *perception of social pressure*. Wave 1 = during pregnancy, wave 2 = approximately 1 month postnatally. Significance and 95% CIs are the result of bias corrected bootstrapping based on 1000 samples.

Full significant results from the moderation analysis can be seen in Table 4.20

ECv) *All women will withdraw emotional investment in response to perceived risk*

The relationship between *perception of risk* during pregnancy and strength of *bonding* at approximately 1 month postnatally was not moderated by any measure of *emotional capital*.

The relationship between *perception of risk* during pregnancy and *bonding confidence* at approximately 1 month postnatally was not moderated by any measure of *emotional capital*.

The relationship between *perception of risk* during pregnancy and *time to bond* was only moderated by the *emotional personality – play* subscale at a level approaching significance (interaction p = 0.065), such that women of low *play* scores showed relatively quick *time to bond* irrespective of their *perception of risk*, while women of average and high *play* scores showed quick *time to bond* when risk perception was low with *time to bond* increasing as risk perception increased, with women of high play scores experiencing the sharpest inclines and taking the longest to bond when risk perception was high (Figure 4.17).

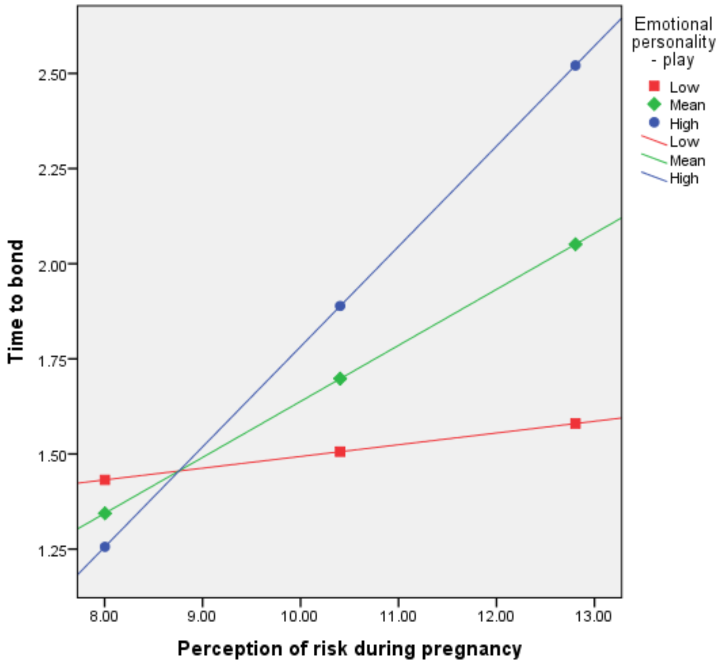

Figure 4.17 Simple slopes equations of the regression of *perception of risk* during pregnancy on the *time to bond* at three levels of *emotional personality - play* during pregnancy. Values for *emotional personality - play* are the mean and +/- one standard deviation of the mean.

Full approaching significant results from the moderation analysis can be seen in Table 4.21.

Variable	Unstandardised coefficient *b*	SE	*p*	95% CI for *b*		R^2
				Lower	Upper	
Outcome – time to bond						
Constant	7.035	4.557	0.130	-2.115	16.226	0.202
Emotional personality - play	-0.331	0.219	0.138	-0.773	0.110	
Perception of risk	-0.637	0.412	0.130	-1.469	0.195	
Emotional personality - play*perception of risk	**0.038**	**0.020**	**0.065**	**-0.002**	**0.078**	

Table 4.12 Significant moderation results from testing the hypothesis that all women will withdraw emotional investment in response to perceived risk. Significance and 95% CIs are the result of bias corrected bootstrapping based on 1000 samples.

Discussion

'Emotional bonding' and the emotional development of offspring was found to be highly important to the women in this sample; 99% of women rated emotional bonding with their infant as 'very to extremely' important to them, and 84% of women rated the emotional development of their infant as more important than their physical or educational development. Such findings bolster the case for emotional investment being a form of investment in embodied capital.

These results are also generally supportive of the idea that the greater a mother's intrinsic emotional capital, the higher her emotional investment in her infant will be, as measured by strength of emotional bonding, and that she will make her emotional investments in a shorter period of time, with a variety of results significant or approaching significance. Parallels may be drawn between this finding and research from the resilience literature. Resilience – as measured by self-esteem, maturity, and relationships between mother and grandmother – positively predict nurturing behaviour and parenting satisfaction in African American adolescent mothers (Hess, Papas, and Black, 2002). A more complex pattern than what was hypothesised appeared when the effects of extrinsic emotional capital were assessed. Overall emotional support did not predict degree of emotional investment or timing of investment onset, which was a result of the differing effects of various sources of support have. While the direction of the effect of higher support generally suggested higher emotional investment, higher support from the infant's father predicted lower bond strength and higher support from the father's family increased the time mothers took to feel strongly emotionally bonded with their infant. This is similar to findings regarding the negative impact paternal and grandmaternal practical support has on breastfeeding rates in the UK (Emmott and Mace, 2015), and suggests mothers may be offsetting their emotional investment costs when their infant's father or paternal kin are available to emotionally invest in the infant instead. Attachment studies have shown who the attachment figure actually is and the number of attachment figures do not matter when it comes to attachment security (Sagi *et al*., 1995), and so emotional alloparenting may reduce a mother's costs without entailing deficits in offspring quality.

Emotional investment, in terms of ‘emotional bonding’ strength and the time it took for mothers to feel strongly ‘emotionally bonded’, was found to be better predicted by all measures of a mother’s emotional capital than either her available practical support or access to other resources, which is supportive of a mother’s emotional resources being key to emotional investment, rather than simply being related to resources in general. This also adds to findings that emotional support and practical support have differing influences on maternal investment decisions (Colletta, 1981; Emmott and Mace, 2015; Moran *et al*., 2007).

As hypothesised, the strength of ‘emotional bonding’ and a mother’s confidence in her ‘emotional bond’ with her infant at approximately one month after birth predicted her experience of PND within approximately the first six months after giving birth, supporting the hypothesised relationship between low emotional investment and PND. Measures of emotional capital predicted emotional investment more accurately than they predicted PND at approximately one month after giving birth, suggesting social stress (as the causal link between emotional investment and PND) is not an inevitable outcome of a low emotional investment strategy. Combined with the findings in Chapter 3, that shame and the perception of social pressure moderate the relationship between emotional investment and PND, this is supportive of the validity of *strategy 2* of the model predicting maternal emotional investments and resultant PND presented in *Part 1* of this chapter – where the sociocultural environment does not penalise women for making low emotional investments, PND will not be the predictable outcome of low investment strategies. Maternal resources (which for analysis purposes do not include maternal emotional capital) did not predict emotional investment; however they did predict the likelihood of experiencing PND within six months of giving birth. This indicates that an emotional investment pathway to PND, moderated by social stress, is distinct from previously recognised PND risk factors. Emotional investments were found to account for a similar amount of variance in PND experience as maternal resources, suggesting that an emotional investment explanation of PND is potentially a significant unrecognised factor in PND aetiology.

The perception of environmental risk, along with resource availability, plays a key role determining life history trade-offs, and these results are indicative of maternal emotional investment being contingent on risk. The awareness of risk causes mothers to lower their emotional investments in their offspring, reducing the strength of emotional bonds and increasing the time taken to attain strong emotional bonds at levels approaching significance. Risk awareness also lowered confidence in the emotional bonds mothers had, which may be a gauge of imminent investment withdrawal.

Regarding emotional capital, these results are supportive both of the concept of emotional capital – that individuals possess some form of reserve of 'emotional energy' that is diminished by making emotional investments and replenished by emotional investments from others, akin to, and possibly related to, the limited resource psychologists have proposed to govern self-control (Muraven, Tice, and Baumeister, 1998; Muraven, Shmueli, and Burkley, 2006; Schmeichel, Vohs, and Baumeister, 2003) – and of the choice of measures used to test the hypothesis. Emotional intelligence and overall intrinsic emotional capital, at a level approaching significance, were responsive to extrinsic emotional capital (or overall emotional support) received at approximately six months postnatal, with support negatively predicting drops in capital from before birth to after birth. However they were not predicted by emotional support received during pregnancy, indicating current emotional support is more important than historical support. Overall practical support during the postpartum also negatively predicted drops in emotional intelligence, while the length of time mothers spent on their own with their infants during the week without the company of another adult predicted falls in emotional personality dispositions to care and play and, at levels approaching significance, increases in anger predisposition. Women whose lower SES was indicated by 'skilled non-manual – unskilled' occupational status showed greater increases in dispositions to anger compared to those whose high SES was indicated 'professional' occupation. The impact of PND was controlled for within these findings and, on the whole, they are suggestive of mothers with access to greater resources having their emotional capital buffered during the postnatal period, while mothers with fewer resources experience losses in emotional capital.

Important support for an emotional capital hypothesis of maternal investment is provided by the results regarding emotional bonding and shifts in intrinsic emotional capital from pregnancy levels to levels reported at approximately 6 months after birth, having controlled for PND. The stronger an emotional bond a mother felt towards her infant, proposed to be a marker of greater emotional capital investment, the greater the drop in her post-birth intrinsic emotional capital, largely the result of a decline in emotional intelligence. This is indicative of emotional intelligence behaving like a limited resource which is diminished by emotionally investing in another. The relationship between emotional investment and shifts in intrinsic emotional capital was also found to be moderated in a variety of ways by available extrinsic emotional capital, which is symptomatic of emotional investment in the mother by others replenishing the deficit left by emotional investment in an infant. Overall intrinsic emotional capital and emotional intelligence remained constant in women with high extrinsic emotional capital in the postpartum, while those with lower support showed decreases in capital as emotional bonding strength increased, and the pattern was replicated at a level approaching significance when assessing the impact of extrinsic emotional capital available during pregnancy. When emotional wellbeing was explored, women of average support during pregnancy experienced a slight decline in their wellbeing irrespective of the strength of their bonding, while women with high support during pregnancy experienced slight improvement in their wellbeing when highly bonded and declines in their wellbeing as their bond strength decreased, and women with low support experienced the opposite. Emotional personality dispositions to express play behaviour remained constant in women with high and average support during pregnancy, at a level approaching significance, and fell in those with low support, and remained constant in women with high support during the postpartum and fell in those with average and low support. Emotional personality dispositions to express care behaviour showed declines as emotional bonding increased in women whose extrinsic emotional capital was low in the postpartum, and finally, dispositions towards sadness decreased as emotional bonding increased in women with high extrinsic capital during pregnancy and increased as bonding increased in women with low support.

On the whole, emotional capital was not protective against the role of sociocultural pressures regarding mothering in generating maternal shame, suggesting all women who experience such pressures are susceptible to PND via inflammatory responses to social threat. However, moderation analysis did find that having a personality with a low disposition to fear during pregnancy provided protection from the negative effects of stigma consciousness on shame during the early postnatal period at a level approaching significance. Emotional capital also did little to alter low emotional investment in the face of perceived risks, with risk perception during pregnancy leading to decreased emotional bonding strength and lowering bond confidence, which potentially signals the imminent withdrawal of investment, and, for the most part, slowing the timing of investment onset in the early postnatal period irrespective of a mother's emotional capital. However, having a personality with a disposition to expressing low levels of the play emotion during pregnancy did lead to speedy emotional bonding irrespective of perceived risks at a level approaching significance, for which I do not have a ready explanation, although play behaviours are thought to promote social bonding more generally (Barrett, Robins, and Janata, 2013).

Conclusions

Overall, these results demonstrate that a mother's emotional investments are contingent on circumstance, much like other forms of parental investment. In general women make more of an emotional investment when they have higher emotional capital themselves. High support from an infant's father and father's family, however, may lead to mother's offsetting their own emotional investment costs in favour of their infant's gaining emotional investment from their paternal kin. Combined with findings that indicate that the proposed measures of emotional capital behave like limited resources, declining when emotional capital is spent on emotional bonding with infants and appearing to be replenished by emotional support from others, these results support the concept of emotional capital.

That strength of emotional bonding and a mother's confidence in her emotional bond with her infant at approximately one month postnatal predicted her experience of PND within approximately the first six months after giving birth indicates that presumed causal pathway of PND leading to poor mother-infant relationships is the wrong way around. This builds on findings by Pearce and Ayers (2005) indicating the association between PND and poor bonding is simultaneous not causal and suggests that interventions aimed at preventing PND for the purpose of improving bonding and attachment, as planned by the US Preventative Services Task Force for instance (USPSTF, 2016), will fail if they do not tackle the factors which determine emotional investment decisions. This is a point which will be returned to in Chapter 7 as part of a general discussion regarding the implications of all of the results for public health, but first a more detailed exploration of the culturally constructed origins of women's perceptions of risk and social threat will be made (Chapter 5) and then a comprehensive model for predicting PND presented (Chapter 6).

Chapter 5 – Experimentally Inducing Risk Perception and Social Evaluative Threat

Chapter outline

In the previous chapter results supporting the emotional capital hypothesis were presented, and in Chapter 3 perceptions of social pressure on mothers and stigma surrounding the behaviour and emotions of mothers were found to predict the experience of maternal shame. The cultural construction of motherhood in contemporary WEIRD societies, with its emphasis on risk, is hypothesised to be the source of such perceptions, and thus play a role in PND causation; however, the pregnancy study from which these findings came did not seek to uncover the origins of women's perceptions of risk and social threat. An experimental design, in which some participants were exposed to, or 'primed' with, messages regarding mothering commonly found in popular and social media and other participants were not, enables the impact of the cultural construction of motherhood to be quantified. Clearly demonstrating sources of maternal distress is important from a public health perspective, allowing for evidence based, targeted preventative actions to be articulated. The focus of this chapter is a priming study which was designed to test hypotheses derived from the framework of the emotional capital hypothesis; it is obviously not ethical to attempt to induce shame in a sample of perinatal women, thus the study was conducted on a group of young, non-pregnant, predominantly nulliparous women.

Introducing a priming experiment

Priming studies are a staple of experimental and social psychological research, and whilst not without their problems (Bargh, 2006; Kahneman, 2012), have the potential to provide valuable insights into human behaviour. There have been a number of experimental studies carried out to investigate factors contributing to decisions regarding fertility and parental investment. For instance, Griskevicius, Cialdini, and Kenrick (2006) found that priming long and short-term mating opportunities in males and long-term mating opportunities in females enhanced creative displays. Mathews and Sear (2008; 2013) found that mortality priming increased the number of desired children for males and also that priming with questions about family and close friends caused unmarried participants of both sexes to increase their expectation of having offspring (Mathews and Sear, 2013). Hill and Del Priore (2013) found that priming for jealously negatively impacted fertility desires in both males and females and lowered hypothetical investment by males.

The emotional capital hypothesis under investigation here, as laid out in Chapter 4, is that mothers vary their emotional investment in new born offspring in response to perceived constraints on, or deficits in, their own emotional capital, or threats to infant survival, leading to the reduced likelihood of investment payoffs in terms of high quality offspring. The sociocultural mothering environment in WEIRD contexts, with its medicalisation of maternal emotional behaviour, is also proposed to be a source of perceived risk, elevating the level of perceived required investment to raise a high quality offspring; a hypothesis which found support in results presented in Chapters 3 and 4. The cultural construction of motherhood in contemporary WEIRD societies also, by the same token, demands high investment, 'intensive' mothering, leaving women who opt for a low emotional investment strategy at heightened risk of a stress response. Such a stress response is triggered by the subjective experience of social threat as a woman's low investment strategy interacts with social pressures to be high investing, and may lead to PND.

The results in Chapters 3 and 4 were generally supportive of the emotional capital hypothesis and a social genome approach to PND by which low emotional investments may result in shame, which then triggers depressive symptoms. However, more evidence regarding how women feel about their investments specifically, rather than their mothering experience more generally is required to add weight to an emotional capital mediated pathway to PND. Additionally, to inform a public health approach to prevent PND caused by this source of psychosocial stress more data on the factors that influence these feelings are needed. To address this, a priming study was conducted on a group of young non-pregnant women to test the hypothesis that exposure to the sociocultural construction of mothering in WEIRD contexts, reflected in messages regarding mothering behaviours sourced from

UK popular and social media, alters women's perceptions of risks and costs associated with mothering and thus their maternal desires and how they subjectively experience these desires. The women were drawn from a UK student population and were predominantly nulliparous, thus, unlike women in the previous pregnancy study (Chapter 3 and 4) their responses were not influenced by unmeasured maternal experiences.

Pregnancy and childcare manuals are a primary source of information regarding mothering for many women and various authors have highlighted their importance in actively constructing the way in which women conceive motherhood and the problematic understandings they create (Clarke-Stewart, 1978; Hardyment, 1983; Marshall, 1991; Rafalovich, 2001). A survey conducted in the US in the 1970s found that nearly all parents use such materials (Clarke-Stewart, 1978), and in the decade between 2002 and 2012 over 8 million[11] individual pregnancy and childcare books were sold in the UK (Nielsen Bookdata, 2013) indicating their usage remains widespread. Women have been found to be uncritical of the advice given in such manuals and to gain no significant boost in confidence from reading them (Clarke-Stewart, 1978), which is perhaps unsurprising when their content is analysed. A discourse analysis by Marshall (1991) of the seven top selling manuals from the 1980s noted five key themes to be apparent: motherhood as ultimate fulfillment; mother's love as natural; the unnatural mother; how to be a modern mother, and; the active mother who monitors normality. Marshall concluded that the messages in these guides places the next generation's moral wellbeing firmly in the hands of the mother, laying any social problems at her door, and that guilt was a palpable consequence of following such messages. Women are also increasingly subject to messages regarding 'right' and 'wrong' ways to mother from government (Gillies, 2008) and an ever widening array of social media. Indeed, the internet is likely to be supplanting, if it has not already, the role of books in providing information to mothers with, for instance, the current largest women's website in the UK, Netmums, receiving traffic of over a million users each week (RCM, 2012a). While parenting manuals may generate guilt, by leading mothers to feel like they're 'getting it wrong', parenting websites bring with them a new potential

[11] Books sold = 8581097. Calculated using sales through the high street, online retailers, and supermarkets of books categorised as 'Pregnancy & Parenting' by Nielsen Bookdata (2013).

for inducing shame, enabling virtual social interaction between mothers via message boards and social media apps, exposing mothers to the judgement of other (supposed) mothers who appear to be ‘getting it right’. The perception of social disapproval from others, manifesting in the subjective experience of shame has been shown to play a causal role in depression (Andrews, Qian, and Valentine, 2012; Slavich *et al*., 2010a), and as contended in the previous chapter, is hypothesised to play an unrecognised role in PND.

To test the idea that exposure to such messaging is problematic for the emotional wellbeing of women, a two part priming study was conducted in which short pieces of text regarding mothering were taken from an array of popular and social media and were used as priming stimuli. In Part 1, women were asked a variety of questions regarding their reproductive desires, hypothetical time budgeting of tasks related to infant care, and perceptions of the costs and risks surrounding mothering. In Part 2, approximately one week later, women were divided into control and prime groups and asked the same questions again; however this time the questions posed to those in the prime condition were interspersed with the priming stimuli. All women were then asked to reflect on, and report their emotional responses to, their answers, with the primary focus being on whether feelings of shame were experienced. The answers of women in the prime group were then compared between Parts 1 and 2 to test hypotheses regarding the effects of exposure to messages regarding mothering on maternal behaviour and the emotional responses were compared between groups. In Part 1 all women also completed measures of *intrinsic* emotional capital, the effects of which were also explored.

Research questions

> *If the social construction of motherhood is a source of social evaluative threat, can it be experimentally induced?*
>
> *Does the perception of social evaluative threat surrounding mothering cause women to alter their hypothetical maternal investment decisions?*

From these questions a range of hypotheses (for a summary see Table 5.1) can be derived using life history theory and the framework for maternal emotional investments presented in Chapter 4.

Hypotheses

-Risk (R)

As discussed in Chapter 3, the contemporary sociocultural mothering environment in WEIRD contexts views infants "as *de facto* 'at risk'" (Lee, 2014b: 11). An example of the prime stimuli used is a screen shot of an online version of a popular UK tabloid newspaper with the headline "Four in ten children fail to connect with mum and dad: Poor parenting in the first three years can hold children back at school and cause behavioural problems", under which it is stated "This puts them at risk of problems including obesity and delayed speech". The priming of environmental cues signalling the high levels of investment required to raise a high quality offspring, and the emotional costs of this investment to the mother, is hypothesised to increase the perception of risk surrounding mothering. Risk perception influences quality-quantity offspring trade-offs, thus exposure to the prime is also hypothesised to result in increases in stated fertility intentions and decreases in hypothetical investment desires.

Ri) *Exposure to the prime will increase the perception of risk surrounding mothering between Parts 1 and 2*

Rii) *Exposure to the prime will increase the perceived costs of mothering between Parts 1 and 2*

Riii) *Exposure to the prime will reduce investment desires between Parts 1 and 2*

Riv) *Exposure to the prime will increase reproductive desires between Parts 1 and 2*

Hypothesis	Dependent variable	Independent variable(s)	Statistical approach
Risk			
Ri. Exposure to the prime will increase the perception of risk surrounding mothering between Parts 1 and 2	**Ri.** <u>Part</u> (ws), <u>condition</u> (bs)	**Ri.** *Perception of risk*, individual measures of emotional capital	**Ri.** Mixed design analysis of variance
Rii. Exposure to the prime will increase the perceived costs of mothering between Parts 1 and 2	**Rii.** <u>Part</u> (ws), <u>condition</u> (bs)	**Rii.** *Financial*, *employment*, *social*, or *emotional costs*, individual measures of emotional capital	**Rii.** Mixed design analysis of variance
Riii. Exposure to the prime will reduce investment desires between Parts 1 and 2	**Riii.** <u>Part</u> (ws), <u>condition</u> (bs)	**Riii.** *Emotional*, *physical*, or *total investment*, individual measures of emotional capital	**Riii.** Mixed design analysis of variance
Riv. Exposure to the prime will increase reproductive desires between Parts 1 and 2	**Riv.** <u>Part</u> (ws), <u>condition</u> (bs)	**Riv.** *Ideal number of children*, *likelihood of having children if not in a stable romantic relationship* or *financially well off*, and *the likelihood not being in a stable romantic relationship or financially well off would lower the ideal number of children*, individual measures of emotional capital	**Riv.** Mixed design analysis of variance
Emotional capital			
ECi. Women of higher emotional capital will report lower fertility desires	**ECi.** Ideal number of children, likelihood of having children if not in a stable romantic relationship or financially well off, and the likelihood not being in a stable romantic relationship or financially well off would lower the ideal number of children	**ECi.** *Overall emotional capital* or *individual measures of emotional capital*	**ECi.** Linear regression
ECii. Women of higher emotional capital will report higher investment desires	**ECii.** Emotional, physical, or total investment	**ECii.** *Overall emotional capital* or *individual measures of emotional capital*	**ECii.** Linear regression
Emotional experience of investment desires			
EEi. Exposure to the prime will increase feelings of shame regarding investment desires	**EEi.** Shame emotional response variables	**EEi.** *Condition*, perception of risk, total investment, overall emotional capital or individual measures of emotional capital	**EEi.** Linear regression

Table 5.1 Hypotheses tested in Chapter 5 and the measures and methods used to test them. Measures in *italics* denote the variable of interest, measures <u>underlined</u> denote subject factors in analysis of variance analyses. Abbreviations: within-subject (ws), between-subject (bs).

Hypothesis	Dependent variable	Independent variable(s)	Statistical approach
Further analysis			
EEii. Those in the control condition who expressed desire for a lower investment strategy will not report higher levels of shame because they have not been primed to detect social threat	**EEii.** Shame emotional response variables	**EEii.** *Condition*, perception of risk, total investment, overall emotional capital or individual measures of emotional capital	**EEii.** Linear regression and moderation analysis
EEiii. Women of higher emotional capital will be more susceptible to the prime and thus report higher levels of shame	**EEiii.** Shame emotional response variables	**EEiii.** *Condition*, perception of risk, total investment, overall emotional capital or individual measures of emotional capital	**EEiii.** Linear regression and moderation analysis
Exposure to the prime will increase negative emotional responses more generally	Negative emotional response variables	*Condition*, perception of risk, total investment, overall emotional capital or individual measures of emotional capital	Linear regression and moderation analysis

Table 5.1 (continued) Hypotheses tested in Chapter 5 and the measures and methods used to test them. Measures in *italics* denote the variable of interest, measures, underlined variables denote subject factors in analysis of variance analyses. Abbreviations: within-subject (ws), between-subject (bs).

-Emotional capital (EC)

Parental investment theory predicts that women make quality-quantity offspring trade-offs dependent in part on their access to resources with which to invest in the embodied capital of their offspring. Emotional capital is hypothesised to reflect a mother's capacity to emotionally invest in her offspring and play a role in reproductive trade-offs. As such, women of higher emotional capital are more able to invest in offspring quality and predicted to report lower hypothetical fertility desires and higher investment desires.

ECi) *Women of higher emotional capital will report lower fertility desires*

ECii) *Women of higher emotional capital will report higher investment desires*

-Emotional experience of investment desires (EE)

The sociocultural mothering environment is hypothesised to create feelings of social stress in women pursuing low maternal investment strategies; this was supported by findings in Chapter 3 showing women making lower emotional investments in their infants were more prone to experiencing shame regarding their maternal behaviour and emotions. Risk perception during pregnancy was also found to predict the experience of maternal shame (Chapter 3). Exposure to the prime stimuli is thus predicted to increase feelings shame and those who are not exposed to the prime stimuli are predicted to remain shame free. As noted in Chapter 4, women of higher emotional intelligence, which is usually protective against depression, are more likely to experience PND (Akerjordet and Severinsson, 2009). A potential explanation for this, based on a social genome approach to PND mediated by emotional capital, is that the higher a mother's emotional intelligence (as a facet of emotional capital), the higher emotional capital investment she should deem necessary in her infant, and the higher the investment, the higher the required returns to make it worthwhile. If women of high emotional intelligence are also more susceptible to the sociocultural messaging regarding the risks of mothering and social pressures on mothers, this may cause them to judge their available capital as inadequate and the likelihood of failure too high, leading them to withdraw their emotional investment and experience shame, leading to PND, as a result.

EEi) *Exposure to the prime will increase feelings of shame regarding investment desires*

EEii) *Those in the control condition who expressed desire for a lower investment strategy will not report higher levels of shame because they have not been primed to detect social threat*

EEiii) *Women of higher emotional capital will be more susceptible to the prime and thus report higher levels of shame*

Materials and methods

-Study design

The study consisted of a questionnaire of two parts. *Part 1* measured intrinsic emotional capital, desires regarding reproduction and investment in infants, and perceptions of costs and risks. *Part 2* took place 1-2 weeks later; the same participants were exposed either to a *prime condition*, consisting of questions regarding the respondent's thoughts about parenting preceded by passages of text taken from popular and social media, or a *control condition* consisting of just questions regarding the respondent's thoughts about parenting. It was assumed participants had a low prior exposure to messages surrounding parenting in popular and social media but this was assessed with questions about their recent exposure.

Prime condition – The prime texts were split into two sections: the first section was designed to prime for physical, social and emotional threat surrounding motherhood, and the second to prime for guilt, shame, and social threat surrounding the level of investment desire expressed (for full details of the prime texts see Appendix I). After reading each set of prime texts participants were asked some basic questions about what they had read to check that they paid attention (with anyone scoring poorly excluded). Following the first section participants investment desires were measured using the same questions posed in *Part 1*. The second prime was then administered and participants measured for shame in relation to their newly stated investment desires.

The study was conducted online and participants consisted of students recruited from the University of Kent. Participants were informed that they were taking part in a study investigating "the effect popular and social media has on young women's thoughts about parenting" and offered the chance to win one £10 Amazon voucher as an incentive. The study received ethical approval from the University of Kent's School of Anthropology and Conservation; all participants were informed that they would be asked questions regarding their current emotional wellbeing and warned that such questions occasionally cause distress, and by continuing to participate were deemed to have given informed consent.

-Measures

All questions which required participants to rate their response used visual analogue scales (VASs), which employ a moveable marker on screen. The exceptions to this were the scales used to construct emotional capital, which employ previously validated Likert scales. VASs are often preferentially used over Likert scales in priming studies because participants can't simply remember their previous answer. For the full questionnaires and explanatory wording as seen by participants, along with the rationale for each question, see Appendix I.

Reproductive desires

Participants were asked their *ideal number of children*; how *likely they would be to consider having children if not in a stable romantic relationship* or *financially well off* (sliding scale 0 'Not at all' to 100 'Extremely'), and; *if not in a stable romantic relationship or financially well of, how likely would this be to lower the number of children they would ideally have* (sliding scale 0 'Not at all' to 100 'Extremely'). All questions were in both *Part 1* and *2*.

Investment desires

Participants read the statement "Imagine you have a 1 month old infant with your romantic partner. On average 1 month olds sleep for 8 hours during the night, and 8 hours at inconsistent times during the day." Participants were then asked to indicate the maximum time they would be happy devoting to a range of child care activities based on those presented by Hill and DelPriore's (2013) priming study of the effect of jealousy on parental investment. Activities were divided into those entailing *emotional investment* (either in terms of requiring emotional input from the mother and/or contributing to the psychological and emotional development of the infant, for example playing with the infant) or *physical investment* (physical acts by the mother contributing to the somatic health of her infant, such as feeding). Scales rated time investment in minutes and responses were summed to give an overall measure of *emotional investment*, *physical investment*, or *total investment*, for the specific activities and associated scales see Appendix I. All questions were in both *Part 1* and *2*.

Risk perception

Participants were asked to rate how safe an environment the UK is in which to be pregnant, raise a baby, and raise children on a scale of 0 'Very dangerous' to 100 'Very safe'. Responses were summed to create an overall measure of *risk perception*. All questions were in both *Part 1* and *2*.

Cost perception

Participants were asked to rate the *financial*, *employment*, *social*, and *emotional* consequences of having a baby on a scale of 0 'Very costly' to 100 'Very beneficial'. All questions were in both *Part 1* and *2*.

Emotional capital

Emotional capital was assessed using the measures of *intrinsic emotional capital* introduced in Chapter 4; *extrinsic emotional capital* was not measured both in an attempt to limit attrition in completing the study by minimising the time taken to complete the questions. It was also thought less likely the available support would influence responses as the questions regarding investment desires were hypothetical.

Emotional wellbeing was measured using Bradburn's Affect Balance Scale (van Schuur and Kruijtbosch, 1995), *emotional intelligence* was measured using Petrides's Trait Emotional Intelligence Short-form (Petrides and Furnham, 2006), and *emotional personality* was assessed using the Brief Affective Neuroscience Personality Scale (BANPS) (Barret, Robins, and Janata, 2013) rating participants on where they fall on the subscales *play*, *seek*, *care, fear*, *anger*, and *sadness*. The scales were employed individually and also as a composite measure of *emotional capital*; for full details of the emotional capital measures see Chapter 4. Scales were employed in *Part 1*.

Feelings about investment desires

Following the methodology of Lickel *et al*. (2005) and Scarnier, Schmader, and Lickel (2009), participants were asked to reflect for a moment on the answers they gave regarding their parenting desires and thoughts, and then rate, on a scale of 0 'Not at all' to 100 'Very intensely', how much of each of a variety of emotions they felt as a result giving a measure of *emotional response*. The emotions of primary interest were those reflecting shame (*ashamed*, *humiliated*, *embarrassed*, and *disgraced*) (Watson and Clark, 1994). These emotions were surrounded by filler emotions (Feldman Barrett, 1998) so that participants would be unaware they were being asked if they felt shameful. These filler emotions specifically included guilt (*sorry*, *guilty*, *remorse*, and *regret*), because guilt has been previously found to be a consequence of mothering in contemporary WEIRD contexts (Rotkirch and Janhunen, 2010), and then a range selected from the spectrum of positive and negative affect listed by Watson and Clark (1994): positive – *happy*, *cheerful*, *delighted*, *joyful*; negative – *alone*, *lonely*, *angry*, *irritable*, *scornful*, *disgusted*, *nervous*, *afraid*, *frightened*, *scared*, *sad*, *downhearted*. Scales were employed in *Part 2* only to minimise the length of *Part 1*, and thus, drop-out rate.

Media exposure

To gauge the level of exposure women have to popular and social media messaging regarding mothering participants were asked how many news stories they had encountered in the last few weeks regarding any aspect of parenting, how many popular articles in magazines or on websites they'd read had related to any aspect of parenting, and how many academic articles they'd read relating to any aspect of parenting on a scale 5 part Likert scale of 'None at all' to 'A lot'. Participants were also asked to report if they'd ever visited a pregnancy/parenting advice website or read a pregnancy/parenting advice book.

Demographics

Participants reported their age in years, whether they had any children, their country of birth, and their ethnicity (options reflect the standard ethic group questions for questionnaires conducted in England and Wales recommended by the HSMO (2003)).

-Sample characteristics

Parts 1 and *2* were completed by 167 women overall; there was non-systematic non-response to the final question regarding *feelings about investment desires* but every participant reported at least one emotion, with 'humiliated' receiving the fewest responses (N = 125). The percentage distributions of exposure to messages regarding parenting from various media sources can be seen in Table 5.2, in addition to which 56.4% of participants reported having ever visited a pregnancy/parenting advice website (*control* = 45.8%, *prime* = 67.1%) and 47.9% reported having read a pregnancy/parenting advice book (*control* = 18.8%, *prime* = 78.0%).

Rating	News stories		Popular articles		Academic articles	
	Control % (95% CI)	Prime % (95% CI)	Control % (95% CI)	Prime % (95% CI)	Control % (95% CI)	Prime % (95% CI)
None at all	20.0 (11.5 – 28.5)	22.0 (13.0 – 31.1)	28.6 (18.9 – 38.3)	19.8 (11.1 – 28.5)	67.1 (57.1 – 77.1)	62.2 (51.7 – 72.7)
Very few	55.3 (44.7 – 65.9)	43.9 (33.2 – 54.6)	36.9 (26.6 – 47.2)	48.1 (37.2 – 59.0)	20.0 (11.5 – 28.5)	24.4 (15.1 – 33.7)
Quite a few	22.4 (13.5 – 31.3)	32.9 (22.7 – 43.1)	28.6 (18.9 – 38.3)	25.9 (16.4 – 35.4)	11.8 (4.9 – 18.7)	6.1 (0.9 – 11.3)
Quite a lot	1.2 (-1.1 – 3.5)	1.2 (-1.2 – 3.6)	6.0 (0.9 – 11.1)	6.2 (1.0 – 11.5)	1.2 (-1.1 – 3.5)	6.1 (0.9 – 11.3)
A lot	1.2 (-1.1 – 3.5)	0.0	0.0	0.0	0.0	1.2 (-1.2 – 3.6)

Table 5.2 The percentage distributions of participants' ratings of their exposure of media regarding parenting in the last few weeks.

Control condition characteristics (N = 85): mean age 24.2 years (s.d.7.1); 92.9% had no children; 71.8% from the UK, 15.3% from the rest of Europe, 4.7% from US, 8.2% from the rest of the world; 87.1% white ethnicity.

Prime condition characteristics (N = 82): mean age 23.0 years (s.d. 4.9); 90.2% had no children; 57.3% from the UK, 18.3% from the rest of Europe, 6.1% from US, 10.1% from the rest of the world; 81.7% white ethnicity.

-Statistical approach

Ri-iv)

Mixed design analysis of variance (ANOVA) models were employed, with survey *Part* acting as the within-subject factor and *condition* acting as the between-subject factor. The within-subject variables were *Ri*) *perception of risk*, *Rii*) *financial*, *employment*, *social*, and *emotional costs*, *Riii*) *emotional*, *physical and total investment* and, *Riv*) *ideal number of children*, *likelihood of having children if not in a stable romantic relationship* or *financially well off*, and *the likelihood not being in a stable romantic relationship or financially well off would lower the ideal number of children*. The individual measures of emotional capital - *emotional wellbeing*, *emotional intelligence*, and the *emotional personality* subscales *play*, *seek*, *care*, *fear*, *anger*, and *sadness* – acted as covariates; in Chapter 4 the individual measures were found to provide a more nuanced perspective than the composite *intrinsic emotional capital* measure and so only the individual measures are employed here for the sake of brevity.

EC)

Linear regression models were run with *ECi*) *ideal number of children*, *likelihood of having children if not in a stable romantic relationship* or *financially well off*, and *the likelihood not being in a stable romantic relationship or financially well off would lower the ideal number of children* or *ECii*) *emotional*, *physical*, or *total investment* as the dependent variable and *emotional wellbeing*, *emotional intelligence*, and the *emotional personality* subscales *play*, *seek*, *care*, *fear*, *anger,* and *sadness*, or *emotional capital* as the independent variables. The values reported in *Part* 1 of the survey, before those in the prime condition were exposed to the prime stimuli, were used as independent variables. Plotting of the residuals indicated heteroscedasticity in some of the regressions so some models were subjected to BCa bootstrapping to improve robusticity (Field, 2013).

EE)

Linear regression models were run in which the various shame *emotional response* variables (*ashamed*, *humiliated*, *embarrassed*, and *disgraced*) acted as the dependent variable and *condition* acted as the main independent variable of interest, while controlling for *total investment* (*Part 2*), *perception of risk* (*Part 2*), and the individual measures of *emotional capital*. Moderation analyses using the SPSS Process add-on tool (Hayes, 2013) were conducted to test for interactions between the predictors. Total investment was used to simplify the analysis as emotional and physical investment were found to be highly correlated (see Appendix J) and, with only one exception, the direction of the effect of the individual measures of emotional capital were the same on both variables (see *ECii results*). Plotting of the residuals indicated heteroscedasticity in some of the regressions so some models were subjected to BCa bootstrapping to improve robusticity (Field, 2013).

Further analysis)

While measures of *shame* were the emotional responses of primary interest, all emotional responses collected were analysed using the statistical approach employed in *EE* to check whether the *prime* only predicted shame or negative responses more generally.

Results

Ri) Exposure to the prime will increase the perception of risk surrounding mothering between Parts 1 and 2.

Exposure to the *prime* did not increase the *perception of risk* surrounding mothering when assessing between-subject effects ($p = 0.470$) and there was no significant interaction between survey *Part* and *condition* when assessing within-subject effects ($p = 0.715$).

Rii) Exposure to the prime will increase the perceived costs of mothering between Parts 1 and 2

When assessing *perception of financial costs* associated with mothering there was an interaction between survey *Part* and *condition* approaching significance when assessing within-subject effects (*Part*condition* $p = 0.051$) (Table 5.3), however both groups rated the costs as being lower in *Part 2* (Figure 5.1).

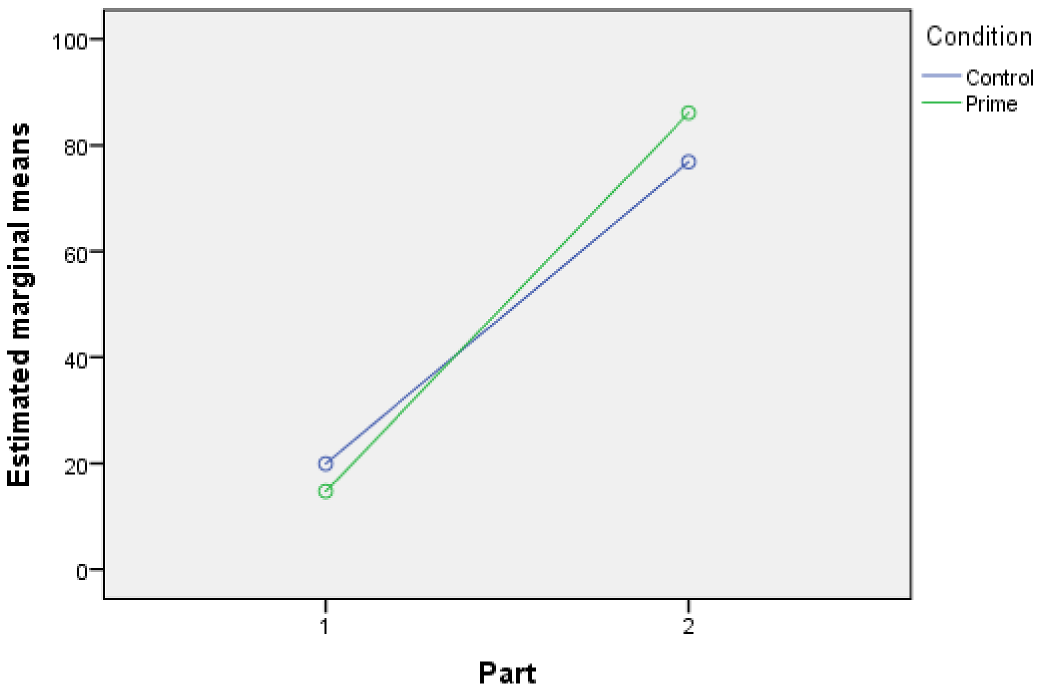

Figure 5.1 Estimated marginal means for the perception of financial costs (higher score = lower cost) associated with mothering at mean values for all emotional capital covariates.

Source		Type III Sum of Squares	df	Mean Square	F	*p*	Partial Eta Squared	Effect Size
Between-subject effects								
Intercept		319.420	1	319.420	1.993	0.161	0.020	
Emotional wellbeing		141.578	1	141.578	0.884	0.350	0.009	0.095
Emotional intelligence		10.617	1	10.617	0.066	0.797	0.001	0.026
Emotional personality – play		1031.681	1	1031.681	6.438	**0.013**	0.062	0.249
Emotional personality – seek		13.646	1	13.646	0.085	0.771	0.001	0.030
Emotional personality – care		118.387	1	118.387	0.739	0.392	0.008	0.087
Emotional personality – anger		360.302	1	360.302	2.249	0.137	0.023	0.151
Emotional personality – fear		59.993	1	59.993	0.374	0.542	0.004	0.062
Emotional personality – sadness		84.512	1	84.512	0.527	0.469	0.005	0.074
Condition		**88.207**	**1**	**88.207**	**0.550**	**0.460**	**0.006**	**0.075**
Error		15543.145	97	160.239				
Within-subject effects								
Part	Part 1 vs. Part 2	95.565	1	95.565	0.078	0.780	0.001	0.028
Part * Emotional wellbeing	Part 1 vs. Part 2	3387.300	1	3387.300	2.779	**0.099**	0.028	0.167
Part * Emotional intelligence	Part 1 vs. Part 2	1746.983	1	1746.983	1.433	0.234	0.015	0.121
Part * Emotional personality – play	Part 1 vs. Part 2	433.167	1	433.167	0.355	0.552	0.004	0.060
Part * Emotional personality – seek	Part 1 vs. Part 2	52.215	1	52.215	0.043	0.836	0.000	0.021
Part * Emotional personality – care	Part 1 vs. Part 2	3544.039	1	3544.039	2.908	**0.091**	0.029	0.171
Part * Emotional personality – anger	Part 1 vs. Part 2	1610.126	1	1610.126	1.321	0.253	0.013	0.116
Part * Emotional personality – fear	Part 1 vs. Part 2	6564.327	1	6564.327	5.386	**0.022**	0.053	0.229
Part * Emotional personality – sadness	Part 1 vs. Part 2	1775.061	1	1775.061	1.456	0.230	0.015	0.122
Part * Condition	**Part 1 vs. Part 2**	**4758.662**	**1**	**4758.662**	**3.904**	**0.051**	**0.039**	**0.197**
Error(Part)	Part 1 vs. Part 2	118230.554	97	1218.872				

Table 5.3 Results of mixed design ANOVA assessing the effect of priming (*condition*) on the *perception of financial costs* surrounding mothering comparing perception before (*Part 1*) and after (*Part 2*) prime exposure.

When assessing *perception of employment costs* associated with mothering no significant effects were found (within-subjects $p = 0.141$, between-subjects $p = 0.644$). When assessing *perception of social costs* associated with mothering no significant effects were found (within-subjects $p = 0.379$, between-subjects $p = 0.623$).

When assessing *perception of emotional costs* associated with mothering exposure to the *prime* did not increase the *perception of emotional costs* associated with mothering when assessing between-subject effects (*condition* $p = 0.219$). There was an interaction approaching significance between survey *Part* and *condition* ($p = 0.058$) (Table 5.4), such that the increase in perceived emotional costs was greater in the *prime* group (Figure 5.2).

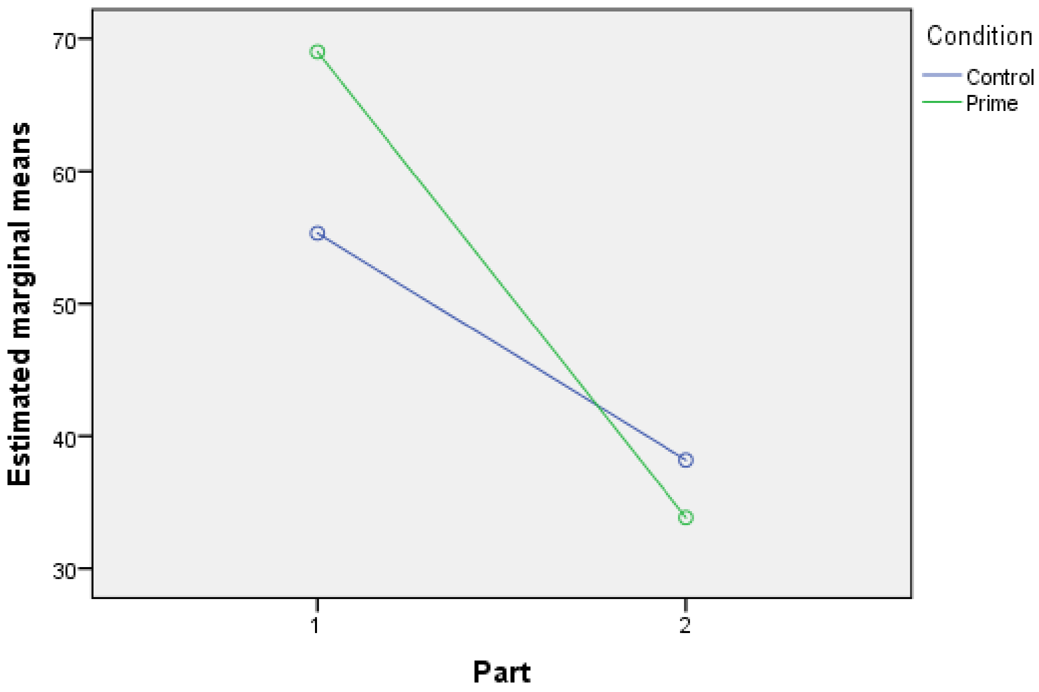

Figure 5.2 Estimated marginal means for the perception of emotional costs (higher score = lower cost) associated with mothering at mean values for all emotional capital covariates.

Source		Type III Sum of Squares	df	Mean Square	F	*p*	Partial Eta Squared	Effect Size
Between-subject effects								
Intercept		628.724	1	628.724	1.639	0.203	0.014	
Emotional wellbeing		353.368	1	353.368	0.921	0.339	0.008	0.090
Emotional intelligence		57.865	1	57.865	0.151	0.698	0.001	0.037
Emotional personality – play		343.350	1	343.350	0.895	0.346	0.008	0.089
Emotional personality – seek		184.807	1	184.807	0.482	0.489	0.004	0.065
Emotional personality – care		59.286	1	59.286	0.155	0.695	0.001	0.037
Emotional personality – anger		367.982	1	367.982	0.959	0.329	0.008	0.092
Emotional personality – fear		32.417	1	32.417	0.085	0.772	0.001	0.027
Emotional personality – sadness		1285.919	1	1285.919	3.353	**0.070**	0.029	0.170
Condition		**585.867**	**1**	**585.867**	**1.527**	**0.219**	**0.013**	**0.115**
Error		43341.403	113	383.552				
Within-subject effects								
Part	Part 1 vs. Part 2	789.568	1	789.568	0.330	0.567	0.003	0.054
Part * Emotional wellbeing	Part 1 vs. Part 2	13399.159	1	13399.159	5.602	**0.020**	0.047	0.217
Part * Emotional intelligence	Part 1 vs. Part 2	733.245	1	733.245	0.307	0.581	0.003	0.052
Part * Emotional personality – play	Part 1 vs. Part 2	77.379	1	77.379	0.032	0.858	0.000	0.017
Part * Emotional personality – seek	Part 1 vs. Part 2	193.074	1	193.074	0.081	0.777	0.001	0.027
Part * Emotional personality – care	Part 1 vs. Part 2	6784.599	1	6784.599	2.837	**0.095**	0.024	0.156
Part * Emotional personality – anger	Part 1 vs. Part 2	1175.240	1	1175.240	0.491	0.485	0.004	0.066
Part * Emotional personality – fear	Part 1 vs. Part 2	680.703	1	680.703	0.285	0.595	0.003	0.050
Part * Emotional personality – sadness	Part 1 vs. Part 2	2400.120	1	2400.120	1.003	0.319	0.009	0.094
Part * Condition	**Part 1 vs. Part 2**	**8768.995**	**1**	**8768.995**	**3.666**	**0.058**	**0.031**	**0.177**
Error(Part)	Part 1 vs. Part 2	270270.661	113	2391.776				

Table 5.4 Results of mixed design ANOVA assessing the effect of priming (*condition*) on the *perception of emotional costs* surrounding mothering comparing perception before (*Part 1*) and after (*Part 2*) prime exposure.

Riii) *Exposure to the prime will reduce investment desires between Parts 1 and 2.*

When assessing level of *emotional investment* desired no significant effects were found (within-subjects p = 0.883, between-subjects p = 0.862). When assessing level of *physical investment* desired no significant effects were found (within-subjects p = 0.793, between-subjects p = 0.750).

When assessing level of *total investment* desired no significant effects were found (within-subjects p = 0.945, between-subjects p = 0.665).

Riv) *Exposure to the prime will increase reproductive desires between Parts 1 and 2.*

When assessing the *ideal number of children* no significant effects were found (within-subjects p = 0.702, between-subjects p = 0.942). When assessing the *likelihood of having children if not in a stable romantic relationship* no significant effects were found (within-subjects p = 0.226, between-subjects p = 0.270). When assessing the *likelihood that not being in a stable romantic relationship would lower the ideal number of children* no significant effects were found (within-subjects p = 0.300, between-subjects p = 0.417). When assessing the *likelihood of having children if not financially well off* no significant effects were found (within-subjects p = 0.106, between-subjects p = 0.356). When assessing the *likelihood that not being financially well off would lower the ideal number of children* no significant effects were found (within-subjects p = 0.679, between-subjects p = 0.754).

ECi) *Women of higher emotional capital will report lower fertility desires*

Women of higher overall *emotional capital* did not report a lower *ideal number of children*, or that not being in a stable romantic relationship or financially well off would lower their ideal number of children, or lower their likelihood of having children if not financially well off (Table 5.5). However, *emotional capital* negatively predicted the likelihood of having children is not in a stable romantic relationship (BCa p = 0.019).

Variable	Ideal number of children		Likelihood of having children if not in a stable romantic relationship		Likelihood not being in a stable romantic relationship would lower ideal number of children		Likelihood of having children if not financially well off		Likelihood not being financially well off would lower ideal number of children	
	Standardised coefficient		Standardised coefficient		Standardised coefficient		Standardised coefficient		Standardised coefficient	
	β	***p***	***β***	***p***	***β***	***p***	***β***	***p***	***β***	***p***
Overall emotional capital										
(Constant)		0.002		*0.001*		*0.002*		*0.148*		*0.001*
Emotional capital	-0.004	0.968	-0.223	***0.019***	-0.016	*0.872*	0.033	*0.692*	-0.154	***0.053***
Adjusted R^2		-0.008		0.041		-0.008		-0.007		0.016
Individual measures of emotional capital										
(Constant)		0.362		*0.308*		*0.257*		*0.153*		*0.056*
Emotional wellbeing	0.025	0.833	0.124	*0.373*	-0.162	*0.205*	-0.188	*0.146*	-0.042	*0.740*
Emotional intelligence	-0.087	0.524	-0.159	*0.229*	-0.143	*0.307*	-0.127	*0.359*	0.031	*0.790*
Emotional personality - play	0.093	0.353	0.040	*0.701*	0.081	*0.446*	-0.029	*0.769*	-0.022	*0.829*
Emotional personality - seek	-0.004	0.963	-0.103	*0.325*	0.069	*0.490*	-0.002	*0.983*	0.021	*0.831*
Emotional personality - care	0.201	**0.043**	0.090	*0.452*	0.081	*0.520*	0.183	*0.116*	-0.092	*0.390*
Emotional personality - anger	-0.031	0.741	-0.039	*0.703*	0.099	*0.365*	-0.056	*0.566*	-0.028	*0.792*
Emotional personality - fear	-0.074	0.569	0.183	*0.211*	0.024	*0.889*	-0.001	*0.995*	0.209	*0.117*
Emotional personality - sadness	0.058	0.679	-0.159	*0.304*	-0.006	*0.975*	0.015	*0.930*	0.059	*0.642*
Adjusted R^2		-0.002		0.032		-0.009		-0.017		-0.012

Table 5.5 Results of linear regression analyses assessing the influence of emotional capital on female fertility decisions. Significance values in *italics* indicate results of bias corrected and accelerated bootstrapping based on 1000 samples to counter heteroscedasticity.

The individual measures of *emotional capital* did not predict any fertility related desires, with the exception of the *emotional personality – care* subscale which positively predicted *ideal number* (p = 0.045) (Table 5.5).

ECii) *Women of higher emotional capital will report higher investment desires*

Women of higher overall *emotional capital* reported greater *emotional investment* (BCa p = 0.043), *physical investment* approaching significance (BCa p = 0.083), and *total investment* desires (BCa p = 0.038) (Table 5.6). When the individual measures of *emotional capital* were assessed, women of higher disposition to express *care* behaviours reported greater *emotional investment* (BCa p = 0.047), *physical investment* (BCa p = 0.012), and *total investment* (BCa p = 0.006) desires (Table 5.6). Women of higher *emotional wellbeing* also reported greater *physical investment* desires approaching significance (BCa p = 0.077) (Table 5.6).

Variables	**Emotional investment**		**Physical investment**		**Total investment**	
	Standardised coefficient		**Standardised coefficient**		**Standardised coefficient**	
	β	***p***	***β***	***p***	***β***	***p***
Overall emotional capital						
(Constant)		0.005		0.001		0.001
Emotional capital	0.164	**0.043**	0.145	**0.083**	0.175	**0.038**
Adjusted R^2		0.019		0.016		0.023
Individual measures of emotional capital						
(Constant)		0.304		0.030		0.071
Emotional wellbeing	-0.049	0.672	-0.200	**0.077**	-0.123	0.278
Emotional intelligence	0.106	0.497	0.027	0.839	0.044	0.764
Emotional personality - play	0.082	0.462	0.075	0.478	0.095	0.392
Emotional personality - seek	-0.067	0.434	-0.050	0.553	-0.044	0.611
Emotional personality - care	0.181	**0.047**	0.227	**0.012**	0.249	**0.006**
Emotional personality - anger	-0.102	0.209	-0.072	0.364	-0.097	0.205
Emotional personality - fear	0.054	0.685	-0.024	0.834	-0.012	0.916
Emotional personality - sadness	0.015	0.927	0.136	0.367	0.081	0.638
Adjusted R^2		0.026		0.065		0.067

Table 5.6 Results of linear regression analyses assessing the influence of emotional capital on female investment decisions. Significance values are the results of bias corrected and accelerated bootstrapping based on 1000 samples to counter heteroscedasticity.

EEi) *Exposure to the prime will increase feelings of shame regarding investment desires*

Women in the *prime* group reported higher levels of shame than the *control* group as measured by scores for *ashamed* and *embarrassed* when asked to report how they felt about their answers, but not *humiliated* or *disgraced* which were equal (Table 5.7), irrespective of their investment desires, risk perception, or emotional capital.

EEii) *Those in the control condition who expressed desire for a lower investment strategy will not report higher levels of shame because they have not been primed to detect social threat*

The models showed that, irrespective of *condition*, level of *total investment* desire negatively predicted feeling shame as measured by *ashamed* and, at a level approaching significance, *humiliated* (Table 5.7).

Higher levels of *perception of risk*, irrespective of *condition*, predicted higher levels of shame as measured by *humiliated* (Table 5.7). *Total investment* and *perception of risk* also interacted such that as *perception of risk* increased, lower levels of *total investment* desire predicted greater levels of shame as measured by feeling *ashamed, humiliated* (Table 5.8, Figures 5.3 and 5.4).

EEiii) *Women of higher emotional capital will be more susceptible to the prime and thus report higher levels of shame*

In general women of higher emotional capital were not found to be more susceptible to the *prime* and they did not experience higher levels of shame. However, women in the *prime* condition experienced relatively moderate (compared to the sample) levels of shame as measured by feeling *disgraced* irrespective of the *emotional wellbeing*, while feeling *disgraced* decreased as wellbeing decreased in women in the *control* condition (Table 5.8, Figure 5.5). Contrary to the hypothesis, women in the *prime* condition with low *emotional intelligence* experienced relatively high levels of shame as measured by feeling *disgraced*, and shame decreased as their *emotional intelligence* increased, whereas women in the *control* experienced relatively low feelings of shame irrespective of their *emotional intelligence* (Table 5.8, Figure 5.6).

Variable	Shame				Guilt			
	Ashamed	Humiliated	Embarrassed	Disgraced	Sorry	Guilty	Remorse	Regret
Emotional wellbeing	0.110	-0.128	-0.033	-0.289	-0.027	0.062	-0.111	0.023
Emotional intelligence	-0.189	-0.278*	-0.398**	-0.203*	-0.053	-0.229*	-0.180	-0.145
Emotional personality - play	0.067	-0.098	-0.050	-0.030	-0.119	0.038	-0.190*	-0.152
Emotional personality - seek	-0.054	-0.059	-0.024	-0.007	0.031	0.029	0.051	0.000
Emotional personality - care	-0.004	-0.041	0.120	-0.033	0.112	-0.046	0.085	0.026
Emotional personality - anger	-0.163	0.033	-0.039	-0.102	-0.141	-0.078	-0.087	-0.018
Emotional personality - fear	-0.163	-0.061	0.011	-0.087	-0.110	0.029	-0.112	-0.187
Emotional personality - sadness	0.048	-0.004	-0.148	0.257	0.121	-0.096	-0.018	-0.024
Perception of risk	-0.156	-0.243**	-0.077	-0.149	-0.163*	-0.024	-0.060	0.019
Total investment	-0.214**	-0.210*	-0.145	-0.145	-0.189**	-0.174**	-0.182**	-0.061
Prime vs control (ref)	0.207**	0.020	0.226**	0.049	0.241**	0.303**	0.196*	0.189
Adjusted R-square	0.112	0.088	0.074	0.014	0.101	0.072	0.038	-0.017

Table 5.7 Standardised coefficients from linear regression models assessing the effect of *condition* on *emotional response* to answers. Significance values in *italics* reflect bias corrected and accelerated bootstrapping based on 1000 samples to counter heteroscedasticity; $p < 0.1$*, $p < 0.05$**, $p < 0.001$***. Variable key: *Perception of risk* (higher score = low risk); *total investment* (higher score = higher investment); *condition* (control = reference category); *emotional wellbeing* (higher score = lower wellbeing); *emotional intelligence* (higher score = higher intelligence); *emotional personality* (higher score = higher expression of trait).

Variable	Positive fillers				Negative fillers			
	Happy	**Cheerful**	**Delighted**	**Joyful**	**Alone**	**Lonely**	**Angry**	**Irritable**
Emotional wellbeing	-0.178	***-0.232****	*-0.202*	-0.154	*-0.083*	***-0.252****	*-0.022*	*-0.107*
Emotional intelligence	-0.209	*-0.187*	*-0.206*	**-0.268***	***-0.262****	***-0.342*****	*-0.273*	*-0.227*
Emotional personality - play	0.047	*0.025*	*0.062*	0.119	*-0.108*	***-0.181****	*0.014*	*-0.069*
Emotional personality - seek	0.022	*-0.005*	*0.156*	0.013	*0.067*	*0.024*	*0.021*	*0.108*
Emotional personality - care	0.193*	*0.058*	*0.053*	0.144	*-0.061*	*0.084*	*0.070*	*0.035*
Emotional personality - anger	-0.081	*-0.056*	***-0.199****	-0.104	*-0.066*	*-0.058*	*0.042*	*0.024*
Emotional personality - fear	-0.056	*-0.020*	*0.150*	-0.079	*-0.005*	*-0.065*	*-0.100*	*-0.061*
Emotional personality - sadness	-0.085	*-0.056*	*-0.116*	-0.077	*-0.044*	*0.112*	*-0.180*	*-0.147*
Perception of risk	0.030	*0.005*	*0.111*	-0.042	*0.055*	*0.020*	*-0.114*	*-0.152*
Total investment	**0.202****	*0.123*	*0.029*	0.085	*-0.039*	*-0.125*	*-0.133*	***-0.159****
Prime vs control (ref)	**0.094**	***0.072***	***0.093***	**0.150**	***0.252*****	***0.218*****	***0.290*****	***0.237*****
Adjusted R-square	0.069	-0.016	0.009	0.005	0.025	0.077	0.042	0.033

Table 5.7 (continued) Standardised coefficients from linear regression models assessing the effect of *condition* on *emotional response* to answers. Significance values in *italics* reflect bias corrected and accelerated bootstrapping based on 1000 samples to counter heteroscedasticity; $p < 0.1$*, $p < 0.05$**, $p < 0.001$***. Variable key: *Perception of risk* (higher score = low risk); *total investment* (higher score = higher investment); *condition* (control = reference category); *emotional wellbeing* (higher score = lower wellbeing); *emotional intelligence* (higher score = higher intelligence); *emotional personality* (higher score = higher expression of trait).

Variable	**Negative fillers**							
	Scornful	**Disgusted**	**Nervous**	**Afraid**	**Frightened**	**Scared**	**Sad**	**Downhearted**
Emotional wellbeing	*-0.195*	*0.007*	-0.101	-0.059	*-0.168*	*-0.166*	-0.041	-0.130
Emotional intelligence	*-0.079*	*-0.028*	**-0.299****	**-0.285****	***-0.307*****	***-0.436*****	-0.152	**-0.266***
Emotional personality - play	*0.062*	*0.011*	-0.069	-0.170*	*-0.131*	*-0.151*	-0.036	-0.072
Emotional personality - seek	*0.015*	*0.166*	0.032	-0.003	*-0.015*	*-0.006*	-0.030	0.071
Emotional personality - care	*-0.056*	*-0.044*	0.088	0.087	*-0.019*	*0.097*	-0.019	0.017
Emotional personality - anger	*0.101*	*-0.044*	-0.071	-0.072	*-0.047*	***-0.174****	-0.147	**-0.194***
Emotional personality - fear	*0.041*	*-0.146*	-0.013	-0.090	*0.028*	*0.026*	-0.083	-0.131
Emotional personality - sadness	*0.023*	*0.026*	-0.054	-0.031	*0.000*	*-0.109*	0.127	0.195
Perception of risk	*-0.043*	***-0.194****	-0.061	**-0.207****	*-0.119*	*-0.048*	0.049	-0.012
Total investment	***-0.226****	*-0.199*	-0.039	-0.070	*-0.093*	*-0.014*	-0.022	-0.036
Prime vs control (ref)	***0.244*****	***0.150***	**0.284****	**0.262****	***0.272*****	***0.304*****	**0.333****	**0.352****
Adjusted R-square	0.022	0.069	0.038	0.123	0.095	0.173	0.072	0.147

Table 5.7 (continued) Standardised coefficients from linear regression models assessing the effect of *condition* on *emotional response* to answers. Significance values in *italics* reflect bias corrected and accelerated bootstrapping based on 1000 samples to counter heteroscedasticity; $p < 0.1$*, $p < 0.05$**, $p < 0.001$***. Variable key: *Perception of risk* (higher score = low risk); *total investment* (higher score = higher investment); *condition* (control = reference category); *emotional wellbeing* (higher score = lower wellbeing); *emotional intelligence* (higher score = higher intelligence); *emotional personality* (higher score = higher expression of trait).

Variable	Unstandardised coefficient *b*	SE	*p*	95% CI for *b*		R^2
				Lower	Upper	
Outcome – feeling ashamed						
Constant	122.643	36.488	0.001	50.186	195.101	0.255
Perception of risk	-0.356	0.121	**0.005**	-0.586	-0.105	
Total investment	-0.015	0.005	**0.004**	-0.025	-0.005	
Perception of risk*total investment	**0.001**	**0.000**	**0.014**	**0.000**	**0.001**	
Emotional wellbeing	1.443	1.175	0.222	-0.890	3.776	
Emotional intelligence	-0.153	0.125	0.224	-0.401	0.095	
Emotional personality – play	0.570	0.695	0.415	-0.811	1.951	
Emotional personality – seek	-0.348	0.548	0.527	-1.435	0.740	
Emotional personality – care	-0.091	0.618	0.884	-1.317	1.136	
Emotional personality – anger	-0.550	0.447	0.222	-1.438	0.338	
Emotional personality – fear	-0.661	0.598	0.272	-1.848	0.526	
Emotional personality – sadness	0.188	0.425	0.659	-0.656	1.032	
Condition	7.591	3.625	**0.039**	0.393	14.788	
Outcome – feeling humiliated						
Constant	103.635	24.071	0.000	55.774	151.495	0.237
Perception of risk	-0.228	0.080	**0.006**	-0.387	-0.068	
Total investment	-0.009	0.003	**0.008**	-0.156	-0.002	
Perception of risk*total investment	**0.000**	**0.000**	**0.026**	**0.000**	**0.001**	
Emotional wellbeing	-0.501	0.792	0.529	-2.075	1.073	
Emotional intelligence	-0.146	0.083	**0.084**	-0.311	0.020	
Emotional personality – play	-0.358	0.464	0.443	-1.281	0.566	
Emotional personality – seek	-0.246	0.384	0.523	-1.009	0.517	
Emotional personality – care	-0.170	0.430	0.693	-1.025	0.685	
Emotional personality – anger	0.199	0.304	0.516	-0.406	0.803	
Emotional personality – fear	-0.164	0.396	0.680	-0.950	0.623	
Emotional personality – sadness	0.022	0.282	0.938	-0.539	0.583	
Condition	0.255	2.241	0.917	-4.559	5.068	
Outcome – feeling disgraced						
Constant	71.412	25.588	0.007	20.283	122.001	0.185
Condition	-13.306	6.645	**0.048**	-26.514	-0.099	
Emotional wellbeing	-8.194	2.562	**0.002**	-13.287	-3.101	
Condition*emotional wellbeing	**3.888**	**1.528**	**0.013**	**0.851**	**6.926**	
Emotional intelligence	-0.101	0.111	0.366	-0.321	0.120	
Emotional personality – play	-0.160	0.620	0.794	-1.372	1.052	
Emotional personality – seek	-0.123	0.497	0.805	-1.111	0.865	
Emotional personality – care	-0.189	0.540	0.727	-1.263	0.885	
Emotional personality – anger	-0.302	0.384	0.434	-1.066	0.461	
Emotional personality – fear	-0.323	0.519	0.536	-1.355	0.709	
Emotional personality – sadness	0.734	0.376	**0.054**	-0.012	1.481	
Total investment	-0.001	0.001	0.213	-0.004	0.001	
Perception of risk	-0.044	0.027	0.106	-0.098	0.010	

Table 5.8 Significant moderation results from testing for interactions between factors influencing maternal investment on emotional response to investment decisions. Significance and 95% CIs are the result of bias corrected bootstrapping based 1000 samples.

Variable	**Unstandardised coefficient *b***	**SE**	***p***	**95% CI for *b***		**R^2**
				Lower	**Upper**	
Outcome – feeling disgraced						
Constant	-19.698	41.109	0.633	-101.407	62.012	0.175
Condition	52.352	22.152	**0.020**	8.322	96.381	
Emotional intelligence	0.357	0.244	0.147	-0.128	0.841	
Condition*emotional intelligence	**-0.347**	**0.150**	**0.023**	**-0.644**	**-0.50**	
Emotional personality – play	-0.052	0.615	0.963	-1.275	1.170	
Emotional personality – seek	0.095	0.502	0.850	-0.902	1.092	
Emotional personality – care	-0.097	0.544	0.859	-1.179	0.984	
Emotional personality – anger	-0.329	0.386	0.396	-1.096	0.438	
Emotional personality – fear	-0.259	0.523	0.622	-1.298	0.780	
Emotional personality – sadness	0.561	0.376	0.140	-0.187	1.309	
Total investment	-0.002	0.001	0.139	-0.004	0.001	
Risk perception	-0.052	0.028	**0.064**	-0.107	0.003	
Emotional wellbeing	-2.536	1.023	**0.015**	-4.569	-0.503	
Outcome – feeling angry						
Constant	-89.913	65.299	0.172	-219.640	39.815	0.210
Total investment	0.029	0.011	**0.014**	0.006	0.051	
Emotional intelligence	0.699	0.389	**0.076**	-0.075	1.472	
Total investment*emotional intelligence	-0.000	0.000	**0.008**	-0.000	-0.000	
Emotional personality – play	0.233	0.820	0.777	-1.397	1.863	
Emotional personality – seek	0.122	0.658	0.853	-1.184	1.428	
Emotional personality – care	0.293	0.759	0.700	-1.214	1.801	
Emotional personality – anger	0.192	0.523	0.715	-0.848	1.232	
Emotional personality – fear	-0.248	0.700	0.700	-1.214	1.801	
Emotional personality – sadness	-0.741	0.501	0.143	-1.737	0.255	
Perception of risk	-0.036	0.037	0.330	-0.110	0.037	
Emotional wellbeing	-0.458	1.360	0.737	-3.160	2.244	
Condition	14.002	4.272	**0.002**	5.515	22.489	
Outcome – feeling sorry						
Constant	154.172	48.187	**0.002**	58.522	249.822	0.260
Perception of risk	-0.528	0.159	**0.001**	-0.844	-0.213	
Total investment	-0.023	0.007	**0.001**	-0.036	-0.009	
Perception of risk*total investment	**0.000**	**0.000**	**0.004**	**0.000**	**0.000**	
Emotional personality – play	-0.935	0.920	0.312	-2.761	0.892	
Emotional personality – seek	0.175	0.725	0.810	-1.265	1.615	
Emotional personality – care	0.798	0.816	0.331	-0.821	2.417	
Emotional personality – anger	-0.574	0.582	0.327	-1.730	0.582	
Emotional personality – fear	-0.548	0.786	0.488	-2.109	1.013	
Emotional personality – sadness	0.558	0.562	0.323	-0.557	1.672	
Emotional wellbeing	0.193	1.539	0.901	-2.862	3.248	
Condition	11.858	4.739	**0.014**	2.452	21.624	
Emotional intelligence	-0.036	0.164	0.829	-0.362	0.291	

Table 5.8 (continued) Significant moderation results from testing for interactions between factors influencing investment on emotional response to investment decisions. Significance and 95% CIs are the result of bias corrected bootstrapping based 1000 samples.

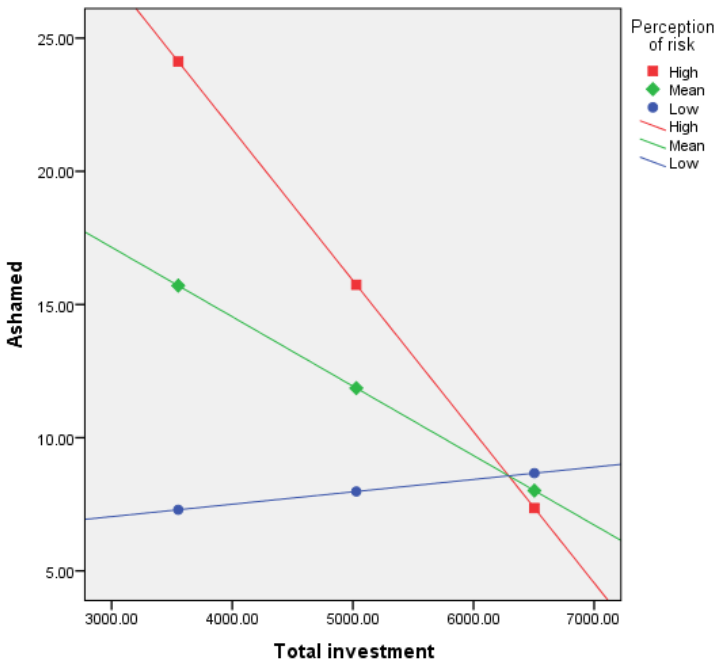

Figure 5.3 Simple slopes equations of the regression of *total investment* (higher score = higher investment) on the experience of shame as measured by feeling *ashamed* (higher score = higher shame) at three levels of *perception of risk*. Values for *perception of risk* are the mean and +/- one standard deviation of the mean.

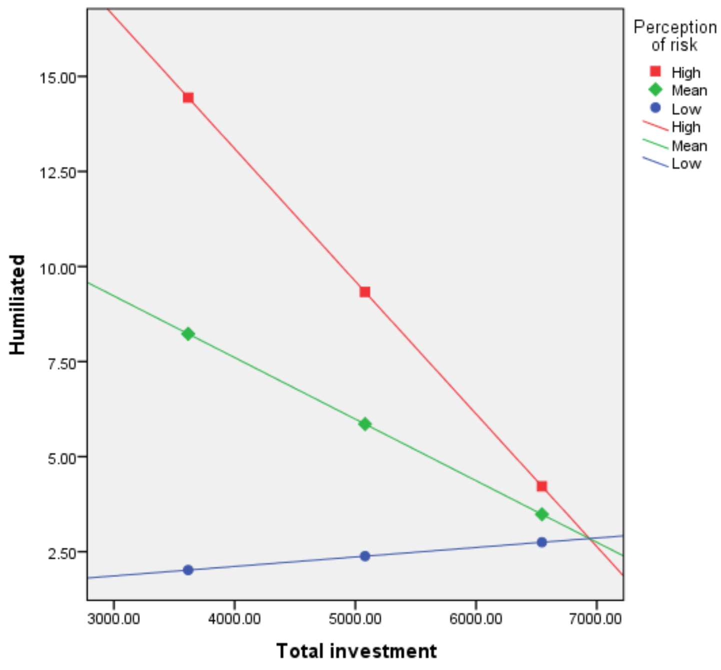

Figure 5.4 Simple slopes equations of the regression of *total investment* (higher score = higher investment) on the experience of shame as measured by feeling *humiliated* (higher score = higher shame) at three levels of *perception of risk*. Values for *perception of risk* are the mean and +/- one standard deviation of the mean.

Further analysis)

Condition

Women in the *prime* group reported higher levels of guilt as measured by feeling *sorry*, *guilty*, and, at a level approaching significance, *remorse*, as well as higher levels of feeling *alone*, *lonely*, *angry*, *irritable*, *scornful*, *nervous*, *afraid*, *frightened*, *scared*, *sad*, and *downhearted* when reflecting on their answers (Table 5.7), irrespective of their investment desires, risk perception, or emotional capital.

Investment desires

Total investment interacted with *emotional intelligence* (Table 5.8) such that at low levels of investment women reported consistent moderate (relative to the sample range) feeling *angry* irrespective of their *emotional intelligence,* while at mean and high levels of investment feeling *angry* decreased as *emotional intelligence* increased (Figure 5.7). The fall was sharpest in the high investing women who report the highest levels of *anger* when low on *emotional intelligence* and the lowest levels of *anger* when high on *emotional intelligence*.

The positive emotion of feeling *happy* was also positively predicted by *total investment* desires (Table 5.7).

Perception of risk

Guilt as measured by feeing *sorry* was positively predicted by *perception of risk* at a level approaching significance (Table 5.7), and higher levels of *perception of risk* also predicted higher levels of feeling *disgusted* approaching significance and *afraid* (Table 5.7).

Total investment and *perception of risk* also interacted (Table 5.8) such that as *perception of risk* increased, lower levels of *total investment* desire predicted greater levels of guilt as measured by feeling *sorry* (Figure 5.8).

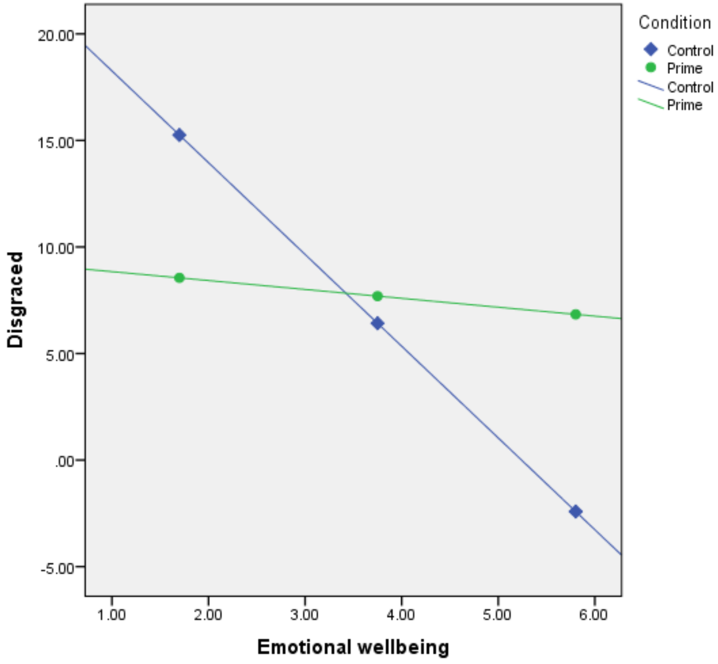

Figure 5.5 Simple slopes equations of the regression of *emotional wellbeing* (higher score = lower wellbeing) on the experience of shame as measured by feeling *disgraced* (higher score = higher shame) dependent on *condition*.

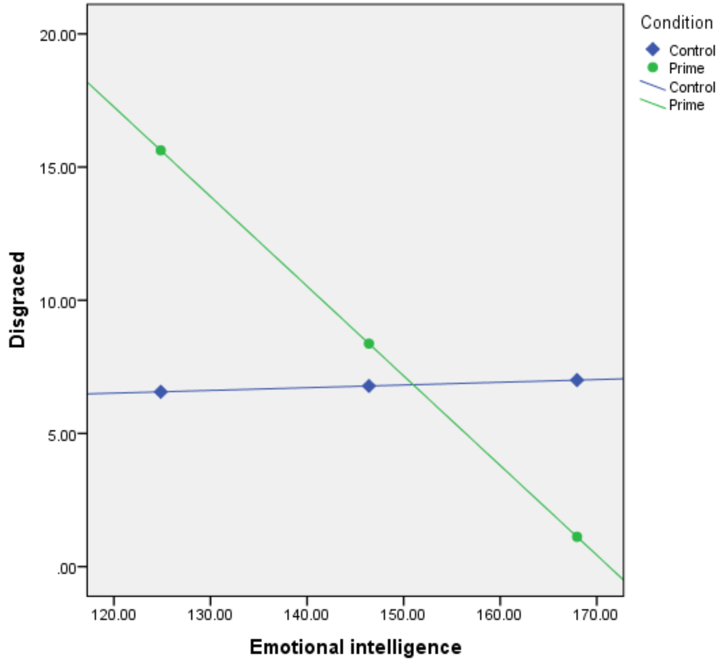

Figure 5.6 Simple slopes equations of the regression of *emotional intelligence* (higher score = higher intelligence) on the experience of shame as measured by feeling *disgraced* (higher score = higher shame) dependent on *condition*.

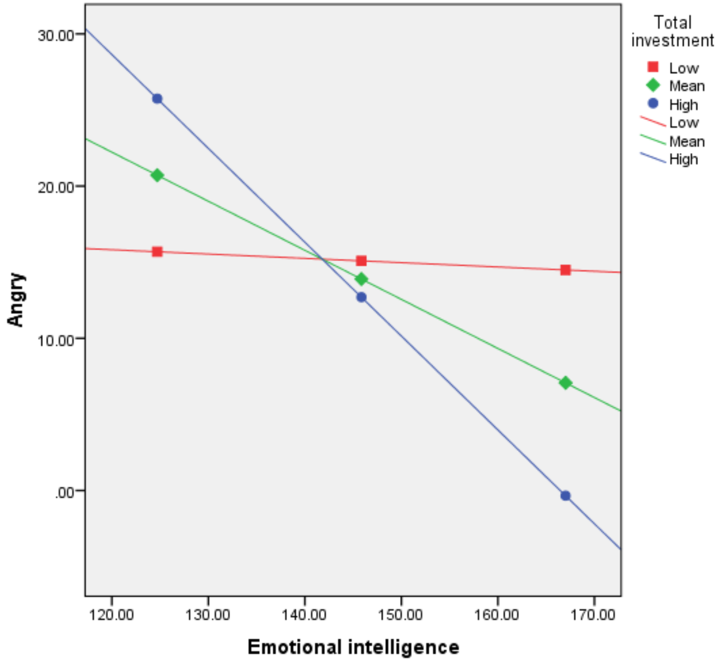

Figure 5.7 Simple slopes equations of the regression of *emotional intelligence* (higher score = higher intelligence) on the experience of feeling *angry* (higher score = higher anger) at three levels of *total investment*. Values for *total investment* are the mean and +/- one standard deviation of the mean.

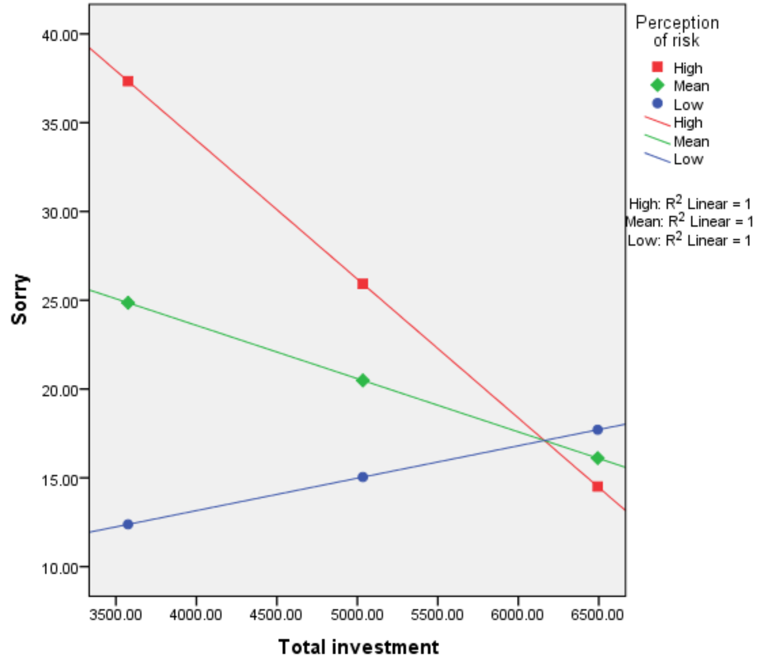

Figure 5.8 Simple slopes equations of the regression of *total investment* (higher score = higher investment) on the experience of feeling *sorry* (higher score = more sorry) at three levels of *perception of risk*. Values for *perception of risk* are the mean and +/- one standard deviation of the mean.

Emotional capital

Emotional wellbeing positively predicted feeling *cheerful,* and *lonely* at levels approaching significance, after controlling for investment desires, risk perception, exposure to the prime, and the other individual emotional capital measures (Table 5.7). *Emotional intelligence* negatively predicted feeling *lonely, nervous, afraid, frightened, scared,* and, at levels approaching significance, *joyful, alone,* and *downhearted*, after controlling for investment desires, risk perception, exposure to the prime, and the other individual emotional capital measures (Table 5.7). The *emotional personality – play* subscale negatively predicted *guilt* as measured by feeling *remorse* and *lonely* at levels approaching significance, the *care* subscale positively predicted feeling *happy* at a level approaching significance, and the *anger* subscale negatively predicted feeling *delighted*, *scared*, and *downhearted* at levels approaching significance, after controlling for investment desires, risk perception, exposure to the prime, and the other individual emotional capital measures (Table 5.7).

Discussion

None of the hypotheses regarding the effect on women's quality-quantity offspring trade-offs of exposure to messages regarding the high costs of raising a high quality infant or the emotional costs to the mother of investing were supported. However, none of the hypotheses were contradicted by significant results in the opposite direction either, which may simply indicate the *prime* was ineffectual rather than the hypotheses incorrect. Exposure to the *prime* did not increase the perception of risks surrounding mothering or the costs of mothering in terms of financial, social, or employment costs; however the emotional costs were found to increase at a level approaching significance which is supportive of the argument that the sociocultural WEIRD mothering environment emphasises the importance of maternal emotional investment. The general lack of support found for the hypotheses may suggest that messaging in popular and social media surrounding mothering does not alter women's risk and cost perceptions. Alternatively, the prime may simply not have been strong enough to create any distinction between the groups because of the levels of exposure women already have to such messages. The women in the control condition were not recruited from a sociocultural vacuum devoid of exposure to similar constructions of motherhood; 29% of the participants reported having encountered ‘quite a few’ to ‘quite a lot’ of news stories regarding some aspect of parenting in the last few weeks, 33% had read ‘quite a few’ to ‘quite a lot’ of popular articles in magazines or on websites regarding some aspect of parenting, 56% had visited a pregnancy or parenting advice website in the past, and 48% had read a pregnancy or parenting advice book. As such all of the women in the study arguably have been effectively ‘primed’ by their day to day experiences, irrespective of the study condition they were assigned to. A future avenue of research would be to conduct a similar study including a third group who were primed messages regarding the resilience of infants and how easy and rewarding women find becoming a mother to see if this resulted in *declines* in cost and risk perception.

These results are generally unsupportive of the hypothesis that women of higher emotional capital will express lower fertility desires stemming from the notion that they will favour a quality over quantity reproductive strategy as a result of being better positioned to raise offspring of higher emotional and cognitive quality. However, women of higher emotional capital did report being less likely to have children if not in a stable romantic relationship. Contrary to the hypothesis, women with a greater disposition towards expressing caring behaviour, as measured by the emotional personality *care* subscale, reported a higher ideal number of offspring, thus the hypothesis may be incorrect. However, as is typical of fertility desires in WEIRD contexts (Goldstein, Lutz, and Testa, 2003), women generally reported low ideal offspring numbers (mean 2.162, s.d. 1.065) thus there was very little variation. The hypothesis may still be correct but if the influence of emotional capital is of small effect size then the sample size would not give enough power to detect it; future work with a larger sample would help resolve this issue.

The hypothesis that women of higher emotional capital will express higher investment desires was supported both in terms of emotional and, at a level approaching significance, physical investment. It is perhaps unsurprising that of the individual measures of emotional capital, the *care* dimension of emotional personality played the largest role in predicting investment. That emotional wellbeing positively predicted physical investment at a level approaching significance but not emotional investment is interesting. People suffering from depression have been shown to be less able to look after themselves (Manning Jr, and Wells, 1992), people low on emotional wellbeing, and thus likely to have depressive symptoms to some degree, may perceive their capacity to physically look after an infant as being reduced based on their current ability to sustain themselves.

Participants who were in the prime condition and exposed to messages from popular and social media regarding the damage mothers can do to their children and the disapproval they may face from other mothers experienced greater levels of shame, supporting the hypothesis that exposure to such messages play a causal role in maternal shame. Thus while the first set of prime texts did not have the anticipated results, priming social threat and poor offspring outcomes by exposing participants to popular and social media appears to have been successful, indicating that these are causal factors in the emotional distress experienced by mothers. Even women who expressed high levels of hypothetical investment, women who perceived low levels of risk surrounding mothering, and women who had high emotional capital, experienced more shame if exposed to the prime stimuli. This demonstrates that the sociocultural mothering environment in WEIRD contexts can be detrimental to women's emotional health irrespective of whether they are of high emotional capital and conforming to culturally expected 'intensive mothering' standards.

The hypothesis that those not in the prime condition would not experience feelings of shame correlating with their investment desires due to their not having been exposed indicators of social threat was also partly supported. Women did report greater levels of feeling ashamed and humiliated the lower their level of investment and the higher their risk perception. However, risk perception moderated the relationship between investment and shame such that low investing women did not experience feeling ashamed or humiliated when their level of risk perception was also low.

These results do not generally support the final hypothesis, with women of high emotional capital being equally, rather than more, susceptible to prime induced shame as women of low emotional capital, as signified by most measures; however, the feeling of disgrace behaved differently to other measures of shame. Women in the prime group appeared to be protected from feeling disgrace if they had higher emotional intelligence, resulting in them having lower feelings of disgrace than women in the control group. Women of lowest emotional wellbeing felt least disgrace in the control group, while moderate levels of disgrace were experienced across the wellbeing spectrum in the prime group. This is suggestive of emotional capital on the whole being neither detrimental nor protective when it comes to the experience of shame relating to mothering, mirroring findings from Chapter 4.

The findings regarding the ‘filler’ emotions are perhaps as interesting as the results regarding the hypotheses which guided the development of this study in the first place. Covering a range of positive and negative affect, these fillers were employed in the survey to disguise the fact that participants were being asked about their feelings of shame, and they were run in the same models as the shame feelings to see whether exposure to the prime lead to negative emotions more generally. While no overt hypotheses were made regarding the experience of these emotions, the results nonetheless have potentially important implications for the aetiology of PND.

Exposure to the prime did indeed increase negative feelings in general when women were asked to reflect on their answers compared to women in the control condition. Feelings of guilt, being alone, lonely, angry, irritable, scornful, nervous, afraid, frightened, scared, sad, and downhearted were all elevated in women in the prime condition, at levels either significant or approaching significance, irrespective of their investment desires, risk perception, or emotional capital, reinforcing the conclusion that elements of the way mothering is culturally constructed in WEIRD contexts are detrimental to female emotional wellbeing and adding to the existing literature on this topic (see Chapter 3).

Even after controlling for exposure to the prime, participants reported increasing levels of guilt and, at a level approaching significance, feeling irritable, in addition to shame, as their desired levels of investment declined. Despite the failure of the prime to elevate women's perception of risk surrounding mothering, reported level of risk perception nevertheless was also found to positively predict feelings of being afraid and, at a level approaching significance, guilt and disgust after controlling for investment desires and emotional capital. In addition to moderating the relationship between shame and total investment, perception of risk was found to moderate the relationship between feeling sorry about low investment desires with this factor of guilt only being positively associated with investment level at higher levels of perceived risk.

While emotional capital was generally found to be protective against negative emotions once prime exposure, investment desires, and risk perception were controlled for, as noted already this protection was not strong enough to moderate the effects of the prime. With the exception of being high on the emotional personality anger spectrum, emotional capital was also not found to moderate the effects of risk perception but it did alter feelings of anger related to desired levels of investment. Women who expressed desire for high levels of investment experienced relatively moderate to high feelings of anger when they were of low emotional intelligence, and feelings of anger decreased as their emotional intelligence increased. While low investing women expressed relatively moderate levels of anger irrespective of their emotional intelligence.

Together these results provide support for the proposition that Western sociocultural constructions of motherhood can be detrimental to maternal emotional health. They also suggest that the ways in which motherhood is discussed in popular and social media is emotionally damaging to women, particularly young women, more generally as the participants in this study were largely childless women in their twenties simply asked to reflect on their maternal desires. In terms of PND more specifically, these results indicate a causal role for perceptions of risk and social threat born of societal construction due to their eliciting feelings of shame, which is a known depression trigger (Andrews, Qian, and Valentine, 2002; Rüsch *et al*., 2007).

Further support for links between in popular and social media messages regarding mothering and PND comes from the additional findings that the prime elevated feelings of social isolation and anger when reflecting on maternal desires. As discussed in previous chapters, social isolation is major risk factor for depression and is held by maintenance based evolutionary explanations of depression to trigger a pre-emptive inflammatory immune response which protects individuals from physical threat and generates depressive characteristics **(**Cole *et al*., 2007; Raison and Miller, 2013). Women with negative attributional styles, of which anger is a factor, have been found to be more at risk of PND (Robertson *et al*., 2004) and qualitative studies of PND frequently document anger to be a prominent factor in women's experiences of PND (Beck, 2002). The prevailing view in psychiatry is that anger, seen to be directed at the infant, is a symptom of PND (Hagen and Clark Barrett, 2007) and Hagen suggests the demonstrable threat this poses to infants motivates kin to take on more care giving activities thus reducing a mother's costs (Hagen, 2002; Hagen and Clark Barrett, 2007). Moderation analysis found that low emotional intelligence women expressed more anger in association with high investment strategies and high emotional intelligence women expressed moderate anger in association with low investment strategies. The women in this study were angry in relation to their investment decisions without actually having an infant or PND, irrespective of their emotional wellbeing, suggesting that anger may be involved in the development of PND rather than a symptom of it. Depression in adolescents is linked to the way in which they cope with anger (Goodwin, 2006); depression is more likely in adolescents who respond to anger with substance misuse, aggressive behaviour, and emotional coping behaviour, and less likely in those who respond with physical activity. Maternal resilience, has been defined in the psychoanalytic literature as the ability to tolerate ambivalent, sometimes angry and aggressive, feelings towards a child, towards mothering, and towards the self as a mother (Baraitser and Noack, 2007). The results of this study indicate coping strategies in the face of anger warrant investigation in perinatal women as a target for preventing PND. That the relationship between investment and anger varies by emotional capital suggests emotional capital affects the way women experience their investment decisions within their sociocultural environment and indicates a pathway by which women of both high and low emotional capital end up with PND.

Potential limitations

Participants in the study were recruited from a student population thus their responses may not be representative of the wider female population; future research should be conducted on a broader sample of women to both assess the generalisability and replicability of these findings. Whilst questions regarding risk associated specifically with mothering were posed, no measures of experience of extrinsic risks which may alter life history strategies, such as childhood adversity and SES, were included so factors other than exposure to the prime could not be controlled for when assessing the influence of emotional capital on fertility and investment. Along similar lines no explicit measure of embodied capital was taken, although given all participants were university students it is reasonable to assume they were of relatively homogenous capital in terms of education at least. The sample included some women who had children already (N = 14) which may have affected their responses, however exploratory analysis found no difference in their reported fertility or investment desires when compared to women who had no children (see Appendix J) and so they were included in the analysis to maximise sample size.

Conclusions

While not all of the hypotheses were supported by these results, the findings that emotional capital increases investment desires and exposure to messages of risk and social threat regarding maternal choices elicits feelings of shame, social isolation, and anger lend support to the hypothesis that PND can be caused by a stress response to the subjective experience of mothering in certain sociocultural contexts. That women of high emotional capital were still found to experience shame when exposed to the prime stimuli, and shame at low investment strategies was tied to risk perception, and by extension perceived detrimental offspring outcomes, is also supportive of this hypothesis, suggesting that women become postnatally depressed because they experience social stress in relation to their maternal decisions under a wide array of circumstances.

Chapter 6 – A Comprehensive Psychosocial Stress Model for Predicting Postnatal Depression

Chapter outline

Approaches to PND combining understanding from both biological and psychosocial perspectives are a rarity at present; Yim *et al* (2015) conclude "…Biological and psychological theories have guided research and provided insight into an important piece of the PPD puzzle, but they do not help us understand how psychosocial stress processes are instantiated in women's brains and bodies, nor how genetic or epigenetic changes interact with psychosocial risk factors to influence PPD risk" (2015: 102). The analysis which follows builds on the results of Chapter 3, which indicated the shame and social isolation predict PND, and develops a comprehensive psychosocial stress model for predicting PND based on theory drawn from human social genomics, a field that offers the integrative framework sought by Yim *et al*.

Postnatal depression – an integrative approach

Although a very limited number of studies have sought to assess biological and psychosocial risk factors in conjunction, the few of those that have showed promising explanatory power. The stress-vulnerability model of PND finds support in three studies of polymorphisms in the serotonin transporter gene, which find interactions between polymorphisms and stressful events during pregnancy (Comasco, *et al*., 2011; Mehta *et al*., 2012; Pinheiro *et al*., 2013). Only one study appears to have been conducted which is integrative in the sense that it assessed biological reactions to social factors and how this altered the probability of PND (Yim *et al*., 2015). Hahn-Holbrook *et al*. (2013) found that support from family during pregnancy lowered increases in CRH, thereby protecting against PND. This is indicative of psychosocial and biological factors, rather than being independent risk factors as often thought, being instead different levels of the same aetiological route to PND (Yim *et al*., 2015).

In their review Yim *et al*. (2015) make passing reference to two evolutionary perspectives on PND, Hagen's (1999) adaptationist approach and Hahn-Halbrook and Haselton's (2014) mismatch approach, noting their capacity to answer the question "Why does PPD exist at all?" (2015: 103). However, perhaps because their focus was on PND in particular, rather than depression in general, they do not consider approaches grounded in human social genomics which cast depression as a maintenance strategy (Kinney and Tanaka, 2009; Raison and Miller, 2013; Slavich *et al*., 2010a), and as such do not recognise the integrative potential this evolutionary framework provides.

The adaptationist and mismatch evolutionary explanations of PND struggle to explain the presence of PND in women who are without the commonly recognised risk factors for PND (Myers, Burger, and Johns, 2016); an issue stemming from the fact these evolutionary explanations are *based* on such risk factors. A social genome approach to depression, on the other hand, views the multiple risk factors for depression as being causally linked via their influence in triggering the immune system's inflammatory response, widening the scope of factors which may explain why a woman develops PND. Kendall-Tackett (2007) highlights the role of maternal psychosocial stress in such an immune response, arguing that the commonly recognised risk factors for PND are all likely to increase inflammation. The results from Chapter 3 provide evidence that two types of social stress linked to depression and inflammation but not previously associated with PND – shame (Slavich *et al*., 2010a) and social isolation (Cole *et al*., 2007) – do indeed predict it.

Antenatal depression is arguably the most important risk factor for PND, with 80% of women depressed during pregnancy going on to suffer from PND (RCM, 2012b). Antenatal depression has also been associated with inflammation (for a review see Miller *et al*., 2013) and, as to be expected from a social genome perspective, it shares risk factors with PND (Lancaster *et al*., 2010). When viewed from a social genome position, the distinction between antenatal depression and PND, and general depression for that matter, is simply temporal and, thus, arguably arbitrary. Nonetheless, it is a distinction that is prevalent in the medical literature and for the purposes of making statements regarding public health antenatal depression provides a useful benchmark against which to compare the effect sizes of other PND risk factors in the following analyses.

Research question

> *Does the experience of social stress explain PND in women lacking commonly recognised risks for PND?*

Hypothesis

Maternal shame and maternal social isolation will positively predict PND when controlling for other risk factors

In a model containing antenatal depression, other recognised PND risk factors, maternal shame, and maternal social isolation, all will positively predict PND due to their independent effect on PND risk.

Material and methods

-Data collection

The experiences of women were collected using a multi-wave questionnaire. Participants were recruited for the first wave during the second and third trimester of pregnancy (wave 1), and they then took part in follow-up questionnaires at approximately 1 month after birth (wave 2) and 6 months after birth (wave 3). For full details see Chapter 3.

-Questionnaires

For the full questionnaires, along with rationales behind each question and relevant references see Appendix E.

-Measures

The following measure was used in addition to those introduced in Chapter 3.

Recognised risks for PND

Analysis presented in Chapter 4 found a composite measure incorporating various recognised PND risk factors, labelled *maternal resources*, was effective in predicting PND. The *maternal resources* measure reflected a composite of SES, education, relationship stability, and childcare stress (financial and transport means to access local mother and baby groups), where a higher score indicated greater resources. As noted in Chapter 3, social support is also a standard predictor of PND (Beck, 2001); it was left out of the *maternal resources* measure used in Chapter 4 for the purposes of assessing the emotional capital hypothesis, but for the purposes of creating a comprehensive model for predicting PND, overall emotional support during pregnancy was added to the *maternal resources*. The higher a score for the *maternal resources* variable the higher a woman's resources; however low resources indicate PND risk (Beck, 2001) so the scores were then reversed to create an expanded measure of *recognised risks* where a higher score indicated higher risk.

-Sample characteristics

See Chapter 3.

-Modelling approach and data handling

Model 1

The first model presented combines *antenatal depression*, other *recognised risks* for PND, *maternal shame*, and *time spent alone* to test the hypothesis that all will positively predict PND due to their independent effect on PND risk.

Model 2

The *time spent alone* variable was only measured at approximately 6 months postnatally; while, it is likely to be a useful proxy for time spent in social isolation from other adults on weekdays for much of the postnatal period up until this point, this is unlikely to be the case for the first four weeks after birth when fathers may be on paternity leave and mothers receive increased attention from family, friends, and health workers. A secondary model (*Model 2*) is also presented to assess whether maternal shame remains a significant predictor of PND at approximately 1 month postnatally after controlling for other recognised risk factors. Unfortunately, level of educational attainment was only recorded for women completing the third wave of the study, and using the full measure of *recognised risks* in this model leaves the sample size too small (N = 33); therefore a cut-down version of the *recognised risks* measure is used in which education has been removed.

-Statistical approach

Model 1) A binary logistic regression model was run in which *PND ever* (wave 3) acted as the dependent variable and *recognised risks* (wave 1), *maternal shame* (wave 1), *time spent alone* (wave 3), and *antenatal depression* (wave 1) acted as the predictor variables. The continuous variables, *recognised risks* and *maternal shame*, were centred and standardised to enable their odds ratios to be interpreted as effect sizes and compared to those from the categorical variables, *time spent alone* and *antenatal depression*.

Model 2) A linear regression was run in which *depressive symptom severity* (wave 2) acted as the dependent variable and *recognised risks* (wave 1), *maternal shame* (wave 1), and *antenatal depression* (wave 1) acted as the predictor variables. BCa bootstrapping was applied to counter heteroscedasticity.

Results

Model 1) *Antenatal depression*, *time spent alone*, and *recognised risks* predicted the experience of PND within 6 months (*PND ever*), while *maternal shame* showed a similar trend but only approached significance (p = 0.092 one-tailed), with the model explaining between 57 – 80% of the variance in PND (Table 6.1); tolerance and VIF statistics indicated no collinearity. *Antenatal depression* showed the largest effect size with an OR = 1664.588 (p = 0.026), followed by *time*

Variable		*b*	SE	Wald	df	*p*	95% CI for odds ratio		Odds ratio/effect size	Pseudo R^2's C&S/N	Collinearity Statistics	
							Lower	Upper			Tolerance	VIF
Recognised risks		2.915	1.315	4.916	1.000	**0.027**	1.402	242.595	18.445	0.574 / 0.798	0.908	1.101
Maternal shame		1.405	1.057	1.767	1.000	0.184	0.514	32.355	4.076		0.909	1.100
Time spent alone	8-24 hrs	6.060	2.887	4.406	1.000	**0.036**	1.495	122853.541	428.500		0.968	1.033
	0-8 hrs (ref)	-	-	-	-	-	-	-	-		-	-
AND	Yes	7.417	3.333	4.952	1.000	**0.026**	2.421	1144354.841	1664.588		0.965	1.036
	No (ref)	-	-	-	-	-	-	-	-		-	-
Constant		-7.168	3.061	5.484	1.000	0.019	-	-	0.001		-	-

Table 6.1 Results of binary logistic regression predicting the experience of PND within approximately 6 months of giving birth. Continuous variables have been centred and standardised to enable the odds ratio to be interpreted as an effect size. Abbreviations: Cox & Snell (C&S), Nagelkerke (N), variance inflation factor (VIF).

Variable	Unstandardised coefficient		Standardised coefficient	*p*	95% CI for *b*		Adjusted R^2	Collinearity statistics	
	b	**SE**	***β***		**Lower**	**Upper**		**Tolerance**	**VIF**
Recognised risks	0.203	0.244	0.112	0.408	-0.262	0.682	0.114	0.917	1.09
Maternal shame	0.334	0.202	0.227	**0.081**	-0.052	0.709		0.885	1.13
Antenatal depression (no = ref)	2.886	1.517	0.251	0.132	-0.938	6.729		0.963	1.038
Constant	2.961	2.159		0.231	-1.894	7.992			

Table 6.2 Results of linear regression predicting the PND symptom severity at approximately 1 month after giving birth. Abbreviations: Variance inflation factor (VIF). Significance and 95% CIs are the result of bias corrected and accelerated bootstrapping based on 1000 samples to counter heteroscedasticity.

spent alone with an OR = 428.500 (p = 0.036), then the composite measure of *recognised risks* with an OR = 18.445 (p = 0.027), and finally *maternal shame* with the smallest effect size with an OR = 4.076 (p = 0.184).

Model 2) *Maternal shame* positively predicted the severity of depressive symptoms at approximately 1 month postnatally at a level approaching significance (BCa p = 0.081) (Table 6.2); there was a general trend for *antenatal depression* to positively predict depressive symptom severity, which approached significance (BCa p = 0.066 one-tailed). The standardised coefficients showed *antenatal depression* to have the largest effect size, tolerance and VIF statistics indicated no collinearity, and the model explained 11% of the variance in PND (Table 6.2).

Discussion and conclusions

PND was predicted by two markers of social stress, social isolation and shame, providing evidence in favour of a social genome approach to PND. Shame appears most relevant to predicting PND in the early postpartum, while later in the first six months after birth social isolation becomes the more powerful risk factor. That social isolation and shame (if significance is one-tailed) remained significant when entered along with previously recognised PND risk factors and antenatal depression is also supportive of the view that there are multiple inflammatory related pathways to the development of PND. These results are supportive of an explanation for PND based on it being reflective of the activation of a conserved transcriptional response to adversity (Slavich and Cole, 2013) and of the potential to explain cases of PND in women without commonly recognised risk factors as being the result of inflammation triggered by social evaluative threat. The length of time women spend alone during the week is a strong predictor of PND, with confidence intervals showing considerable overlap with those of antenatal depression, and appears to be separate from the emotional support received from family and friends (encompassed in the *recognised risks* variable), and as such is indicative of its being an independent unrecognised PND risk factor and opens up avenues for preventative action.

Potential limitations

Due to small sample size the applicability of these results to the wider population is uncertain; however they certainly highlight the need for larger scale studies. A larger scale study would also clarify the predictive power of maternal shame. The lack of education data on the full sample is potentially problematic and this should be addressed in future research.

Chapter 7 – Conclusions and Public Health Implications

Chapter outline

A large amount of novel empirical data has been presented in the preceding chapters for the purposes of both developing and testing various evolutionary hypotheses regarding PND and making public health recommendations aimed at improving medical practitioners ability to identify women at risk of developing PND, and more generally at preventing it. In this concluding chapter the implications of the results generated in previous chapters for evolutionary approaches of PND and maternal investment in infants will be briefly reviewed, before moving on to finish with some suggestions for enhancing public health measures surrounding PND and maternal mental wellbeing.

Evolutionary implications

Previously existing evolutionary approaches to PND, reviewed in Chapters 1 and 2, were grounded in Evolutionary Psychology, viewing it as an adaptive mechanism signalling to a mother that she should withdraw investment (Hagen, 1999, 2002; Hagen and Clarke Barrett, 2007; Thornhill and Furlow, 1998), as an adaptive aid to maternal responsiveness (Crouch, 1999), a bargaining adaptation to enhance maternal resources via social subsidy (Crouch, 1999; Hagen, 2002; Hagen, and Rosenström, 2016; Thornhill and Furlow, 1998), or a ‘disease of modern civilisation’ resulting from a mismatch between physiology and behaviour evolved in the EEA and contemporary WEIRD environments (Hahn-Holbrook and Haselton, 2014). Until now, empirical data had only been used to test and support adaptationist claims regarding the incidence of PND; however, as noted in Chapter 2, evidence from the medical literature suggested that PND, and depression more generally, is associated with very high costs in terms of morbidity, mortality, infant development, and female reproductive functioning. These are costs which the benefits proposed by adaptive accounts must surmount, yet despite being formulated over a decade ago and being relatively widely recognised, in particular the work of Hagen, their claims had not been subjected to substantive empirical testing. This led to the posing of the first research question outlined in Chapter 1: *'Are there identifiable adaptive benefits to PND or is it too costly to show good design as a signal/aid to maternal investment?'* The study presented in Chapter 2 was designed to address this gap in the literature, and the results were largely unsupportive of the case for good design with PND instead associated with high costs. Women experiencing PND were found to incur costs in terms of lower completed fertility, as a result of reduced parity progression likelihood and increased interbirth intervals, and had lower quality relationships with their offspring born in association with PND and the grandchildren from these offspring, which is suggestive of intergenerational reductions in offspring quality. Previous findings supportive of an adaptationist account in relation to decreased PND incidence with age (Hagen, 2002) also failed to be replicated in a larger sample size. These results, combined with findings of the presence of PND in the pre-industrialised Tsimane (Myers *et al*., 2016), highlighted the need for a more nuanced evolutionary approach to PND.

The Pathogen Host Defense hypothesis (Raison and Miller, 2013), one of two broadly similar social genome approaches to general depression based on its being a 'conserved transcriptional response to adversity' (Slavich and Cole, 2013), the other being Slavich *et al*.'s (2010a) psychobiological model of social rejection and depression, had received support from findings regarding pathogen load and general depressive symptoms in the Tsimane (Stieglitz *et al*., 2015). While PND had not been previously subject to targeted investigation by social genome researchers, the links between psychosocial stress, inflammation, and PND had been noted by Kendall-Tackett (2007), indicating a social genome based approach to PND to be a productive avenue for illuminating novel PND risk factors. The need for new risk factors was also highlighted by findings published in Myers, Burger, and Johns (2016) (see Appendix C) which showed that commonly recognised risk factors cannot account for all cases of PND.

While the current adaptationist paradigm for PND is disputed, the framework of parental investment theory which underlies the work of Hagen and Thorhill and Furlow is still held to be relevant to understanding a particular pathway to PND – namely maternal shame. Rather than PND being causal to the withdrawal of maternal investment, evidence presented in Chapters 3 and 4 indicated a reverse causal relationship. As reviewed in Chapter 3, pregnant women in contemporary WEIRD contexts are under considerable sociocultural pressure regarding their maternal behaviour and emotions, while at the same time being bombarded with messages of risk. Mothers who respond to the perception of risk by pursuing a low emotional investment strategy, while at the same time being subjected to sociocultural pressures to pursue a high emotional investment strategy, experience shame and have increased odds of PND as a result. The evidence is thus affirmative with regard to the research questions '*Does social evaluative threat predict PND?'* and '*Does the social construction of motherhood in WEIRD settings act as a source of social threat for mothers, thereby playing a causal role in PND?'* Results from the priming study presented in Chapter 5 also suggest a positive answer to the former question and that of '*If the social construction of motherhood is a source of social evaluative threat, can it be experimentally induced?*' Participants exposed to the prime stimuli of messages regarding mothering drawn from popular and social media experienced greater levels of shame when asked to reflect on hypothetical investment decisions, both indicating that the social construction of motherhood acts as a source of social threat and that this perception of social threat is readily experimentally induced. Further support for a social genome approach to PND, and the research question '*Does social evaluative threat predict PND?*', is also found in the dramatically increased odds of PND (odds ratio of 428.5) if a mother spends 8 hours or more on a weekday in social isolation with her offspring without the company of another adult. Social isolation is causally linked to general depression due to its triggering the immune system's inflammatory response (Cole *et al.*, 2007); the finding that the longer mothers spend on their own, the more likely they are to experience PND, suggests that lengthy periods without the company of another adult also triggers inflammation in postnatal women.

The final research question posed in Chapter 1 was ‘*Does the experience of social stress in relation to emotional investment explain PND in women lacking commonly recognised risk factors?*’ As argued in Chapter 6, the application of theory from human social genomics to explain PND provides an integrative framework linking together disparate risk factors via a shared causal pathway of inflammatory immune activation, illuminating how psychosocial, subjective experience alters gene expression, ultimately leading to the expression of a depressive phenotype. The existing literature on the causes of PND fails to encompass all cases; recognising the links between social stress, inflammatory responses, and depression leads to the prediction that women who experience PND, without being associated with any of the commonly recognised risk factors, may be subjectively experiencing social stress. The results relating to the two forms of social stress explored here – shame in relation to mothering and social isolation – are supportive of its role in causing PND and point to the need to explore other forms of social stress in conjunction with PND. Thus an affirmative answer in response to the research question may be tentatively given, with the caveat that a larger scale study is required to confirm this conclusion.

The questions ‘*Can maternal emotions be understood as forms of embodied capital?*’ and ‘*what influences trade-offs in relation to maternal investment?*’ were addressed in Chapter 4. The results of hypothesis testing support the expansion of embodied capital theory to encompass the emotional investments mothers (and presumably fathers) make in offspring; emotional investments were found to be responsive to risk, be positively predicted by available emotional capital (with the exception of emotional support from offspring fathers who may act as emotional allocarers), and be considered by mothers to be important for infant development. Intrinsic emotional capital – as conceptualised by a mother’s emotional personality, emotional intelligence, and emotional wellbeing – was also shown to act like a limited resource, diminishing as emotional investments were made in infants, and falls in capital being buffered by available support from others. While the study of emotional capital presented in Chapter 4 marks only the first attempt to explore a new framework for understanding maternal investments, and as such are largely exploratory, these results are suggestive of emotional resources, akin to a form of capital, constraining a mother’s capacity to emotionally invest in her offspring. This framework also proposes a new terminology with which to discuss the emotional relationships between mothers and their offspring not loaded with the baggage of ‘bonding’ and “the negative and pessimistic implications of using this concept in social work and clinical practice” (Herbet, Sluckin, and Sluckin, 1982: 205). Framing emotional relationships as investments which are tied to resource availability and, thus by extension, likely to be increased by the acquisition of resources, rather than evolved patterns of behaviour sent awry by a mismatch with the contemporary environment, indicates more productive ways of improving mother-infant relationships whilst also protecting maternal mental health. Current approaches which are often based on giving women information about what is best for ‘bonding’, such as encouraging breastfeeding for the purposes of bonding (NHS, 2012), places the onus on the mother, pressuring her into expending resources she may not have, and engenders shame in women who cannot spare the resources to invest. However, an investment based approach highlights the likely benefits of providing mothers with extra resources with which they can invest.

Public health implications

The primary focus of this thesis was to explore the current evolutionary approaches PND and general depression with a view to bringing new insights into the aetiology of the condition, suggesting new ways of identifying women at risk, and proposing public health measures to prevent women becoming depressed after giving birth. As noted, while various factors linked to poor maternal and infant condition have been found to predict PND, little explanation existed for why women seemingly without any such risk factors might develop PND; results presented in Chapters 3, 4, and 6 indicate social stress, in the forms of shame and social isolation, is the causal factor in many such women, and results in Chapter 2 highlight that the birth of male infants is also an unrecognised risk factor, particularly when born in conjunction with birth complications. Existing approaches to PND may also be critiqued for a lack of an integrative framework able to elucidate the instantiation of psychosocial stress processes in the brain and body and how psychosocial risk factors interact with genetic and epigenetic changes to influence the risk of PND (Yim *et al*., 2015), without which the full scope of potential preventative measures will not be realised. In his opening editorial for the journal *Evolution, Medicine, & Public Health,* Stephen Stearns argues "…Like physics and chemistry, evolution is a basic science that permeates medicine and helps to generate explanations for everything we encounter in it" (2013: 1); an evolutionary perspective, combing life history theory and social genome approaches to depression, has the potential to provide the elusive integrative framework PND research needs, as evidenced by the results presented in the preceding chapters. These results also suggest a number of ways in which PND might be prevented.

A main research question under investigation was whether social stress plays a causal role in PND aetiology and if the sociocultural mothering environment in WEIRD contexts generates conditions in which women are particularly exposed to social stress during the perinatal period; in support of this contention, the experience of maternal shame was found to predict PND while controlling for other risk factors. While the size of the effect of maternal shame was relatively small, this nonetheless is a readily targetable risk factor, and as well as affecting PND, reductions in the experience of shame will also improve maternal emotional wellbeing more generally. In terms of identifying women who are experiencing feelings of shame in relation to their maternal thoughts and behaviour, the Maternal Shame Scale (MSS) presented in Chapter 3 provides a quick and simple means of identification for use by health practitioners. The MSS consists of 5 questions, with slightly altered wording depending on whether the respondent is pregnant or has already given birth, with Likert-type response categories generating a score out of 20, where higher scores indicate more shameful feelings. Exploratory analysis (see Appendix K) indicates a cut-off of 9 during pregnancy as being the most appropriate way of identifying women at risk of going on to develop PND (correctly classifying 72.9% of women overall and 52.6% of the women who were depressed within 6 months of giving birth) and a cut-off of 8 at one month postnatally (correctly classifying 77.2% of women overall and 53.3% of the women who were depressed within 6 months of giving birth). Future research should seek to validate this measure in a fresh sample of perinatal women.

While the use of a cut-off may be useful for identifying women at high risk of developing PND if shameful feelings are not addressed and reduced, all women should be encouraged to discuss the reasons they feel ashamed to prevent their shame escalating and use of the MSS may provide a useful tool for health practitioners with which to start such conversations. Women report valuing being asked questions by their GP and are more likely to disclose sensitive concerns if directly asked (Hartley *et al*., 2012). There is a very limited literature on the ways in which women experience postnatal care (Beake *et al*., 2010; Hartley *et al*., 2012); however, a study of Australian mothers found "…Overwhelmingly, women wanted GPs to ask about physical, emotional and social health problems affecting their lives as women and mothers" (Hartley *et al*., 2012: 311). Although the present study was not designed to test whether shame also predicts antenatal depression, given the generalised inflammatory response to shame, it is likely to play a causal role in depression prior to birth as well. Therefore, monitoring throughout the perinatal period for the purposes of early identification of feelings of shame is the key to preventing depression arising via this pathway.

Beyond identification, the way in which women experiencing feelings of shame are managed will be a crucial determinant in whether prevention is successful. While discussion with open-minded and understanding health practitioners has the potential to alleviate feelings of shame, if women are met with unsympathetic and judgemental responses, then their feelings are likely to be exacerbated and the likelihood of PND increased. This is likely to be particularly salient in the early postnatal period when highly prevalent social messaging highlighting the risks maternal behaviour may pose to infants are likely to be a primary source of shame for women, as evidenced by the results regarding shame and emotional investment in Chapter 3 and maternal investment more generally in Chapter 5. An overt focus on infant risk by health practitioners when mothers express concern regarding their behaviour, confirming or encouraging rather than allaying fears, will detrimentally engender further shame. It is important the health practitioners acknowledge and address the role they play in potentially increasing PND risk. An NCT report into the experiences of first-time mothers in the UK found that one in eight mothers were extremely critical of the interactions they experienced with health practitioners, reporting “insensitivity, inconsistent advice, inadequate assessments and care, lack of emotional support and/ or too few home visits” (NCT, 2010: 7), while three in ten mothers reported they felt unable discuss their concerns; this is not an environment currently conducive to identifying and helping women experiencing maternal shame. The styles in which health practitioners communicate are known to influence patient outcomes in other areas of medicine (for a review see Charlton *et al*., 2008); a patient-centred, biopsychosocial communication style, which encourages the sharing of patient’s thoughts and takes into account their social and emotional environments, increases adherence to treatment plans, patient satisfaction, and, ultimately, patient health compared to a more traditional, biomedical style which is authoritative, patriarchal, and symptom focussed (Charlton *et al*., 2008). The removal of a biomedical communication style from maternal health services, combined with postnatal care which is focussed on the needs of the mother rather than those of the professionals as is often the case (Beake *et al*., 2010), has the potential to reduce PND prevalence and improve maternal emotional wellbeing in general.

On a related note, and notwithstanding the methodological critiques of bonding theory presented in Chapter 1, highlighting the importance of ‘bonding’ in the cultural construction of motherhood and the pressures this places on mothers is not to deny the role it plays in infant development. As feminist and evolutionary researcher Sarah Hrdy (1999) notes in relation to John Bowlby, father of attachment theory and who thought mothers should stay at home, “Bowlby’s personal views about working mothers do not undermine the validity of his theory about *how* and *why* infants become attached to their caretaker anymore than Charles Darwin’s blindness to the sexual assertiveness of females in some species invalidates the theory of sexual selection” (1999: 496). The potential benefits of emotional investment are detailed in Chapter 4 – *Part 1*, and indeed inherent in the proposed emotional capital theory of maternal investment is the idea that emotional investments from mother to infant enhance offspring quality. Nor is any of the preceding discussion intended to imply that the general public should not be informed of scientific knowledge and discoveries regarding infant development. Rather, the manner in which such information is conveyed requires sensitivity and re-evaluation in the light of findings presented here. Researchers of parenting culture studies (Lee, 2014b), whose work is drawn on in Chapter 3, have been heavily critical of the way in which neuroscience has been employed by the UK and US governments to exert control over parental, particularly maternal, behaviour; however, they draw a clear distinction between neuroscience and *neuroscientism* – which is linked to the appropriation of “scientific objectivity to pursue moral, political or commercial agendas in the public sphere” (Macvarish, 2013: 1). It is neurscientism that is detrimental, not neuroscience, and similarly it is not the evidence indicating the importance of emotional investment (from either the mother or allomothers) to infants which is problematic, it is the way this knowledge is currently conveyed (notably without reference to allomothers, for instance). While the science may not be at fault, scientists and public health officials should also not ignore the way in which popular discourse of said science impacts on maternal wellbeing.

A second novel risk factor for PND identified is the amount of time mothers spend in social isolation from other adults during the week in the first six months after giving birth, as highlighted in the results of Chapters 3 and 6. Comparison with antenatal depression, the strongest predictor of PND, shows social isolation to be a major risk factor. The amount of time a mother is spending alone is something easily assessed via a minimal number of questions on the part of health practitioners. The attendance of mother-baby groups is known to facilitate the formation of long-lasting social networks (Scott, Brady, and Glynn, 2001); women who are found to be spending long periods of time on their own should be given information regarding local mother-baby activity groups and actively encouraged to attend.

Another means by which maternal social isolation can be tackled is via shifts in working practices to enable partners to remain at home with the mother for longer periods during an infant’s first year. Rights to paternity leave vary widely across the industrialised world; among the Organisation for Economic Cooperation and Development (OECD) countries, as of April 2015, the average paid time offered specifically to fathers was eight weeks (OECD, 2016). At the low end of the entitlement spectrum, eleven countries offer two weeks or less, and nine countries, including the US, offer no leave at all, while at the high end seven countries allow three months or more, with Japan and South Korea providing up to 12 months. However, while Japan offers by far the most generous deal to fathers, with 30.4 weeks of 'full-rate equivalent' paid leave, the actual uptake by new fathers is only around 2% (OECD, 2016). The low uptake of paternity leave is common, with only Nordic countries having high rates, achieved by allocating leave that can only be claimed by the father, as opposed to being traded with the mother (Bittman, 2004). It is perhaps no coincidence then that Nordic countries have some of the lowest rates of PND prevalence of industrialised nations (Halbreich and Karkun, 2006)

In the UK, a new system for shared parental leave was introduced in 2015 which entitles parents to share 50 weeks of leave between them, 37 weeks of which is guaranteed to be paid at the statutory rate of £139.85 (Gov.uk, 2015); theoretically enabling both mothers and their partners to remain at home together for 25 weeks on top of the two weeks which they are both automatically allowed. However, the new rules have been criticised on the grounds of the various eligibility criteria, which mean as many as 2 in 5 fathers are not eligible because their partners have not worked enough in the run up to giving birth (Osborne, 2016), employers who often offer maternity pay well above the statutory rate are also not required to pay mothers a higher rate if the intend to share leave (Peachey, 2015), and employers are under no obligation to pay fathers above the statutory rate, thus, for many it will be financially unviable to share leave. The stated aim of the UK government when setting up the new scheme was to enable women to go back to work if they wished, rather than enable parents to remain at home together (Peachey, 2015). However, a year after the scheme was launched neither situation appears to be coming to fruition, with uptake of shared parental leave by men proving low. A survey of 200 companies found only 11% of new fathers have taken up the option and 60% of employees report their company did not encourage the use of shared parental leave, although roughly half of companies state they offer pay to fathers at the equivalent rate to maternity leave (Osborne, 2016). Frances O'Grady, the general secretary of the Trade Union

Congress (TUC), argues "…If the government is serious about men playing a more active role after their child is born, they must increase statutory pay and give all new dads a right to some independent parental leave that is not shared with their partners" (O'Grady in Osborne, 2016); the UK government will review the new system in 2018, until which time little is likely to change. The finding that time spent alone by mothers in the first six months after birth, in large part a consequence of their partner being at work, positively predicts PND incidence should provide an incentive for the UK government, and other governments alike, to enable parents to take time off work together by making shared parental leave financially viable.

Conclusions

The conclusions from this thesis impact two key areas – evolutionary theory and public health. With regards to evolutionary research, novel quantitative evidence was brought to bear on a previously under-tested explanation of PND, raising substantial questions as to its efficacy and supporting the need for a more nuanced understanding of the aetiology of depressive symptoms in the postnatal period. The presentation of a new framework for conceptualising maternal investments highlights the utility of considering early mother-infant emotional relationships as a facet of life history trade-offs, and as such advances understanding of the forms parental investment can take and the factors which influence it. This work also adds to the growing literature recognising the role of subjective experience, particularly in the realm of social interaction, in guiding phenotypic expression.

In relation to public health, this research highlights novel risk factors for PND and indicates new preventative strategies. Recently a report estimated the long-term cost to UK society of maternal mental health issues to be £8.1 billion per one-year cohort of births (Bauer *et al*., 2014). Results presented in Chapter 3 indicate this cost is actually even higher because the report did not take into account costs incurred as a result of population ageing – PND has a detrimental impact on completed fertility indicating it contributes to below replacement fertility which drives population ageing (Myers, Burger, and Johns, 2016), implicating PND in the massive financial and social costs ageing entails (Coale, 1986; Lutz *et al*., 2003). To bring perinatal mental health services up to the standard needed to effectively treat all mothers with mental health issues, Bauer *et al*. (2014) calculated around an extra £400 would need to be spent per birth, compared to a cost of about £10,000 per birth if such investments are not made. Thus, they argue "even a relatively modest improvement in outcomes as a result of better services would be sufficient to justify the additional spending on value for money grounds" (Bauer *et al*., 2014: 5); however, missing from this report is the old adage 'prevention is better than a cure'. In 2013, Public Health England and the NHS England launched 'A call to action: commissioning for prevention' (NHS England, 2013), stating that the core business of the NHS of the future was prevention on the grounds of its being more cost effective. The evolutionary approach taken towards PND in this thesis, combining life history theory and a social genome approach to depression, provides a more nuanced perspective of PND than existing evolutionary accounts and a fresh understanding of the causal factors involved in the development of PND, highlighting two novel targets for preventative action. Incorporating questions regarding maternal shame and the amount of time mothers are spending lone into the routine practice of health practitioners provides a low cost way to identify women at risk of developing PND who do not fall within current risk brackets. Training GPs and midwives to compassionately discuss and allay women's feelings of shame and equipping them with the relevant information to offer practical advice to socially isolated mothers, regarding local mother and baby groups and rights surrounding shared parental/paternity leave, has the potential to prevent PND occurring and significantly lower the burden currently placed on health services.

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Appendix A – Myers, Burger, and Johns (2016)

The following reflects an uncorrected proof original version of Myers, Burger, and Johns (2016); the version of record published by OUP, along with supplementary materials, can be found at: https://academic.oup.com/emph/article/2016/1/71/2802572/Postnatal-depression-and-reproductive-success-in

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Postnatal depression and reproductive success in modern, low-fertility contexts.

Sarah Myers School of Anthropology and Conservation, Marlowe Building, University of Kent, Canterbury, Kent, CT2 7NR United Kingdom

Oskar Burger School of Anthropology and Conservation, Marlowe Building, University of Kent, Canterbury, Kent, CT2 7NR United Kingdom

Sarah E. Johns School of Anthropology and Conservation, Marlowe Building, University of Kent, Canterbury, Kent, CT2 7NR United Kingdom

Page Heading Title: Postnatal depression and reproductive success

Lay Summary: Postnatal depression reduces completed fertility; women who experience it early in their childbearing careers are less likely to have a third birth. Postnatal depression at the first birth leads to lowered fertility levels, indicating a causal role in population ageing and highlighting a new incentive to invest in prevention.

Word counts:

i) Abstract: 242

ii) Text of article: 4,519 (7,069 with references)

Tables: 3

Figures: 2

Abstract:

Background and objectives: Postnatal depression presents a puzzling phenomenon to evolutionary anthropologists as it is highly prevalent and yet detrimental to child development and maternal health. Adaptive explanations have been proposed, but have not been tested with data that directly links postnatal depression to female fertility.

Methodology: A survey was designed to gather complete reproductive histories and retrospective measures of postnatal depression to measure the effects of postnatal depression on fitness. Respondents were born between 1930-67, with the majority based in the UK during their childrearing years. The hypothesis that postnatal depression is detrimental to fitness is assessed using Mann-Whitney U tests on completed fertility. Binary logistic regression modelling is used to test the hypothesis that postnatal depression reduces the likelihood of parity progression.

Results: Women experiencing PND at their first or second birth have lower completed fertility, with postnatal depression at the first birth leading to lowered fertility. Logistic regression analyses show that this is the result of reductions in the likelihood of parity progression to a third birth when postnatal depression is experienced at the first birth or when repeat bouts occur.

Conclusions and implications: Our results call in to question adaptationist arguments, contribute to the growing understanding of the importance of emotional wellbeing to fertility decision making, and given the economic consequences of markedly below replacement fertility, highlight a potential new source of financial incentive to invest in screening and preventative measures to ensure good maternal mental health.

Keywords: postnatal depression, life history, evolutionary demography, fertility, parity progression

Background and objectives:

Postnatal depression (PND), operationally defined as a depressive episode occurring within 12 months after a birth [1-3], presents a puzzling phenomenon for evolutionary anthropologists because it has detrimental impacts on social, emotional, physical, and cognitive development in children [4-9]. These deficits arise from the negative affect PND has on the quality of mother-infant interaction [10-13]. Because it involves investment in children, emotional stress, and condition of the mother, PND should be of great interest for researchers of parental investment or quality-quantity offspring trade-offs. Yet, since pioneering theoretical work by Hagen [14-15], Thornhill and Furlow [16], and Crouch [17], PND has received very little empirical study leaving open questions as to why this emotional state is so prevalent, a meta-analysis of studies found an average prevalence rate of 13% [18], and whether it could be adaptive.

Parental investment in an individual offspring is costly, taking up a parent's energy and time [19]. Parenting prevents investment in other existing offspring, future offspring, or in mating effort, thus there will always be a trade-off between parenting and other activities related to survival and reproduction. Parental investment theory predicts the withdrawal or diversion of parenting when the benefits are outweighed by the costs [19]. Using this framework, Hagen [14-15] and Thornhill and Furlow [16] have sought to explain PND as an adaptive signal to a mother that she is experiencing a cost to her fitness by investing in a particular offspring and should therefore reduce or eliminate investment [14-16]. Hagen [15] and Crouch [17] further propose that distress displayed by those with PND is also an adaptation to elicit support from kin, thus offsetting costs associated with childrearing. If PND is an aid to maternal investment decision making [14-17], then women in poor circumstances who have PND may be expected to benefit from future reproduction enabled by resources saved or gained from kin, relative to those who do not experience PND.

However, PND also carries a range of costs. It is characterised by active social isolation and refusals of offers of help [20], so is unlikely to be an effective means of enhancing offspring investment through social subsidy. The deficits to child development are indicative of costs to the mother in terms of offspring reproductive potential. If the effects of an episode are confined to just one offspring, it is possible that a mother's other offspring will be unaffected or benefit in terms of the total investment they receive. Yet, PND is highly recurrent [21], it inhibits a woman's ability to care for herself and other existing offspring [22-23], and predisposes women to future bouts of depression [24]. The occurrence of PND in women in seemingly affluent circumstances is problematic for explanations of PND which frame it as an adaptive aid to maternal investment decisions when circumstances are poor and thus, constrain fitness. Hahn-Holbrook and Haselton [25] have recently put forward an evolutionary based 'mismatch hypothesis' for PND aetiology, proposing that it results from a modern parenting environment characterized by low kin support, dietary alterations, early weaning, and lack of physical activity. If PND is a disease of modern civilization then its impact on reproductive success would be expected to be detrimental, or at least neutral.

The evidence to evaluate the relationship between PND and fitness is limited and indirect, drawn from studies of depression at other times in the life course. Depression presents major costs to morbidity and mortality, causing prolonged inflammation increasing the risks of various diseases [for example see 26-27] and heightens suicide risk [28-29]. The single study that has investigated the impact of general depression on female fertility found compared to a control group depressed women had fewer pregnancies and live births [30]. The physical effects of PND may render women less able to conceive as it alters the hypothalamic-pituitary-ovarian axis [31]. PND becomes chronic in 38% of sufferers [32], and a lifetime history of depression increases risk of earlier menopause [33]. It may also make women less attractive to mates. PND leads to increases in marital problems [34] and depression reduces social attractiveness [35], increases rate of failure for relationships [36-38], and reduces economic prospects [39-40]. Finally, women may actively avoid childbearing to prevent repeated PND [41].

The evidence on the fitness-related consequences of PND is limited, but strongly suggests that adaptationist explanations are in need of targeted investigation. The lack of data quantifying the effects of PND on fertility is surprising given its likely negative impact [42], especially as PND occurs at relatively high levels in Western countries; estimates range to 63% [43]. We report the results of a survey designed to gather complete reproductive histories and retrospective measures of PND to measure its effect on fitness.

Hypotheses tested

Hypothesis 1 – PND is detrimental to fitness. Examining the effects of PND on completed fertility indicated that PND was costly, so we tested two further hypotheses to investigate how this effect arises.

Hypothesis 2 – PND reduces the likelihood of progression from the parity at which it is experienced. Multivariate binary logistic regression models are used to assess the effect of PND on parity progression, after controlling for other variables which influence fertility. While we predict that PND will always reduce fertility, we also conduct a moderation analysis to assess adaptive predictions that PND will have a positive effect on the fertility of women in poor circumstances.

Hypothesis 3 – PND will show an additive negative effect on the likelihood of progression from higher parities. We assess *a*) *the effect of increasing number of bouts* and *b*) *the effect of PND beyond the parity at which it occurred*. Further, if as the medical literature suggests, PND is costly and causes an additive negative effect, then models accounting for repeat bouts, or effects beyond the parity at which the PND occurred, will be better at predicting parity progression than models in which a bout of PND is only considered as an independent event as implied by adaptive accounts. To test this prediction we compare the models from *hypothesis 3* to those from *hypothesis 2*. For the same reasons the effect sizes of the PND measures utilised in *hypothesis 3* should be larger, because they are cumulative, than those used in *hypothesis 2*, and this prediction is also assessed.

Methodology:

a) Data collection

Complete reproductive histories of post-menopausal women were collected by retrospective questionnaire. Respondents reported details about every birth they had experienced and were assessed on a number of demographic and psychological measures. Participants were recruited via advertising in newsletters and social media channels of UK-wide branches of the Women's

Institute [44], alumni networks of two UK universities, and social media aimed at older women. The survey was conducted online using SurveyGizmo and, to minimise inaccurate reporting due to the nature of information requested, participants remained anonymous with the exception of their IP address to control for multiple responses from the same address: 306 valid responses were received. Data are available from the Dryad Digital Repository: http://dx.doi.org/10.5061/dryad.cf6nh

b) Measures

Postnatal Depression

Women self-reported their PND history in three ways: whether they had received an official medical diagnosis, the Bromley Postnatal Depression Scale (BPDS) [45], and a modified Edinburgh Postnatal Depression Scale (EPDS) [46]. PND is notoriously under-diagnosed [47] and retrospective use of the BPDS and EPDS provided valuable additional screening.

The BPDS consists of a statement regarding depressive symptoms and a question regarding whether such symptoms were experienced; if the answer is affirmative their duration is recorded, with anything over a month indicating PND. This was used to determine a categorical measure of PND incidence at a given parity. The BPDS is designed to assess PND symptoms retrospectively [45] and has been used in studies assessing similar durations of recall [48-49], yet it provides no scope for assessing severity of symptoms. For this reason we use a modified version of the EPDS.

The 30 point EPDS is the most widely used screen for PND [50]. Questions were presented in the past tense and participants were requested to reflect back on the first year after each birth. To the best of our knowledge this is the first application of this form of the EPDS retrospectively over a long-recall duration, but it has been used retrospectively over 5 years [51]. An alternatively modified EPDS has also been used as part of the Netherlands Study of Depression and Anxiety (NESDA) to assess lifetime prevalence of PND [52]. The EPDS score for each birth was used as a continuous measure of *PND severity*. A categorical measure of PND incidence after each birth was determined using a cut-off score of 12 following Payne *et al*. [51] and the NESDA [52]; this is a higher cut-off than suggested by Cox *et al*. [46] and deemed appropriate due to the accuracy of recall in retrospective reporting of depression increasing with severity [53]. Finally this measure of incidence was used to determine a continuous measure of *PND history*, i.e. the number of PND bouts up to and including a given parity.

In addition to PND, the other measures used within the regression analyses can be seen in Table 1. These include demographic and sociological controls, along with measures that are especially influential in the probability of parity progression, and a measure of general depressive tendency throughout the life course.

c) Sample characteristics

Respondents were born between 1930 and 1967, and their average age was 59.1 years (standard deviation 7.5). The majority of respondents (82.3%) were married throughout their childbearing years, of high to medium SES (‘professional’ 68.0%, ‘managerial and technical’ 20.6%), with the women’s husband/partner contributing the majority to household finances (77.1%). The majority did their childrearing in the UK (73.9%), followed by the US (12.8%). On average respondents gave birth to 2.28 infants (range 1 - 6). For the percentage of the sample that continued childbearing at each parity and the distributions of each measure of PND across parities see the supplementary material.

d) Data analysis

Hypothesis 1

Completed fertility was used as the main fitness-relevant fertility measure to evaluate the impact of PND. We compared respondents who had experienced PND at least once with those who did not and then respondents who experienced PND in association with a specific parity level (1-3) with those who did not; a Mann-Whitney U test on completed fertility was conducted for each group.

Hypotheses 2 & 3

Binary logistic models assessed the likelihood of parity progression from parity 1 to 2 (*P1*), 2 to 3 (*P2*), and 3 to 4 (*P3*), with the exception of *hypothesis 3a* when only P2 was analysed owing to inadequate sample size (see supplementary material for details). Progression to greater parities was not analysed because very few women in the sample had more than four births (N = 3).

To test *hypothesis 2* we fit models for each parity that increased in complexity based on the number of variables included in the generalized linear model. The first *PND only model* estimates how PND severity alone affects parity progression. Second, a *base model* controlled for the effects of *year of mothers birth*, *age at birth*, and *SES*. Third, a *full model* including all possible variables in Table 1 was run. While we had theoretical reasons (see Table 1) to enter all of our covariates at once into our analysis, the results from the *full model* (see supplementary material for details) found the influence on parity progression of numerous variables to be either entirely neutral or variable by parity. Therefore, we then created a *selected model* in which forward stepwise selection searched for the strongest predictor variables at each parity from the full selection of variables (Table 1), to which we then added, if excluded, PND (to track its effects) and the variables *year of mothers birth*, *age at birth*, and *SES* (to control for demographic effects).

The same procedure was utilised to test *hypotheses 3a* and *b* (for the resulting *selected models* see supplementary material). In *hypothesis 3a* the measure of interest was *PND history*, i.e. the number of bouts of PND experienced. The effect of *PND severity* at parity 1 on progression from P2 and P3, and the effect of *PND severity* at parity 2 on progression from P3, were the measures of interest in *hypothesis 3b*.

Effect sizes and model comparison

Akaike's information criterion with a second order bias correction (AICc) is used to compare models across *hypotheses 2 – 3b*. Additionally, continuous variables were centred and standardised and reported in the supplementary material. This not only removes some of the potential for collinearity but it makes the regression coefficients interpretable as effect sizes because the units have been removed and the variance standardised.

Moderation

We test for moderation at each parity level as part of *hypothesis 2* by testing for interaction effects between *PND severity* and each of our categorical covariates (Table 1), controlling for *age at birth* and *mother's year of birth*. We also create a continuous measure of a mother's circumstance at a given parity, reflecting the number of "poorest" categories a mother was rated in for each of the covariates. A score of 1 was assigned if the mother fell into the following categories: minor or major *birth complications*, not *breastfeeding*, negative *emotional experience of birth*, abnormal *infant birth weight*, *infant health issues*, low *SES*, low *support from family*, *friends*, the offspring's *father*, and low or no *support from their mother* (*social pressure* was excluded due to the poorest category choice being debateable). The scores were summed and used as a continuous numerical variable with a possible range of 0-10. Using this measure we test for an interaction between *maternal circumstances* and *PND severity*, again controlling for *age at birth* and *mother's year of birth*. Variables were centred and standardised before performing the moderation analysis.

All statistical analysis was conducted using R (v.3.2.1).

Results:

Hypothesis 1

When parity was not taken into account respondents who experienced PND at least once showed a non-significant trend toward lower completed fertility (Table 2). When PND experience at different parity levels was assessed, respondents who experienced PND at their first birth had lower completed fertility compared to those who did not according to all measures of PND, as did those with PND measured by the EPDS at their second birth (Table 2). Those with PND measured by the EPDS at their third birth had lower completed fertility at a level approaching significance.

Hypothesis 2

The direction of the effect of increasing *PND severity* at a given parity on progression from that parity was not consistent across parity levels (Table 3). The point estimate for the effect of increasing EPDS score at parity one was non-significant for each model but always negative. At parity two there was a significant negative effect in models with EPDS on its own and after controlling for demographic factors; the effect remained negative yet lost significance once more factors were controlled for. At parity three the negative effect found when EPDS was on its own and after controlling for demographic factors shifted to a positive effect once more factors were controlled for, although all results were non-significant and our sample size is small (N = 92 at parity 3). The full regression results for each model, including the effect sizes for each variable, are provided in the supplementary material.

Moderation – Hypothesis 2

Only two significant interactions were found (p <.05) in 60 possible interactions assessed and so we resign the full results of the moderation analysis to the supplementary material. The significant interactions were between *PND severity* and having *support from the infant's father* (*low* vs. *high*) and *PND severity* and the respondent's *emotional experience of birth* (*mixed* vs. *positive*) at parity 2. Further, there was no significant interaction between the combined *maternal circumstances* variable and *PND severity*. The interaction between *PND severity* and *father support* was significant (p = .047); separating women by level of support found that when women received *high support* the effect of increasing *PND severity* on parity progression had an odds ratio of .898 (p = .000), and when women received *low support* it was 1.063 (p = .321) (see supplementary material for full details). The interaction between *PND severity* and *emotional experience of birth* was significant (p = .005); in women with a *positive emotional experience* the effect of increasing *PND severity* had an odds ratio of .901 (p = .001), and when they had *mixed emotions* the odds ratio was 1.070 (p = .204).

Hypothesis 3a

Experiencing more bouts of PND (*PND history*) decreased the likelihood of progressing from parity two (Table 3); this was significant across all models. The full results for each regression model can be found in the supplementary material.

Hypothesis 3b

Higher *PND severity* at the first birth was associated with decreasing likelihood of progressing from parity two (Table 3, Figure 1); this effect was significant across all models. The effect of higher *PND severity* at either the first or second birth on progression from parity 3 did not reach significance. The full results for each regression model can be found in the supplementary material

Model comparison

The effect of PND is found to be significant in various models at parity 2 across *hypotheses 2-3b*. Comparing the AICc's of the strongest model (the *selected models*) generated under each hypothesis at parity 2 shows the model containing *PND severity at birth one* (*hypothesis 3b*) to lose the least information (Table 3), followed by *PND history* (*hypothesis 3a*); AICc weights find there to be a probability of .863 that the *hypothesis 3b* model is the strongest (see supplementary material for full calculations). When only *PND severity at first birth* was entered at parity 2 it had an odds ratio of .929, falling to .915 after controlling for *age at birth*, *year of mother's birth*, *SES*, *birth complications*, *breastfeeding*, and *support from friends* in the *selected model*. The negative effect of *PND severity at birth one* on progression from parity 2 is of a similar effect size to *age at birth,* and within the range of *minor birth complications* (Figure 2). Having *a bout of PND at both first and second birth* has the second largest effect size on progression from parity two, smaller yet within the range of *major birth complications* (Figure 2). The full list of effect sizes for all variables in each regression model can be found in the supplementary material.

Conclusions and implications:

This study is the first to empirically test the effects of PND on fitness. By showing that PND at the first or second birth is associated with lower completed fertility, and that increasing number of bouts of PND and higher PND severity at the first birth reduce the likelihood of a third birth, our study identifies potential pathways by which PND is detrimental to fitness. These results call into question existing evolutionary explanations of PND based on its having adaptive value and contribute to the growing understanding of the importance of emotional wellbeing to fertility decisions [77].

PND at parities one and two was found to be costly when analysing completed fertility, being significantly associated with reductions in fertility. Repeat bouts of PND and PND at the first birth are particularly costly, producing the strongest models, and show effect sizes comparable to factors with well-documented influence on fertility such as birth complications [68-69]. We suggest impacts on parity progression are more strongly seen after two bouts due to the physical or emotional costs of PND being additive. Alternatively, the impact of repeated PND on offspring quality is too great to risk a third bout or the additional costs of a third child. That PND at the first birth has a stronger negative impact on progression from parity two than parity one is also indicative of its reducing a mother's capacity to cope with increasing numbers of offspring. Of the women in our sample who had a second birth, roughly 50% of women experiencing PND at their first birth also had it at their second (see supplementary material), mirroring the general population [78]. Depression has a priming effect on the immune system, causing epigenetic changes that lower stress reactivity thresholds, increasing the likelihood of future bouts [79]. PND is as likely, if not more likely, to be experienced at the first birth, raising the probability of repeat bouts if childbearing continues and also increasing the likelihood of depression at other points in the life course.

In terms of evolutionary trade-offs between current vs. future offspring, PND appears to be costly. Low fertility strategies in modern post-industrial societies do not result in increased reproductive success in descendants [80], so there are unlikely to be longer term gains from the lower fertility of women with PND. Humans have been found to follow quality-quantity offspring trade-offs in a number of societies [81-84]. PND poses risks to the mother and her offspring, and if taken at face value it would seem unlikely that these women are benefiting in terms of reproductive success from higher quality offspring. However, ceasing to reproduce could provide protective benefits to existing offspring whose level of maternal investment, already impoverished by PND, would be further reduced by the addition of siblings.

These results may reflect PND just being maladaptive in contemporary environments [17], where fertility behaviour in general is not fitness maximising [85]. Model comparison indicated that the effect of PND is cumulative, suggesting a physical cost is incurred, even in contemporary populations, in line with medical literature [26-27, 31-33]; it is unclear why the physical costs of depression to health and reproductive function would not be detrimental in past environments. Crouch suggests that in the dense social settings of small-scale societies maternal distress would be quelled by support before it developed into depression [17]. Little research has been conducted on depression in small-scale societies; yet recent findings in the Tsimane, Bolivian forager-horticulturalists, run counter to the notion that depression is simply one of modernity's by-products [86]. If the effects on fertility are psychological rather than physical in origin, then PND may simply increase the use of contraception and abortion in modern environments. However, cross-cultural data on infanticide and child abandonment are consistent with the optimisation of available resources for reproductive effort [87-88]; if potential future offspring are avoided by postnatally depressed women in contemporary developed settings via increased use modern birth control, then unavoidable offspring born to postnatally depressed women without access to contraception seem likely candidates for experiencing much heightened risk of infant death.

We did not find complete support for all our hypotheses, and do not have adequate data to fully examine the effect of PND at higher parities. We cannot rule out the possibility that it has a positive effect on parity progression likelihood at level three and beyond. Our moderation analysis does provide limited support for adaptionist explanations of PND in that its effect was found to be fitness neutral in women experiencing low support from their offspring's father and a mixed emotional experience of birth at parity 2. However, for the most part our results are not supportive of the adaptive explanations proposed by Hagen [14-15], Crouch [17], Thornhill and Furlow [16], with the vast majority of our moderation models finding no interaction between PND and circumstance. That PND significantly reduces the chances of progression from parity 2 in women who had high levels of paternal support or positive emotional experiences of birth also raises the question as to why women of such good circumstances become depressed in the first place, and how PND can occur in such women and reduce fitness. Our results do not preclude 'mismatch hypotheses' [25] or maintenance based adaptive explanations of PND such as the Pathogen Host Defence hypothesis [89] and the related psychobiological model of depression and social rejection [71]. It has been proposed that PND is a product of particular sociocultural environments [16-17, 90]. It is possible that, in contemporary developed populations at least, PND is a product of stress responses to low investment under certain circumstances, masking the benefits of a current vs. future trade-off. PND may not be an evolved signal to cease investment, but instead be the by-product of responding to some other signal of threatened fitness.

Women diagnosed with PND at their first birth had lower completed fertility than those who were PND free. Factors which contribute to completed fertility are of import due to the widespread nature of below replacement fertility in the developed world [91]. Below replacement fertility leads to ageing population structures with problematic dependency ratios [92]. Older age structures present major challenges to health and social security systems, potentially inhibit gains in productivity, may negatively impact relations between generations, and reduce social cohesion [93], leading governments to search for ways to raise fertility levels [77]. With PND prevalence around 13% [18], and reaching 63% [43], our results indicate measures to safeguard maternal mental health would be effective as means to increase fertility. Implementation of preventative measures is currently lacking for PND, yet effective strategies are known [94]. In the UK routine screening is not recommended [95] as is does not prove cost effective [47]. Were PND to be accepted as a factor contributing to below replacement fertility, and thus a causal factor in population ageing and the economic burden this entails [92, 96], the financial costs and benefits of prevention would undoubtedly change.

Unmeasured factors that might be important to our results include abortions, miscarriages, or illness, which may impede fertility. Such factors undoubtedly affected some women, yet for this to be a substantial issue they would have to have disproportionately affected women with PND. Marital/long-term partnership status throughout the reproductive lifespan was not taken into account, however from an evolutionary perspective this can be taken as a proxy for underlying mate quality, for which we had other measures such as depressive tendency. A drawback of our dataset is that we cannot control specifically for level of educational attainment, which is known to influence fertility [97]. However, due to our methods of respondent recruitment, we are confident that the majority of our sample were educated to at least university undergraduate level. A major pathway by which education affects fertility is in the shifting of childbearing to older ages [98], and we did control for age at childbirth in all models with controls. SES is highly positively correlated with educational attainment [99] and this is also controlled for. The use of the EPDS as a retrospective measure of PND may capture women who would not be clinically diagnosed with depression if showing symptoms today; screening measures generally find higher rates of PND than are diagnosed [43], and retrospective assessment it likely to introduce some recall bias. While specific depressive symptoms are more likely to be forgotten than incorrectly reported as having occurred [100], prospective assessment of PND and its effect on progression to subsequent parities may provide stronger causal evidence. Finally our premise, based on medical and psychological literature, was that PND was costly, and thus unlikely to be an adaptive signal to a woman that she is too low on resources to continue investing. Therefore, it is particularly interesting to see what effect PND has in contemporary, developed populations where costs may be borne more easily. However, future research should be aimed at assessing how the results vary across other social and economic contexts.

This study, to our knowledge, represents the first evidence regarding the curtailing impact of PND on female reproductive decisions, and adds to findings emphasising the importance of parental wellbeing [77]. The results, in combination with the culturally widespread nature [2] and high prevalence of PND, indicate the importance of factoring in women’s emotional experience of early motherhood to demographic models of fertility. Future research is needed to clarify the effect of PND at higher parities, ascertain the cross-cultural range of these findings, and also further assess the influence on fertility of depression at other points in the life course. The effect of PND on fitness-relevant measures other than fertility, such as offspring quality, also needs exploring. Importantly, given the economic consequences of markedly below replacement fertility, our results highlight a potential new source of financial incentive to invest in screening and preventative measures to ensure good maternal mental and emotional health.

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Table 1. Measures taken retrospectively from 306 post-reproductive women. PND (postnatal depression), BPDS (Bromley Postnatal Depression Scale), EPDS (Edinburgh Postnatal Depression Scale).

Variable	Measure/ Description	Reason for Measuring / Influence on Parity Progression
Dependent		
Parity progression	Was there a subsequent birth? Yes/No (categorical)	-
Predictors		
PND	Actual diagnosis, BPDS, EPDS (*see main text*) (categorical/continuous)	*Hypothesised* to negatively influence parity progression
Age at previous birth	Age at birth in years. Year of offspring's birth minus year of mother's birth (continuous)	To control for fertility decline with age [54]
Breastfeeding	Were the offspring breastfed? Yes/No (categorical)	Suppression of ovulation is short-lived [55-56] and it may enhance experience of motherhood due to improved attachment [57-58].
Depressive tendency	Depression score from the Depression Anxiety Stress Scales short version [59]. Trait wording is used to assess depressive tendency throughout the adult life course [60]. Possible scores range from 0-42 (continuous)	Negatively influences CFR [61]
Emotional experience of birth	Rate the emotional experience of this birth. Positive/Mixed/Negative (categorical)	Birth trauma impacts maternal wellbeing and willingness to undergo future pregnancies [43, 62]
Infant birth weight	Was birth weight normal? Birth weight classified as 'normal' or 'not normal' (low or high) (categorical)	Low birth weight increases CFR [63-64] and high birth weight at increased risk of future morbidity [65-67]
Infant health	Did offspring have any serious health issues in their first year? Yes/No (categorical)	Poor health increases CFR [63-64]
Physical experience of birth	Were complications experienced at this birth? No complications/Minor complications/Major complications (categorical)	Complications likely to reduce the likelihood of parity progression [68-69]
Socioeconomic status (SES) during childbearing years	Social Class Based on Occupation method [70] Participants classified occupation of household member contributing majority of finances. SES either high (professional), medium (managerial and technical), or low (skilled non-manual, skilled manual, partly-skilled, and unskilled) (categorical)	To control for any effects of SES
Social pressure to be a good mother	Did you experience social pressure to be a 'good mother'? Yes/No (categorical)	Perception of social stigma associated with stress and depression [71-72], so likely to increase negative affect and alter fertility desires
Support from family	Rate the level of support in offspring's first year High/Medium/Low (categorical)	Kin network influences female fertility decision making in contemporary Western populations [73-74], that peer support may prevent PND [75], and that social isolation is linked to depression [71].
Support from friends	Rate the level of support in offspring's first year High/Medium/Low (categorical)	*As above*
Support from mother	Rate the level of support during pregnancy and offspring's first year. None indicates respondent's mother was not alive at time of first reproduction. High/Medium/Low/None	*As above*

	(categorical)	
Support from offspring father	Rate the level of support in offspring's first year. High/Medium/Low (categorical)	*As above*
Year of mother's birth	Year of mother's birth (continuous)	Controlled for any confounding effects of the respondents being born during a period of fertility decline [76]

Table 2. Mean number offspring born dependent on postnatal depression (PND) experience, standard error (S.E.), 95% confidence intervals (C.I.), and Mann-Whitney *p* (one-tailed) values for tests on the difference in completed fertility dependent on experience. *Exact test used due to small sample size. BPDS (Bromley Postnatal Depression Scale), EPDS (Edinburgh Postnatal Depression Scale).

PND Experience		**PND Measure**					
		BPDS		**EPDS**		**Actual Diagnosis**	
		Mean Offspring No. (S.E.) (*95% C.I.*)	**Mann-Whitney *p***	**Mean Offspring No. (S.E.) (*95% C.I.*)**	**Mann-Whitney *p***	**Mean Offspring No. (S.E.) (*95% C.I.*)**	**Mann-Whitney *p***
PND at least once	No	2.313 (0.058) (*2.200 – 2.427*)	0.104	2.280 (0.062) (*2.158 – 2.401*)	0.397	2.291 (0.053) (*2.186 – 2.395*)	0.297
	Yes	2.178 (0.090) (*2.003 – 2.354*)		2.269 (0.081) (*2.109 – 2.428*)		2.220 (0.124) (*1.970 – 2.469*)	
PND at first birth	No	2.332 (0.055) (*2.224 – 2.440*)	**0.002**	2.347 (0.058) (*2.232 – 2.462*)	**0.004**	2.302 (0.052) (*2.199 – 2.404*)	**0.017**
	Yes	1.936 (0.083) (*1.770 – 2.103*)		2.076 (0.086) (*1.905 – 2.247*)		1.964 (0.120) (*1.717 – 2.211*)	
PND at second birth	No	2.541 (0.051) (*2.450 – 2.642*)	**0.075**	2.567 (0.054) (*2.461 – 2.673*)	**0.008**	2.524 (0.048) (*2.429 – 2.619*)	0.164
	Yes	2.372 (0.100) (*2.170 – 2.574*)		2.328 (0.083) (*2.161 – 2.494*)		2.391 (0.151) (*2.079 – 2.704*)	
PND at third birth	No	3.300 (0.060) (*3.181 – 3.419*)	0.596*	3.338 (0.066) (*3.205 – 3.470*)	0.**053**	3.311 (0.061) (*3.191 – 3.431*)	0.404*
	Yes	3.333 (0.333) (*1.900 – 4.768*)		3.077 (0.077) (*2.909 – 3.245*)		3.000 (na) (*na*)	

Table 3. Odds ratios (OR) for the effect of PND on parity progression across models testing *hypotheses 2-3b*. The PND only model contains only the PND measure listed under variable of interest, the Base model contains the additional variables age at birth, mother's year of birth and SES, the Full model contains all the additional variables listed in Table 1, and the Selected model contains the variables retained after forward selection on the full set of variables after forcing the retention of PND and the Base model variables (see supplementary material for details). PND severity ORs reflect unstandardised results (for effect sizes see supplementary material). Akaike's information criterion with bias correction (AICc) shows the relative information loss across models at each parity, and Cox and Snell's (R^2_{CS}) and Nagelkerke's (R^2_N) pseudo R^2's estimate the variance captured by the models. ****p* < 0.001, ***p* <0 .05, **p* <0.1.

Model	Variable of interest		Progression from parity 1				Progression from parity 2				Progression from parity 3			
			OR	AICc	R^2_{CS}	R^2_N	OR	AICc	R^2_{CS}	R^2_N	OR	AICc	R^2_{CS}	R^2_N
Hypothesis 2														
1 PND only	PND severity at birth *n*		0.963	256.691	0.007	0.012	**0.952****	316.376	0.021	0.029	0.967	97.510	0.005	0.008
2 Base	PND severity at birth *n*		0.976	233.031	0.110	0.189	**0.937****	303.230	0.104	0.143	0.947	97.487	0.102	0.155
3 Full	PND severity at birth *n*		1.000	250.032	0.177	0.305	**0.947***	324.978	0.174	0.237	1.066	128.112	0.316	0.479
4 Selected	PND severity at birth *n*		0.984	222.176	0.166	0.287	0.966	299.595	0.156	0.214	1.075	91.467	0.230	0.348
Hypothesis 3a														
1 PND only	PND history	Bouts x1	-	-	-	-	0.774	315.389	0.033	0.045	-	-	-	-
		Bouts x2	-	-	-	-	**0.290****				-	-	-	-
2 Base	PND history	Bouts x1	-	-	-	-	0.700	303.203	0.112	0.153	-	-	-	-
		Bouts x2	-	-	-	-	**0.240****				-	-	-	-
3 Full	PND history	Bouts x1	-	-	-	-	0.786	324.314	0.185	0.252	-	-	-	-
		Bouts x2	-	-	-	-	**0.256****				-	-	-	-
4 Selected	PND history	Bouts x1	-	-	-	-	0.791	297.538	0.148	0.203	-	-	-	-
		Bouts x2	-	-	-	-	**0.236****				-	-	-	-
Hypothesis 3b														
1 PND only	PND severity birth 1		-	-	-	-	**0.929****	312.404	0.037	0.051	0.999	97.952	0.000	0.000
2 Base	PND severity birth 1		-	-	-	-	**0.922****	300.635	0.114	0.156	0.995	98.264	0.094	0.143
3 Full	PND severity birth 1		-	-	-	-	**0.907****	321.328	0.195	0.266	0.965	135.991	0.317	0.481
4 Selected	PND severity birth 1		-	-	-	-	**0.915****	292.806	0.172	0.235	0.996	91.585	0.251	0.380
1 PND only	PND severity birth 2		-	-	-	-	-	-	-	-	0.978	97.648	0.003	0.005
2 Base	PND severity birth 2		-	-	-	-	-	-	-	-	0.979	98.070	0.096	0.146
3 Full	PND severity birth 2		-	-	-	-	-	-	-	-	1.029	135.991	0.317	0.481
4 Selected	PND severity birth 2		-	-	-	-	-	-	-	-	0.961	91.162	0.210	0.318

Figure 1. Odds of a third birth at parity 2 dependent on postnatal depression (PND) severity (Edinburgh Postnatal Depression Scale (EPDS) score) at first birth across all models. The dashed vertical line indicates the cut-off beyond which PND is deemed to have occurred.

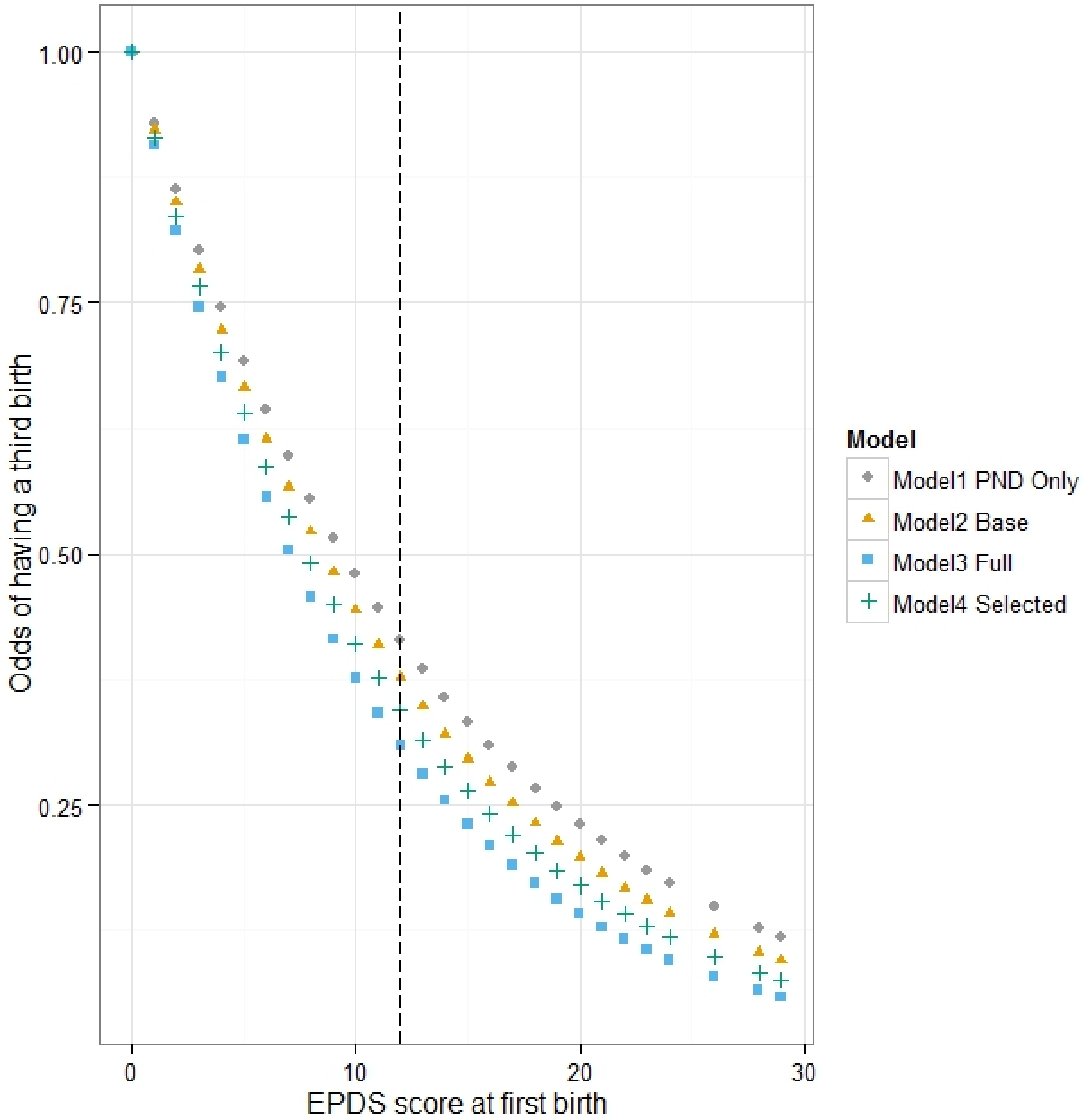
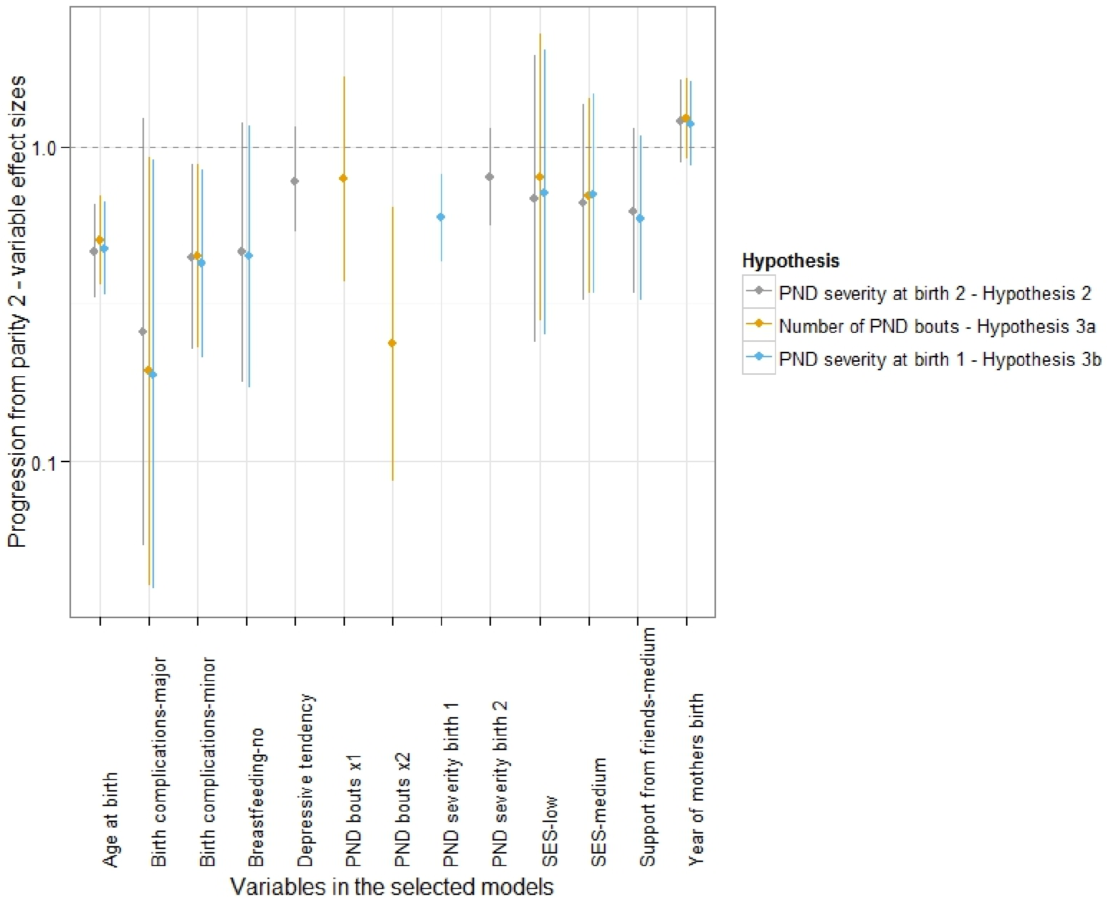


Figure 2. Odds ratio plot showing the effect sizes for the impact of variables in the *selected models* on progression from parity 2. Error bars reflect 95% confidence intervals. Continuous variables have been standardised and centred. Postnatal depression (PND), socioeconomic status (SES).



Appendix B – Reproductive Success Questionnaire

Development

The average completed fertility of women born in 1963 is 1.93, rising to a high of 2.42 for those born in 1934 and 1935 (Office of National Statistics, 2011). 10-15% of women are currently diagnosed with postnatal depression after childbirth (Halbreich and Karkun 2006), and levels rise to at least 63% when self-reported postnatal depression symptoms are used (Beck *et al.* 2011; Hayes *et al.* 2010). So even though the completed fertility rates of the women surveyed will be low, if the fertility of the 10-60% who suffered from postnatal depression was negatively impacted then a large sample size should be able to detect this. Eaves *et al.* (1990) found significant differences in reproductive success in relation to personality in a sample of postmenopausal 1101 Australian twins surveyed in 1981, who displayed a mean completed fertility of 2.55 and a total variance of 3.16. The survey will remain open for at least a year with the aim of gathering as large a sample size as possible. As the only apparent direct study of the effect of depression on fertility had a sample composed of 23 depressed women and 300 controls, matched demographically but not obviously queried regarding their depressive history (Essock and McGuire, 1989), hopefully this survey will represent an improvement no matter what the eventual sample size.

Women will be asked to report their date of birth, the total number times they gave birth, the date of each birth, whether the birth involved single of multiple infants, the sex of the infants, and her history of postnatal depression. To control for potential confounding factors, socioeconomic status, relationship status, social support and the health of the infant will measured along with when the woman first had sexual intercourse. For a more detailed account of the measures used and the objective behind each question see Appendix A.

To account for the fact that postnatal depression is reportedly currently under diagnosed (Chew-Graham *et al*., 2009; Dennis and Chung-Lee, 2006), and thus can be assumed to also be the case historically, self-reported screening for symptoms will be used as well as asking for diagnostic history. Women will be asked to reflect on each birth individually and for each complete an augmented Edinburgh Postnatal Depression Scale (EPDS) (Cox, *et al*., 1987) to reflect the past tense. Whilst the EPDS is not validated for retrospective use it has been used to assess depressive symptoms over a retrospective period of 5 years (Payne *et al*., 2010). However, it will be used here primarily to aid memory retrieval (Belli, 1998) before the Bromley Postnatal Depression Scale (BPDS) (Stein and van den Akker, 1992) is applied. This will also allow the EPDS scores to be compared to the BPDS to assess its potential use over long periods of time. The BPDS was developed specifically to retrospectively assess the experience of episodes of postnatal depression (Stein and van den Akker, 1992). It has been used to assess whether mothers experienced postnatal depression in women aged 51at the time of questioning (McLaren *et* al., 2007) and over a retrospective period of at least 42 years by Séjourné *et al*. (2011), who took depression to have occurred if women gave a positive answer to the first item in the scale 'Did you suffer from postnatal depression after the birth of one of your children as described above?'. As the scale is explicit in its aims it relies not only on women recalling their feelings from the time of their child's early infancy but also willingly accepting a label of postnatal depression if she does identify with the description. Given the stigma attached to postnatal depression and mental health diagnoses more generally it is thought likely that this second step causes women to under report symptoms. A more subtle approach will be taken here in which women will be asked simply if they experienced feelings described in the statement provided (from Stein and van den Akker, 1992), with the words 'postnatal depression' and 'symptoms' omitted, and then asked about their duration, with anything over a month taken to indicate depression. The use of any retrospective reporting poses problems with recall bias, and it has been found that retrospective interviews encompassing a longer period of time result in higher reported rates of postnatal depression (Gotlib *et al*., 1989). To attempt to balance this, towards the end of the survey each woman will be asked if she received an official diagnosis of postnatal depression with any of her births and if so to which it was associated, thus allowing for the possibility of conflicting answers, although arguably it is the subjective retrospective recall of distressing symptoms that play a greater role in decision making than do official diagnoses.

Questionnaire

Key: Sections in *italics* indicate what the respondent will be presented with, with sections in **bold** indicating explanation or instruction. Sections in brackets [] are for the researcher's purposes only and will not be presented to respondents.

[**Objective – to provide respondents with some background to the study and incentive to partake. To obtain informed consent and warn them of the potentially sensitive nature of the questions].**

Emotional Well-being and the Transition to Motherhood

Are you a woman and a mother over the age of 50? If so, please spare some time* to share your experiences of giving birth and raising children to help future generations of women.

In recent decades much has been written about the emotions a woman feels on becoming a mother and their impact, good or bad, on her infant's development. However, this research has almost entirely been done with the infant in mind, very little has been concerned with the woman for her own sake. The following questionnaire has been designed to redress this balance, with the aim of better understanding the long-term impact of these emotions; what effect they have on a woman's emotional well-being, her future reproductive desires, and the relationship she has with her children and grandchildren.

Please be aware you will be asked to recall some potentially sensitive events, and you may end your participation at any point. Your answers will remain strictly anonymous, so please feel free to express your experiences then, and now, whether good, bad, or indifferent – the more honest and diverse, the more help they will be.

****Time will vary depending on how many children you had, for a mother of two it will take approximately x minutes.***

The first set of questions are about you and your living circumstances during your childbearing years (defined here as being from the time you were first pregnant until your youngest child reached the age of one).

[**Objective – to calculate length of reproductive career, and control for the impact of marital and socioeconomic status (SES) and contraceptive use.** SES measured on the basis of the Social Class Based on Occupation (aka the Register General's Social Classes) of the person who contributed the majority of the family income, this takes into account the SES of single mothers, and can be used to assign people to social classes of given time periods (CeLSIUS, 2007)].

1. What is your date of birth? (DDMMYYYY)

2. How old were you when you first had sexual intercourse? (*Please give your age in years*)

3. Which of the following best describes your marital status during your childbearing years? (Married throughout, married for part of the time, unmarried throughout)

4. During your childbearing years who contributed the majority of the family's financial income? (You, your husband/partner/other)

5. Which of the following best describes the occupation of the majority contributor during your childbearing years? (Professional, managerial and technical, skilled non-manual, skilled manual, partly-skilled, unskilled)

6. Did you use any form of contraception, at any point, during the years in which you were fertile?

The following questions are to get a picture of your general emotional wellbeing to help interpret your answers to the main questions of interest in the remainder of the questionnaire.

[Objective – to check for current depressive symptoms. Trait Depression, Anxiety and Stress – Lovibond and Lovibond's (1995) Depression Anxiety Stress Scales (DASS) short version, using trait wording – rate the extent to which each item *applies in general* to them (Lovibond, 1998). (Four-point scale ranges from 0 (did not apply to me at all), 1 (applied to me to some degree, or some of the time), 2 (applied to me a considerable degree, or a good part of the time), and 3 (applied to me very much, or most of the time). Anxiety has also been found to reduce female fertility in the West (Jokela *et al*., 2009) so scores here will help control for its effects on completed fertility]

7. Please select the option which best describes how the following statements apply to you in general:

[DEPRESSION]
[Dysphoria]
- *I felt downhearted and blue. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)*

[Hopelessness]
- *I felt I had nothing to look forward to. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)*

[Devaluation of life]
- *I felt that life was meaningless.(Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)*

[Self-depreciation]
- *I felt I wasn't worth much as a person. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)*

[Lack of interest/involvement]

- I was unable to become enthusiastic about anything. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)

[Anhedonia]

- I couldn't seem to experience any positive feeling at all. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)

[Inertia]

- I found it difficult to work up the initiative to do things. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)

8. Please select the option which best describes how the following statements apply to you in general:

[ANXIETY]

[Autonomic arousal]

- I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat). (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)

- I was aware of dryness of my mouth. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)

- I experience difficulty breathing (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion). (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)

[Skeletal musculature effects]

- I experienced trembling (e.g. in the hands). (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)

[Situational anxiety]

- I was worried about situations in which I might panic and make a fool of myself. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)

[Subjective experience of anxious affect]

- I felt I was close to panic. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)

- I felt scared without any good reason. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)

9. Please select the option which best describes how the following statements apply to you in general:

[STRESS]

[Difficulty relaxing]

- *I found it hard to wind down. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)*
- *I found it difficult to relax. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)*

[Nervous arousal]

- *I felt that I was using a lot of nervous energy. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)*

[Easily upset/agitated]

- *I found myself getting agitated. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)*

[Irritable/over-reactive]

- *I tended to over-react to situations. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)*
- *I felt that I was rather touchy. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)*

[Impatient]

- *I was intolerant of anything that kept me from getting on with what I was doing. (Did not apply to me at all; applied to me some of the time; applied to me a good part of the time; applied to me most of the time)*

The remaining questions focus on you, the times you gave birth, the emotions you experienced after each birth, and your relationship with your children and any grandchildren you may have.

You will be asked to record all of the times which you gave birth, including those associated with an infant death or adoption of that infant. In the event of infant death you will only be asked further questions relating to the event in the case of multiple births where at least one child survived – you will be given the option not to answer these questions should you feel it too distressing. In the event of adoption you will not be requested to answer any further questions.

For each birth event (please count multiple births, e.g. twins, as one birth event), please report the following information as far as you are willing and able, starting with the first time you gave birth and working through to the last.

[**Objective – to collect data to check for parity and multiple birth effects**. Questions of my own design]

10. What was the date of the birth? (DDMMYYYY)

11. Did you give birth to a singleton, twins, triplets, quadruplets or more?

12. Did the infant survive its first year? (Yes or no) [this question will be tailored to account for the answer given to the previous question. If all infants died no further questions will be asked regarding this birth, if there was a death but one or more infants survived then the mother will be given to option to continue with the questions or skip to the next birth]

13. Did you give the infant up for adoption? (Yes or no) [if the answer is yes no further questions will be asked regarding this birth]

14. What was the sex of the infant? (Male or female) [the answer to question 11 regarding number of infants given birth to will ensure the correct number of response options for this question are presented].

Please reflect back to the birth and the first year afterwards.

[**Objective – to aid memory recall and control for the effects of child ill health, birth weight (Bereczkei *et al*., 2000), and breastfeeding (Howie and McNeilly, 1982) and potential effects of social support on interbirth interval**].

15. Which of the following options best characterises the physical experience of this labour and birth?
(Major complications which required an extended recovery time, major complications but no extended recovery time, minor complications which required an extended recovery time, minor complications but no extended recovery time, without complication)

16. Which of the following best characterises how did found the emotional experience of this labour and birth? (Extremely positive, positive, mixed emotions, negative, extremely negative)

17. Which of the following best describes the birth weight of your child? (Low, normal, high)

18. Did your infant have any serious health issues in its first year? (Yes or no)

19. Did you breastfeed this infant for any amount of time? (Yes or no)

20. If so for approximately how long did you continue to give breastmilk, of any amount, to this child? (Less than 6 months, between 6 months to 1 year, between 1 year and 1 ½ years, between 1 ½ years and 2 years, 2 years or more)

21. How would you rate the level of support available to you in this first year from the father of your child? (Very high, high, moderate, low, very low)

22. How would you rate the level of support available to you in this first year from your family? (Very high, high, moderate, low, very low)

23. How would you rate the level of support available to you in this first year from your friends? (Very high, high, moderate, low, very low)

[**Objective – to aid memory recall and potentially measure postnatal depression**. Based on an augmented Edinburgh Postnatal Depression Scale (EPDS) (Cox, *et al*., 1987) to reflect the past tense. Whilst this is not validated for retrospective use it has been used to assess depressive symptoms over a retrospective period of 5 years (Payne *et al*., 2010). It will be used here primarily to aid memory retrieval (Belli, 1998) before the Bromley Postnatal Depression Scale (BPDS) (Stein and van den Akker, 1992) is applied. However, scores will be compared to the BPDS to assess its potential use over long periods of time].

24. Please reflect back to the first year after that birth and then select the answer that comes closest to how you typically felt during that time in relation to the following statements:

I was able to laugh and see the funny side of things
- *As much as I always could*
- *Not quite so much as I could*
- *Definitely not so much as I could*
- *Not at all*

I looked forward with enjoyment to things
- *As much as I ever did*
- *Rather less than I had before*
- *Definitely less than I had before*
- *Hardly at all*

I blamed myself unnecessarily when things went wrong
- *Yes, most of the time*
- *Yes, some of the time*
- *Not very often*
- *No, never*

I was anxious or worried for no good reason

- No, not at all

- Hardly ever

- Yes, sometimes

- Yes, very often

I felt scared of panicky for no very good reason

- Yes, quite a lot

- Yes, sometimes

- No, not much

- No, not at all

Things got on top of me

- Yes, most of the time I wasn't able to cope

- Yes, sometimes I wasn't coping as well as usual

- No, most of the time I coped quite well

- No, I coped as well as ever

I was so unhappy that I had difficulty sleeping

- Yes, most of the time

- Yes, sometimes

- Not very often

- No, not at all

I felt sad or miserable

- Yes, most of the time

- Yes, quite often

- Not very often

- No, not at all

I was so unhappy that I cried

- Yes, most of the time

- Yes, quite often

- Only occasionally

- No, never

The thought of harming myself occurred to me

- Yes, quite often

- *Sometimes*
- *Hardly ever*
- *Never*

[**Objective – to test for postnatal depression**. The BPDS was developed to retrospectively assess the experience of episodes of postnatal depression (Stein and van den Akker, 1992). It has been used to assess whether mothers experienced postnatal depression in women aged 51 (McLaren *et* al., 2007) and over a retrospective period of at least 42 years by Séjourné *et al*. (2011), who took depression to have occurred if women gave a positive answer to the first item in the scale 'Did you suffer from postnatal depression after the birth of one of your children as described above?'. As the scale is explicit in its aims it relies not only on women recalling their feelings from the time of early infancy but also willingly accepting a label of postnatal depression if she does identify with the description. Given the stigma attached to postnatal depression and mental health diagnoses more generally it is thought likely that this second step causes women to under report symptoms. A more subtle approach will be taken here in which women will be asked if they experienced feelings described in the statement provided (from Stein and van den Akker, 1992), with the words 'postnatal depression' and 'symptoms' omitted, and then asked about their duration, with anything over a month taken to indicate depression. Once this section has been completed for each of a woman's births she will then be asked if she received an official diagnosis of postnatal depression with any births and if so to which it was associated, thus allowing for the possibility of conflicting answers].

Please read the following statement and then answer the questions below it:

'A period of a few weeks or months starting in the first year after giving birth to a baby when you felt depressed or low-spirited, or rather anxious with times of panic, slept poorly, wept very frequently, daily or almost daily, couldn't really laugh or enjoy anything, felt irritable and in poor temper, had headaches, and felt awful for much of the time.'

24. Did you experience a period when such feelings were experienced daily or almost daily following the birth of this child? (Yes or no)

If so, please answer the following question: [only presented if the answer to question 24 is yes]

25. How long did this period last for? (Less than one month, 1-3 months, 4-6 months, 7-12 months, more than 12 months)

Thinking about your relationship with this child in general, please answer the following questions:

[**Objective – to assess the long term impact of postnatal depression on mother-child relationships**. Positive Affect Index (Bengtson & Schrader, 1982) measures relationship quality, the questions in this version come from Bengtson and Black (1973) in (Bengtson & Schrader, 1982), but the response scale follows Birditt, K.S. *et al.'s* (2009) adaptation from a 1-6 scale to a 1-5 scale, as the original scale is grammatically and semantically awkward.]

26. How well do you feel this child understands you? (Not at all, a little, moderately, a lot, extremely)

27. How well do you feel your child trusts you? (Not at all, a little, moderately, a lot, extremely)

28. How fair do you feel this child is toward you? (Not at all, a little, moderately, a lot, extremely)

29. How much respect do you feel from this child? (None at all, a little, moderate, a lot, extreme)

30. How much affection do you feel this child has for you? (None at all, a little, moderate, a lot, extreme)

31. How well do you understand him (or her)? (Not at all, a little, moderately, a lot, extremely)

32. How much do you trust this child? (Not at all, a little, moderately, a lot, extremely)

33. How fair do you feel you are toward this child? (Not at all, a little, moderately, a lot, extremely)

34. How much do you respect this child? (Not at all, a little, moderately, a lot, extremely)

35. How much affection do you have toward this child? (None at all, a little, moderate, a lot, extreme)

[**Objective – to assess the long term impacts of postnatal depression on grandmother-grandchild relationships**. Questions of my own design]

36. Do you have any grandchildren from this child? (Yes or no)

37. If so how many? [questions 37-39 only presented if the answer to question 36 is yes]

38. How emotionally close do you feel you are with this grandchild [or *these grandchildren*]*? (Very close, close, moderately close, quite close, not at all)*

39. How would you rate the impact your relationship with your child has had on your relationship with their children? (Very positive, positive, no impact, negative, very negative)

Please repeat questions 10-39 for every time you have given birth.

[**Objective – to gather data on official diagnoses to bolster self-reports and to assess fertility intentions vs. results**. Question of my own design]

The final questions are about the end results of your fertility.

40. Did you receive a diagnosis of postnatal depression in association with any of the times you gave birth? (Yes or no)

41. If so, please indicate which birth(s) by selecting all that apply: (1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th, other) [only presented if the answer to question 40 is yes]

42. Thinking back to before you had children, how does the number of children you actually had compare with how many you initially thought you would have? (A lot less, less, equal to, more, a lot more).

43. Would you have liked to have more children than you did? (Yes or no)

44. If so how many? [only presented if the answer to question 43 is yes]

45. Would you have liked to have fewer children than you did? (Yes or no)

46. If so how many? [only presented if the answer to question 45 is yes]

47. The questions you have answered were designed to quantify specific information, and as such are necessarily generic. However, this is an area in which everyone's experience is importantly unique to them, so if you have any related thoughts or feelings you would like to express, please do so in the following space:

[**Objective – to thank participants, offer them a summary of the final results, and provide guidance to anyone how requires help regarding any issues raised by answering questions on potentially sensitive issues**].

You have now completed the questionnaire. Thank you for your time, understanding the emotions which surround childbirth and their long term impact is a significant issue and crucial to helping future generations of mothers, your valuable contribution to this important subject is very much appreciated.

If you would like to receive a summary of the results once finalised please provide your email address in the following box (please note this may take some time):

You have just been asked to reflect on some sensitive issues, if you find yourself experiencing any emotional distress as a result, or would simply like to discuss things further with someone, please contact your GP, or alternatively you may find the following websites helpful.

Mind – for better mental health:

http://www.mind.org.uk/

The Association for Postnatal Illness:

http://apni.org/

Perinatal Illness UK:

http://www.pni-uk.com/

Royal College of Psychiatrists:

http://www.rcpsych.ac.uk/

Family Therapy UK:

http://www.familytherapy.org.uk/

Counselling Directory:

http://www.counselling-directory.org.uk/

Appendix C – AICc Comparisons

PND Measure	AICc					
	P1	Rank	P2	Rank	P3	Rank
EPDS incidence	267.747	2	316.421	3	96.122	1
BPDS incidence	271.136	3	321.536	4	97.266	4
Actual diagnosis	275.424	5	336.378	9	104.240	6
EPDS severity	267.239	1	316.058	2	96.998	2
BPDS longevity	274.472	4	334.373	7	104.059	5
EPDS history	na	na	327.404	6	105.017	7
BPDS history	na	na	336.472	8	108.264	10
EPDS severity history	na	na	313.245	1	97.064	3
EPDS severity B1	na	na	326.073	5	105.345	8
EPDS severity B2	na	na	na	na	107.803	9

AICc's resulting from binary logistic regressions predicting parity progression with only PND.

PND measure	IBI		IBI dummy	
	AICc	Rank	AICc	Rank
EPDS incidence	3644.481	1	4560.772	1
BPDS incidence	3656.261	3	4578.970	3
Actual diagnosis incidence	3655.835	2	4579.673	4
BPDS longevity	3656.917	4	4578.029	2

AICc's resulting from Cox regressions predicting IBI with only PND, all parities treated equally.

PND measure	AICc	Rank
EPDS incidence	4151.056	2
EPDS severity	4123.194	1
BPDS incidence	4157.747	4
BPDS longevity	4151.681	3
Actual diagnosis	4164.602	5

AICc's resulting from linear regressions predicting relationship quality (PAI) with offspring with PND only.

Appendix D – PND and Maternal Circumstances

Circumstance at birth 2	Frequency	Percent	Valid Percent	Cumulative Percent
Worse	12	15.2	19.7	19.7
Same	16	20.3	26.2	45.9
Better	33	41.8	54.1	100.0
Total	61	77.2	100.0	

Of women who had PND at birth 1 as assigned by the EPDS did their *maternal circumstances* score increase at birth 2?

Appendix E – Pregnancy Questionnaires

Perceptions of Pregnancy and Early Motherhood – Pregnancy Questionnaire Wave 1

Page 1 – Intro covering ethics requirements, informed consent, reading age 15-16 years based on the Flesch-Kincaid Grade Level.

Are you in your second trimester of pregnancy and interested in taking part in research to help future mums? Then join in with this simple but important survey study.

In todays' world there is a lot of pressure put on pregnant women and mums of young babies. Doctors, parenting guides, the media, other women, all have something to say on what you can and can't do. But very little attention has been paid to what this does to women, how it affects their confidence, behaviour and emotions.

This study is designed to look at how these things combine to effect female emotional health in early motherhood. It is hoped that a better knowledge of the things that impact women will help women to better understand their feelings and lead to new and more effective ways of dealing with things like postnatal depression.

The study is made up of three surveys between now and six months after you give birth. This first one is the longest and will take roughly 45 minutes. It doesn't need to be done all in one go, if you wish to pause and return a later you may do so as many times as you like by selecting the 'Save and continue later' option at the top of each page. There are then two shorter ones for after you have your baby to follow up on your experiences. You will only be entered into the draw to win one of ten £10 Boots eGift vouchers if you complete all three surveys.

Your answers will remain ANONYMOUS* and STRICTLY CONFIDENTIAL. The surveys include a number of standard psychological tests for anxiety, stress, and depression which include a small number of questions regarding self-harm. Research into similar studies has found that a very small percentage of people may find taking part distressing. However many people, no matter what their emotional history is, actually find the experience to be positive. Should you feel any distress a list of places from which to seek help can be found on the last page of each survey. This research has received ethical approval from the University of Kent's School of Anthropology and Conservation. Should you have any questions or concerns please email them to motherhood@kent.ac.uk

*IP addresses will be recorded to stop multiple responses by the same user, and your email address will be requested to send you the follow up surveys.

Page 2 – Fulfils ethics requirements.

You may find that some of the issues you are asked to reflect upon are sensitive. If you find yourself experiencing any emotional distress as a result, or would simply like to discuss things further with someone, please contact your GP, or alternatively you may find the following websites helpful:

http://www.mind.org.uk Mind – for better mental health http://apni.org The Association for Postnatal Illness

http://www.pni-uk.com Perinatal Illness UK

http://www.rcpsych.ac.uk Royal College of Psychiatrists

http://www.counselling-directory.org.uk Counselling Directory

Page 3 - The importance of the emotional development of the child and the mother's role in this development. Questions of my own design, aimed at garnering the mother's attitudes towards emotional bonding and its importance in general.

A lot has been written over the years on the subject of maternal emotions. This first section deals with your thoughts and opinions on mother-infant bonding. The following questions relate to the impact of bonding generally on a baby both in it's first year and during later child development.

1. Women differ in the length of time it takes them to emotionally bond with their baby. How long do you think the maximum normal time is? (No time it should be instant, 1 day, 2-3 days, 4-6 days, 1 week, 2 weeks, 3 weeks, 1 month, 1-3 months, 4-6 months, 6months to a year, over a year, there isn't one)

2. How important do you think it is it for a mother to emotionally bond with her baby? (Extremely, very, moderately, a little, not at all)

3. How important is it *to* you that you emotionally bond with your baby? (Extremely, very, moderately, a little, not at all)

4. How important do you think emotional bonding is to a baby's emotional development in its first year? (Extremely, very, moderately, a little, not at all)

5. How important do you think emotional bonding is to a baby's educational development in its first year? (Extremely, very, moderately, a little, not at all)

6. How important do you think emotional bonding is to a baby's physical development in its first year? (Extremely, very, moderately, a little, not at all)

7. How important do you think emotional bonding is to a child's long-term emotional development? (Extremely, very, moderately, a little, not at all)

8. How important do you think emotional bonding is to a child's long-term educational development? (Extremely, very, moderately, a little, not at all)

9. How important do you think emotional bonding is to a child's long-term physical development? (Extremely, very, moderately, a little, not at all)

Page 4 - The importance of the emotional development of the child and the mother's role in this development. Questions of my own design, aimed at garnering the mother's attitudes towards emotional bonding and the importance of it occurring quickly.

The following questions are similar to those on the previous page but this time relate to the importance you place on emotional bonding occurring QUICKLY.

10. How important do you think it is it for a mother to quickly emotionally bond with her baby? (Extremely, very, moderately, a little, not at all)

11. How important is it to you that you quickly emotionally bond with your baby? (Extremely, very, moderately, a little, not at all)

12. How important do you think quick emotional bonding is to a baby's emotional development in its first year? (Extremely, very, moderately, a little, not at all)

13. How important do you think quick emotional bonding is to a baby's educational development in its first year? (Extremely, very, moderately, a little, not at all)

14. How important do you think quick emotional bonding is to a baby's physical development in its first year? (Extremely, very, moderately, a little, not at all)

15. How important do you think quick emotional bonding is to a child's long-term emotional development? (Extremely, very, moderately, a little, not at all)

16. How important do you think quick emotional bonding is to a child's long-term educational development? (Extremely, very, moderately, a little, not at all)

17. How important do you think quick emotional bonding is to a child's long-term physical development? (Extremely, very, moderately, a little, not at all)

18. Please rank the following on the basis of their personal importance to you (1 being the most important, 3 being the least):
- The physical development of your child.
- The emotional development of your child.
- The educational development of your child.

Page 5 - Questions of my own design, aimed at garnering the mother's attitudes towards the importance of the role of 'mother' relative to other factors in child development.

The relative importance of a parent on their child's development is often a hot topic in the media and elsewhere. The next section focuses on your opinions in this regard, with a specific focus on the role of the mother.

19. How important do you think the role of the mother is to a child's physical development compared to that of the father? (Much more important, more important, equally important, less important, a lot less important)

20. How important do you think the role of the mother is to a child's emotional development compared to that of the father? (Much more important, more important, equally important, less important, a lot less important)

21. How important do you think the role of the mother is to a child's educational development compared to that of the father? (Much more important, more important, equally important, less important, a lot less important)

The following questions are about the importance of factors other than the mother on a child's development. Here the wider world is taken to mean everything other than the mother that can play a role in a child's development (for example school, friends, media, etc.).

22. How important do you think the role of the mother is to a child's physical development compared to that of the wider world? (Much more important, more important, equally important, less important, a lot less important)

23. How important do you think the role of the mother is to a child's emotional development compared to that of the wider world (Much more important, more important, equally important, less important, a lot less important)

24. How important do you think the role of the mother is to a child's educational development compared to that of the wider world? (Much more important, more important, equally important, less important, a lot less important)

Page 6 - *Questions of my own design, aimed at garnering how immersed the woman is in her pregnancy, where her concerns lie how potentially exposed she is to messages of intensive mothering, and what this has done for her confidence.*

There are many sources of information about pregnancy and childcare available to women today, the following questions are about your use of these sources.

25a. Have you done any research into pregnancy, either during this pregnancy or whilst trying to get pregnant? (Yes, no)

25b. What sort of things are you mainly seeking advice on? (Open textbox, responses to be coded) *[Question asked if answer to q.25a is 'yes']*

26. Which resources have you used? Select all that apply (pregnancy books, websites aimed at pregnant women, the internet more generally, talking to friends or family, talking to a doctor or nurse, other) *[Question asked if answer to q.25a is 'yes']*

27. How many different books have you read? *[Question asked if 'pregnancy books' is selected in q.26]*

28. How many different websites have you visited? *[Question asked if 'websites aimed at pregnant women or parents' is selected in q.26]*

29. What effect has this had on your confidence? (Very positive, positive, neutral, negative, very negative.) *[Question asked if answer to q.25a is 'yes']*

30. Has any of the advice you received been conflicting? (Not at all, a little, moderately, very, extremely.) *[Question asked if answer to q.25a is 'yes']*

31a. Have you done any research into parenting, either during this pregnancy or whilst trying to get pregnant? (Yes, no)

31b. What sort of things are you mainly seeking advice on? (Open textbox, responses to be coded) *[Question asked if answer to q.31a is 'yes']*

32. Which resources have you used? Select all that apply (parenting books, websites aimed at parents, the internet more generally, talking to friends or family, talking to a doctor or nurse, other) *[Question asked if answer to q.31a is 'yes']*

33. How many different books have you read? *[Question asked if 'parenting books' is selected in q.32]*

34. How many different websites have you visited? *[Question asked if 'websites aimed at parents' is selected in q.32]*

35. What effect has this had on your confidence? (Very positive, positive, neutral, negative, very negative.) *[Question asked if answer to q.31a is 'yes']*

36. Has any of the advice you received been conflicting? (Not at all, a little, moderately, very, extremely.) *[Question asked if answer to q.31a is 'yes']*

Page 7 - Questions of my own design, aimed at garnering the mother's perceptions surrounding risk, following Lee et al. (2010). The final two questions are included on the basis of recent findings on the links between fear of childbirth and postnatal depression (Räisänen et al., 2013)

The following questions are about the extent to which you feel you and your baby are subject to risk.

35. Do you feel a baby may be exposed to risk during pregnancy? (Yes or no)

36. How much risk do you feel your baby has been exposed to during your pregnancy so far? (None, a little, moderate, a lot, extreme)

37. How much risk do you feel your baby will be exposed to once it is born? (None, a little, moderate, a lot, extreme)

38. Do you feel under pressure to protect your baby from risk? (No not at all, Yes a little, Yes moderately, Yes a lot, Yes extremely)

39. How confident are you in your ability to protect your baby from risk? (Not at all, quite, moderately, very, extremely)

40. Would you say you are fearful of childbirth itself? (Yes, no)

41. How would you rate your level of fear? (Very mild, mild, moderate, strong, very strong, extreme.) *[Question asked if answering 'yes' to question 30]*

Page 8 - Based on Pinel's (1999) Stigma Consciousness Questionnaire for Women but wording altered to tap stigma regarding mothering, trying to avoid suggesting where stigma may be coming from by using 'others' or 'people' instead of a specific group – men were used in the original questionnaire for women. The reverse scoring has been removed following Fowler (1995) due to it being deemed too confusing, especially when combined with 'agree-disagree' questions which are cognitively complex. The scoring scale ranges from 0 (strongly disagree) to 6 (strongly agree), with a midpoint of 3 (neither agree nor disagree) (Pinel, 1999) – full scale not listed so using strongly, moderately and mildly.

42. Stereotypes about becoming/being a mother have affected me personally.

43. I worry that my behaviour as a mother will be judged.

44. When interacting with others, I feel like they interpret all my behaviours in terms of the fact that I am pregnant.

45. Most people judge mothers on the basis of their mothering behaviour.

46. My being pregnant influences how women act with me.

47. I almost always think about the fact that I am pregnant when I interact with others.

48. My being pregnant influences how men act with me.

49. Most people have a lot more judgemental thoughts regarding motherhood than they actually express.

50. I often think women are unfairly judged regarding their childrearing decisions.

51. Most non-mothers have a problem viewing mothers as equals.

Page 9 - Based on question 14 of Corning's (2000) Perceived Social Inequity-Women's Form with wording altered to tap the social pressures surrounding mothers and their sources.

The following questions relate to some potential sources of social pressure on women during pregnancy and early motherhood. Please select the answer option which best reflects your personal opinion.

52. Do you feel affected by the way mothering is portrayed by medical professionals?

53. Do you want to be affected by the way mothering is portrayed by medical professionals?

54. Are other women affected by the way mothering is portrayed by medical professionals?

55. Should you have to feel affected by the way mothering is portrayed by medical professionals?

56. Do you feel affected by the way mothering is portrayed in pregnancy and childcare manuals/websites?

57. Do you want to be affected by the way mothering is portrayed in pregnancy and childcare manuals/websites?

58. Are other women affected by the way mothering is portrayed in pregnancy and childcare manuals/websites?

59. Should you have to feel affected by the way mothering is portrayed in pregnancy and childcare manuals/websites?

60. Do you feel affected by the way other women conduct their pregnancy and childcare?

61. Do you want to be affected by the way other women conduct their pregnancy and childcare?

62. Are other women affected by the way other women conduct their pregnancy and childcare?

63. Should you have to feel affected by the way other women conduct their pregnancy and childcare?

64. Do you feel affected by the way mothering is portrayed on TV or in magazines and the news?

65. Do you want to be affected by the way mothering is portrayed on TV or in magazines and the news?

66. Are other women affected by the way mothering is portrayed on TV or in magazines and the news?

67. Should you have to feel affected by the way mothering is portrayed on TV or in magazines and the news?

Page 10-12 - Based on Andrew's et al. (2002) Experience of Shame Scale (ESS) which is designed to ask direct questions regarding shame and the specific origins of shame. Andrew's et al. found that shame at time 1 predicted depression at time 2. Altered from 'anytime in the last year' to apply to the time since discovering pregnancy. Questions regarding the body have been switched to similar style questions relevant to pregnancy and mothering.

Everybody at times can feel embarrassed, self-conscious or ashamed. These questions are about such feelings DURING THIS PREGNANCY, although they may be new or continuing feelings. There are no 'right' or 'wrong' answers.

68. Have you felt ashamed of any of your personal habits?

69. Have you worried about what other people think of any of your personal habits?

70. Have you tried to cover up or conceal any of your personal habits?

71. Have you felt ashamed of your manner with others?

72. Have you worried about what other people think of your manner with others?

73. Have you avoided people because of your manner?

74. Have you felt ashamed of the sort of person you are?

75. Have you worried about what other people think of the sort of person you are?

76. Have you tried to conceal from others the sort of person you are?

77. Have you felt ashamed of your ability to do things?

78. Have you worried about what other people think of your ability to do things?

79. Have you avoided people because of your inability to do things?

80. Do you feel ashamed when you do something wrong?

81. Have you worried about what other people think of you when you do something wrong?

82. Have you tried to cover up or conceal things you felt ashamed of having done?

83. Have you felt ashamed when you said something stupid?

84. Have you worried about what other people think of you when you said something stupid?

85. Have you avoided contact with anyone who knew you said something stupid?

86. Have you felt ashamed when you failed at something which was important to you?

87. Have you worried about what other people think of you when you fail?

88. Have you avoided people who have seen you fail?

89. Have you felt ashamed of any aspect of your pregnancy or feelings towards it?

90. Have you worried about what other people think of your pregnancy, your behaviour and feelings during it, or your future mothering ability?

91. Have you avoided thinking about your feelings regarding being pregnant or becoming a mother?

92. Have you wanted to hide or conceal your pregnancy or any aspect of your pregnancy related behaviour or feelings?

Page 13 – Perceived availability of emotional support, questions of my own design.

Pregnancy and early motherhood is a time during which a woman needs a lot of support, both practical and emotional, from those around her. The following section concerns the level of emotional support available to you.

93. How would you rate the level of emotional support available to you from the father of your child? (Very high, high, moderate, low, very low)

94. How would you rate the level of emotional support available to you from your own family? (Very high, high, moderate, low, very low)

95. How would you rate the level of emotional support available to you from the father of your child’s family? (Very high, high, moderate, low, very low)

96. How would you rate the level of emotional support available to you from your friends? (Very high, high, moderate, low, very low)

97. How would you rate the level of emotional support available to you from your GP? (Very high, high, moderate, low, very low)

98. How would you rate the level of emotional support available to you from the health workers you have encountered in relation to your pregnancy? (Very high, high, moderate, low, very low)

Page 14 – Availability of practical support, questions of my own design.

The following section concerns the level of practical support available to you.

99. How would you rate the level of practical support available to you from the father of your child? (Very high, high, moderate, low, very low)

100. How would you rate the level of practical support available to you from your own family? (Very high, high, moderate, low, very low)

101. How would you rate the level of practical support available to you from the father of your child's family? (Very high, high, moderate, low, very low)

102. How would you rate the level of practical support available to you from friends? (Very high, high, moderate, low, very low)

103. How would you rate the level of practical support available to you from your GP? (Very high, high, moderate, low, very low)

104. How would you rate the level of practical support available to you from the health workers you have encountered in relation to your pregnancy? (Very high, high, moderate, low, very low)

105. Are you aware of the local facilities and support groups available for mothers and babies? (Yes or no)

106. Do you have easy transport access to these facilities? (Yes or no)

107. Do you have the financial means to comfortably access these facilities? (Yes or no)

Page 15 – Emotional capital: Emotional well-being measured by Bradburn's Affect Balance Scale (van Schuur and Kruijtbosch, 1995), scoring yes or no.

The following section is devoted to your feelings and your opinions and expectations of yourself. Some of the questions may seem rather similar but they are part of scales assessing slightly different things so your patience is much appreciated.

Please read the following statements and answer yes or no as to whether you have ever felt like this in the past few weeks.

108. Particularly excited or interested in something

109. So restless you couldn't sit long in a chair

110. Proud because someone had complimented you on some-thing you had done

111. Very lonely or remote from other people

112. Pleased about having accomplished something

113. Bored

114. On top of the world/feeling that life is wonderful

115. Depressed or very unhappy

116. That things were going your way

117. Upset because somebody criticized you

Page 16-21 – Emotional capital: Emotional intelligence accessed using Petrides's Trait Emotional Intelligence Short-form (Petrides and Furnham, 2006).

Please read the following statements and select the answer option which best applies to you. Don't think too long about the exact meaning of the statements, there are no right or wrong answers. There are seven possible responses to each statement ranging from 'Completely Disagree' (number 1) to 'Completely Agree' (number 7).

1 . . . . 2 . . . . 3 . . . . 4 . . . . 5 . . . . 6 7

Completely Disagree — **Completely Agree**

118. Expressing my emotions with words is not a problem for me.	1	2	3	4	5	6	7
119. I often find it difficult to see things from another person's viewpoint.	1	2	3	4	5	6	7
120. On the whole, I'm a highly motivated person.	1	2	3	4	5	6	7
121. I usually find it difficult to regulate my emotions.	1	2	3	4	5	6	7
122. I generally don't find life enjoyable.	1	2	3	4	5	6	7
123. I can deal effectively with people.	1	2	3	4	5	6	7
124. I tend to change my mind frequently.	1	2	3	4	5	6	7
125. Many times, I can't figure out what emotion I'm feeling.	1	2	3	4	5	6	7
126. I feel that I have a number of good qualities.	1	2	3	4	5	6	7
127. I often find it difficult to stand up for my rights.	1	2	3	4	5	6	7
128. I'm usually able to influence the way other people feel.	1	2	3	4	5	6	7
129. On the whole, I have a gloomy perspective on most things.	1	2	3	4	5	6	7
130. Those close to me often complain that I don't treat them right.	1	2	3	4	5	6	7
131. I often find it difficult to adjust my life according to the circumstances.	1	2	3	4	5	6	7
132. On the whole, I'm able to deal with stress.	1	2	3	4	5	6	7

133. I often find it difficult to show my affection to those close to me.	1	2	3	4	5	6	7
134. I'm normally able to "get into someone's shoes" and experience their emotions.	1	2	3	4	5	6	7
135. I normally find it difficult to keep myself motivated.	1	2	3	4	5	6	7
136. I'm usually able to find ways to control my emotions when I want to.	1	2	3	4	5	6	7
137. On the whole, I'm pleased with my life.	1	2	3	4	5	6	7
138. I would describe myself as a good negotiator.	1	2	3	4	5	6	7
139. I tend to get involved in things I later wish I could get out of.	1	2	3	4	5	6	7
140. I often pause and think about my feelings.	1	2	3	4	5	6	7
141. I believe I'm full of personal strengths.	1	2	3	4	5	6	7
142. I tend to "back down" even if I know I'm right.	1	2	3	4	5	6	7
143. I don't seem to have any power at all over other people's feelings.	1	2	3	4	5	6	7
144. I generally believe that things will work out fine in my life.	1	2	3	4	5	6	7
145. I find it difficult to bond well even with those close to me.	1	2	3	4	5	6	7
146. Generally, I'm able to adapt to new environments.	1	2	3	4	5	6	7
147. Others admire me for being relaxed.	1	2	3	4	5	6	7

Page 22-27 – Emotional capital: Emotional personality assessed using the Brief Affective Neuroscience Personality Scale (BANPS) (Barret et al., 2013), developed from Davies and Panksepp's (2011) Affective Neuroscience Personality Scales (ANPS). Scoring scale 1 Strongly disagree, 2 Disagree, 3 Neither agree nor disagree, 4 Agree, 5 Strongly agree, with those marked (R) reverse scored.

Please read the following statements and select the answer option which best applies to you.

148. People who know me would say I am a very fun-loving person.

149. When I am frustrated, I usually get angry.

150. I am usually not highly curious. (R)

151. I am the kind of person that likes to touch and hug people.

152. I rarely get angry enough to want to hit someone. (R)

153. I rarely worry about my future. (R)

154. I rarely become sad. (R)

155. I seldom experience sadness or despair. (R)

156. I am very playful.

157. I often have the feeling that I am going to cry.

158. My friends would probably describe me as hotheaded.

159. I do not feel lonely very often. (R)

160. I like to kid around with other people.

161. I often feel the urge to nurture those closest to me.

162. I often worry about the future.

163. I am not particularly affectionate. (R)

164. There are very few things that make me anxious. (R)

165. I often feel lonely.

166. I am a person who is easily amused and laughs a lot.

167. People who know me well would say I almost never become angry. (R)

168. I am usually not interested in solving problems and puzzles just for the sake of solving them. (R)

169. I do not particularly enjoy kidding around and exchanging “wisecracks.” (R)

170. I sometimes cannot stop worrying about my problems.

171. I hardly ever become so angry at someone that I feel like yelling at them. (R)

172. I am not an extremely inquisitive person. (R)

173. When someone makes me angry, I tend to remain fired up for a long time.

174. I do not especially want people to be emotionally close to me. (R)

175. My curiosity drives me to do things.

176. My friends would probably describe me as being too serious.

177. I have very few fears in my life. (R)

178. I enjoy finding new solutions to problems.

179. I often feel sad.

180. I like to think outside of the box.

Page 28-29 - Controlling for factors previously correlated with postnatal depression based on Beck (2001 and 2002): Self-esteem, assessed using the Rosenberg Self-Esteem Scale (Rosenberg, 1965) – questions marked (R) are reverse scored, sum scores, scale: strongly agree, agree, disagree, strongly disagree.

Please read the following statements and select the answer option which best describes how they generally apply to you.

181. On the whole, I am satisfied with myself.

182. At times, I think I'm no good at all. (R)

183. I feel that I have a number of good qualities.

184. I am able to do things as well as most other people.

185. I feel I do not have much to be proud of. (R)

186. I certainly feel useless at times. (R)

187. I feel that I am a person of worth, at least on an equal plane with others.

188. I wish I could have more respect for myself. (R)

189. All in all, I am inclined to feel that I am a failure. (R)

190. I take a positive attitude towards myself.

Page 30-32 - Controlling for factors previously correlated with postnatal depression based on Beck (2001 and 2002): History of depression, stress, and anxiety, assessed using Lovibond and Lovibond's (1995) Depression Anxiety Stress Scales (DASS) short version, using trait wording – rate the extent to which each item applies in general to them (Lovibond, 1998). (Four-point scale ranges from 0 (did not apply to me at all), 1 (applied to me to some degree, or some of the time), 2 (applied to me a considerable degree, or a good part of the time), and 3 (applied to me very much, or most of the time.

Please select the option which best describes how the following statements have applied to you in general in your life.

[DEPRESSION]

[Dysphoria]

191. I felt downhearted and blue.

[Hopelessness]

192. I felt I had nothing to look forward to.

[Devaluation of life]

193. I felt that life was meaningless.

[Self-depreciation]

194. I felt I wasn't worth much as a person.

[Lack of interest/involvement]

195. I was unable to become enthusiastic about anything.

[Anhedonia]

196. I couldn't seem to experience any positive feeling at all.

[Inertia]

197. I found it difficult to work up the initiative to do things.

[ANXIETY]

[Autonomic arousal]

198. I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat).

199. I was aware of dryness of my mouth.

200. I experience difficulty breathing (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion).

[Skeletal musculature effects]

201. I experienced trembling (e.g. in the hands).

[Situational anxiety]

202. I was worried about situations in which I might panic and make a fool of myself.

[Subjective experience of anxious affect]

203. I felt I was close to panic.

204. I felt scared without any good reason.

[STRESS]

[Difficulty relaxing]

205. I found it hard to wind down.

206. I found it difficult to relax.

[Nervous arousal]

207. I felt that I was using a lot of nervous energy.

[Easily upset/agitated]

208. I found myself getting agitated.

[Irritable/over-reactive]

209. I tended to over-react to situations.

210. I felt that I was rather touchy.

[Impatient]

211. I was intolerant of anything that kept me from getting on with what I was doing.

Page 33 - Controlling for factors previously correlated with postnatal depression based on Beck (2001): Antenatal depression assessed using Choi et al.'s (2012) simplified EPDS to detect antenatal depression (cut off of 3). Diagnosis will also be enquired about in stage 3.

Please read the following statements and then select the option which comes closest to how you have felt *in the past 7 days*.

212. I have felt scared of panicky for no very good reason
- Yes, quite a lot
- Yes, sometimes
- No, not much
- No, not at all

213. I have felt sad or miserable
- Yes, most of the time
- Yes, quite often
- Not very often
- No, not at all

Page 34 – Demographics and possible risk factors: actual parity, effective parity (stepchildren), unplanned and unwanted pregnancy. Questions of my own design.

Thank you, you have now reached the last section. The final questions concern you, your living situation, and events in your life which may have some bearing on your emotional health.

214. What is your date of birth?

215. How many times have you been pregnant before this current pregnancy?

216. How many biological children do you have?

217. How many children currently live under your care for the majority, if not all, of the time?

218. How many children currently live under your care for the minority of the time (for example stepchildren staying at weekends)?

219. What is your due date for giving birth?

220. Was this pregnancy planned?

221. How happy are you to be pregnant at this time in your life? (Extremely, very, moderately, a little, not at all)

Page 35 - Controlling for factors previously correlated with postnatal depression based on Beck (2001): socioeconomic status assessed using the Social Class Based on Occupation (aka the Register General's Social Classes) of the person who contributes the majority of the family income, this takes into account the SES of single mothers, and can be used to assign people to social classes of given time periods (CeLSIUS, 2007); relationship status, questions of my own design; relationship quality, questions of my own design.

222. Who contributes the majority of your household's financial income? (You, your husband/partner/, you and your husband/partner equally, other)

223. Which of the following best describes the occupation of the majority contributor? (Professional, managerial and technical, skilled non-manual, skilled manual, partly-skilled, unskilled)

224. Which of the following best describes your current relationship status? (Single, married/civil partnership, in a relationship, separated)

225. Which of the following best describes your living arrangements with your partner? (Living separately, living separately but planning to move in together before the birth, cohabiting) *[Question asked to anyone not answering single]*

226. Which of the following best describes the state of your relationship in terms of happiness? (Very happy, happy, moderately happy, quite unhappy, unhappy, very unhappy) *[Question asked to anyone not answering single]*

227. Which of the following best describes the state of your relationship in terms of stability? (Very stable, stable, moderately stable, quite unstable, unstable, very unstable) *[Question asked to anyone not answering single]*

Page 36 – Controlling for life event stress and history of mental health issues proposed as a risk factors (Beck, 2001). Questions based on Austen et al.'s (2005) question to determine perceived life event stress prior to pregnancy, with an altered rating scale to include labels for each response option to aid respondents.

228. In the 12 months prior to your pregnancy did you have any major stresses, changes or losses (e.g., separation, bereavement, moving house, domestic violence)? Yes or no.

229. How many major stresses, changes, or losses would you say you experienced? *[Questions asked in answering 'yes' to q.216]*

230. How would you rate the extent this stress affected your emotional well-being? (Very little, a little, moderately, quite a lot, very much) *[Questions asked in answering 'yes' to q.216]*

231. In the course of this pregnancy, have you had any major stresses, changes or loses (e.g., separation, bereavement, moving house, domestic violence)? Yes or no.

232. How many major stresses, changes, or losses would you say you experienced? *[Questions asked in answering 'yes' to q.219]*

233. How would you rate the extent this stress affected your emotional well-being? (Very little, a little, moderately, quite a lot, very much) *[Questions asked in answering 'yes' to q.219]*

234. Have you ever been diagnosed with depression?

235. Have you ever been diagnosed with an anxiety disorder?

236. Have you ever been diagnosed with another form of mental health disorder?

Page 37 – Gathering email address to which to send the follow up surveys, and requesting any further comments.

237. You have now completed the survey, thank you very much for your time. Understanding the factors which impact maternal emotional health is incredibly important and your time and effort will go towards helping in this crucial task. There are two short follow-up surveys to gather your experiences of birth and the months afterwards, the first a month after you give birth and the second six months after.

Please provide your email address so a link to these surveys may be sent to you. The first link will be emailed four weeks after the due date you reported here, with a reminder email sent a week later. The record of your email address will remain strictly confidential, it won't appear in any data sets and will be destroyed once the study is complete.

238. The questions you have answered were designed to quantify specific information, and as such are necessarily generic. However, this is an area in which everyone's experience is importantly unique to them, so if you have any related thoughts or feelings you would like to express, please do so in the following space:

You have just been asked to reflect on some sensitive issues, if you find yourself experiencing any emotional distress as a result, or would simply like to discuss things further with someone, please contact your GP, or alternatively you may find the following websites helpful:

http://www.mind.org.uk Mind – for better mental health

http://apni.org The Association for Postnatal Illness

http://www.pni-uk.com Perinatal Illness UK

http://www.rcpsych.ac.uk Royal College of Psychiatrists

http://www.counselling-directory.org.uk Counselling Directory

If for any reason you later wish to avoid being sent the links to the follow-up surveys please email motherhood@kent.ac.uk and simply put 'Unsubscribe' in the subject line.

Perceptions of Pregnancy and Early Motherhood – Pregnancy Questionnaire Wave 2

Page 1 – Introduction and verification of email so data can be matched with previous answers.

Many thanks for continuing to show support for this research. This is the first of two surveys following up on your experiences and perceptions of early motherhood. This survey will take approximately 15 minutes to complete and focuses on the emotions you have been experiencing in the first month since giving birth.* It doesn't need to be done all in one go, if you wish to pause and return a later you may do so as many times as you like by selecting the 'Save and continue later' option at the top of each page.

1. First, in order to match your responses to this survey with your previous ones please enter the email address to which this link was sent.

*The timing of this email was based on your expected due date, don't worry if you gave birth early but if you gave birth over a week late it would be appreciated if you could wait another week before completing this survey.

Page 2 – Ensuring that no one who suffered a miscarriage or early infant death is subjected to further questioning, question of my own design. Anyone answering yes will be directed to page 3a.

You will be asked to reflect on some issues which may be sensitive. If you find yourself experiencing any emotional distress as a result, or would simply like to discuss things further with someone, please contact your GP, or alternatively you may find the following websites helpful:

http://www.mind.org.uk Mind – for better mental health

http://apni.org The Association for Postnatal Illness

http://www.pni-uk.com Perinatal Illness UK

http://www.rcpsych.ac.uk Royal College of Psychiatrists

http://www.counselling-directory.org.uk Counselling Directory

2. It is very sadly the case that some mothers experience the loss of their baby. Before going any further, please indicate if this happened to you so that you do not receive any further unwanted questions or survey details at this terrible time. (No, my baby is alive, Yes, my baby passed away)

Page 3a – Assuring anyone returning to the survey even though they lost their infant that they will not be contacted further unless they would still like to receive a summary of the study result.

91. Please accept our sincere condolences for your loss. Your email will now be removed from the mailing list and we will make no more intrusions on your time. However, we are offering all participants a summary of the results of the study, so if you would like to still receive this please indicate below (please note that this may take some time). (Yes, I would like to receive a summary, No, please do not contact me again)

Page 3b – Obtaining details of the birth, questions of my own design.

3. What date did you give birth on?

4. How many babies did you give birth to during this birth event? (Singleton, twins, triplets, quadruplets, more) *[Note where appropriate all future question wording will be varied to reflect a multiple as opposed to single birth experience]*

5. What is the sex of your baby? *[If answering single to q.4]*

6. How many males did you give birth to? *[If answering anything other than single to q.4]*

7. How many females did you give birth to? *[If answering anything other than single to q.4]*

8. What type of delivery did you have? (Vaginal without drugs (inc. Gas and air, TENS), vaginal with drugs (inc. epidural), planned caesarean, emergency caesarean, ventouse/suction, forceps)

9. Where did you give birth? (Hospital, home)

Page 4 – To assess the perceptions surrounding the progression of emotional bonding, questions of my own design.

The following questions focus on the relationship you have with your baby and the feelings you have surrounding this relationship.

Emotionally bonding with your baby is a process, women differ in the length of time it takes them to emotionally bond with their baby and there is no ‘normal’ timeframe in which this occurs. Please reflect on your developing emotional relationship with your baby and answer the following questions. There are no ‘right’ or ‘wrong’ answers.

10. Do you feel you have begun to emotionally bond with your baby? (No, yes)

11. If you have begun to feel emotionally bonded with your baby, approximately when did this occur? (Before birth, in the first few hours after birth, on the first day, in the first 3 days, by the end of the first week, during the second week, during the third week, during the fourth week, during the fifth week) *[Only asked to those answering ‘yes’ to q.10]*

12. Would you say you feel strongly emotionally bonded to your baby at this point in time? (Yes, no) *[Only asked to those answering ‘yes’ to q.10]*

13. How confident do you feel about the developing emotional bond between you and your baby? (Very confident, confident, moderately confident, slightly confident, not confident)

Page 5 – Bonding measured by Taylor et al.'s (2005) Mother-to-Infant Bonding Scale – scoring reflected in numbers in table, the lower the score the greater the bond.

These questions are about your feelings for your child in the first few weeks. Some adjectives are listed below which describe some of the feelings mothers have towards their baby in the FIRST WEEKS after they were born. Please make a tick against each word in the box which, best describes how you felt in the FIRST FEW WEEKS.

	Very Much	A Lot	A Little	Not at All
14. Loving	0	1	2	3
15. Resentful	3	2	1	0
16. Neutral or felt nothing	3	2	1	0
17. Joyful	0	1	2	3
18. Dislike	3	2	1	0
19. Protective	0	1	2	3
20. Disappointed	3	2	1	0
21. Aggressive	3	2	1	0

Page 9 – Assessing the occurrence of maternity or baby blues, which has been associated with postnatal depression (Beck, 2001). The following definition is based on Riecher-Rössler and Hofecker Fallahpour (2003) and the question is of my own design following the Bromley Postnatal Depression Scale (Stein and van den Akker, 1992).Also assessed is the extent to which the woman feels emotionally drained – question of my own design.

The following section is devoted to your feelings and your opinions and expectations of yourself. Some of the questions may seem rather similar but they are part of scales assessing slightly different things so your patience is much appreciated.

The baby blues, also known as the maternity blues, is a common experience and may be defined as a period of mild depression and/or mood swings, lasting a few hours or days, and occurring within the first week after delivery.

47. On the basis of this definition, would you say you experienced the baby blues? Yes or no.

48. Would you say this experience has had a negative effect on your confidence in your mothering ability? (Extremely, very, moderately, a little, not at all) *[Only asked to those answering 'yes' to q.47]*

49. Would you say this experience has had a negative effect on the emotional bond between you and your baby? (Extremely, very, moderately, a little, not at all) *[Only asked to those answering 'yes' to q.47]*

50. In the last two weeks would you say you have felt emotionally drained/exhausted? (Not at all, a little, moderately, very, extremely.)

Page 10 – Assessing postnatal depression using the Edinburgh Postnatal Depression Scale Cox et al. (1987).

Please read to following statements and then select the option which comes closest to how you have felt *in the past 7 days*:

61. I have been able to laugh and see the funny side of things
- As much as I always could
- Not quite so much now
- Definitely not so much now
- Not at all

62. I have looked forward with enjoyment to things
- As much as I ever did
- Rather less than I used to
- Definitely less than I used to
- Hardly at all

63. I have blamed myself unnecessarily when things went wrong
- Yes, most of the time
- Yes, some of the time
- Not very often
- No, never

64. I have been anxious or worried for no good reason
- No, not at all
- Hardly ever
- Yes, sometimes
- Yes, very often

65. I have felt scared of panicky for no very good reason
- Yes, quite a lot
- Yes, sometimes
- No, not much
- No, not at all

66. Things have been getting on top of me
- Yes, most of the time I haven't been able to cope
- Yes, sometimes I haven't been coping as well as usual
- No, most of the time I have coped quite well
- No, I have been coping as well as ever

67. I have been so unhappy that I have had difficulty sleeping
- Yes, most of the time
- Yes, sometimes
- Not very often
- No, not at all

68. I have felt sad or miserable
- Yes, most of the time
- Yes, quite often
- Not very often
- No, not at all

69. I have been so unhappy that I have been crying
- Yes, most of the time
- Yes, quite often
- Only occasionally
- No, never

70. The thought of harming myself has occurred to me
- Yes, quite often
- Sometimes
- Hardly ever
- Never

Page 6-8 – Assessing shame in relation to emotions surrounding birth using a version of Andrew's et al. (2002) Experience of Shame Scale (ESS) altered to investigate shame in this regard.

Everybody at times can feel embarrassed, self-conscious or ashamed. These questions are about such feelings if they have occurred at any time SINCE GIVING BIRTH, although they may be continuing or new feelings. There are no 'right' or 'wrong' answers.

22. Have you felt ashamed of any of your personal habits?

23. Have you worried about what other people think of any of your personal habits?

24. Have you tried to cover up or conceal any of your personal habits?

25. Have you felt ashamed of your manner with others?

26. Have you worried about what other people think of your manner with others?

27. Have you avoided people because of your manner?

28. Have you felt ashamed of the sort of person you are?

29. Have you worried about what other people think of the sort of person you are?

30. Have you tried to conceal from others the sort of person you are?

31. Have you felt ashamed of your ability to do things?

32. Have you worried about what other people think of your ability to do things?

33. Have you avoided people because of your inability to do things?

34. Do you feel ashamed when you do something wrong?

35. Have you worried about what other people think of you when you do something wrong?

36. Have you tried to cover up or conceal things you felt ashamed of having done?

37. Have you felt ashamed when you said something stupid?

38. Have you worried about what other people think of you when you said something stupid?

39. Have you avoided contact with anyone who knew you said something stupid?

40. Have you felt ashamed when you failed at something which was important to you?

41. Have you worried about what other people think of you when you fail?

42. Have you avoided people who have seen you fail?

43. Have you felt ashamed of any aspect of your emotions and feelings towards your baby or the relationship you have with it?

44. Have you worried about what other people think of your emotions and feelings towards your baby or the relationship you have with it?

45. Have you avoided thinking or talking about of your emotions and feelings towards your baby or the relationship you have with it?

46. Have you wanted to hide or conceal any of your emotions and feelings towards your baby or the relationship you have with it?

Page 10 – Emotional well-being measured using Bradburn's Affect Balance Scale (van Schuur and Kruijtbosch, 1995), to assess whether emotional well-being falls after birth.

Please read the following statements and answer yes or no as to whether you have ever felt like this in the past few weeks:

51. Particularly excited or interested in something

52. So restless you couldn't sit long in a chair

53. Proud because someone had complimented you on some-thing you had done

54. Very lonely or remote from other people

55. Pleased about having accomplished something

56. Bored

57. On top of the world/feeling that life is wonderful

58. Depressed or very unhappy

59. That things were going your way

60. Upset because somebody criticized you

Page 12 – Measuring postnatal anxiety using the anxiety arm of the DASS short version (Lovibond and Lovibond, 1995) with state wording. The use of just the anxiety and stress arms is considered acceptable by the authors (Psychology Foundation of Australia, 2013) and the EPDS is a more *appropriate measure of depression in the target audience. [ref http://www2.psy.unsw.edu.au/dass/DASSFAQ.htm#_15.__Can_I_just_administer_one_or_t]*

Please select the option which best describes how the following statements have applied to you in the LAST 7 DAYS.

[ANXIETY]

[Autonomic arousal]

71. I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat).

72. I was aware of dryness of my mouth.

73. I experience difficulty breathing (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion).

[Skeletal musculature effects]

74. I experienced trembling (e.g. in the hands).

[Situational anxiety]

75. I was worried about situations in which I might panic and make a fool of myself.

[Subjective experience of anxious affect]

76. I felt I was close to panic.

77. I felt scared without any good reason.

Page 13 - Measuring postnatal stress using the stress arm of the DASS short version (Lovibond and Lovibond, 1995) with state wording.

Please select the option which best describes how the following statements have applied to you in the LAST 7 DAYS.

[STRESS]

[Difficulty relaxing]

78. I found it hard to wind down.

79. I found it difficult to relax.

[Nervous arousal]

80. I felt that I was using a lot of nervous energy.

[Easily upset/agitated]

81. I found myself getting agitated.

[Irritable/over-reactive]

82. I tended to over-react to situations.

83. I felt that I was rather touchy.

[Impatient]

84. I was intolerant of anything that kept me from getting on with what I was doing.

Page 14 – Time spent alone with the infant, question based on Kitzinger, S. (1989), who found this was positively related to negative maternal emotions. Directed at the last 2 weeks because most women have extra help immediately after giving birth what with paternity leave etc. so this time period is likely to be more reflective of the norm that is being potentially negatively reacted to. Life event stress proposed as a risk factor (Beck, 2001); questions based on Austen et al.'s (2005) question to determine perceived life event stress prior to pregnancy, with an altered rating scale to include labels for each response option to aid respondents. Actual diagnosis of antenatal depression or anxiety.

85. Thinking about the last 2 weeks, on weekdays how long are you usually at home without another adult? Less than 2 hours, 2-4 hours, 4-8 hours, 8-12 hours, 12-24 hours.

86. In the course of your pregnancy with this baby or since giving birth, have you had any major stresses, changes or loses (e.g., separation, bereavement, moving house, domestic violence)? Yes or no.

87. How would you rate the extent this stress affected your emotional well-being? (Very little, a little, moderately, quite a lot, very much). *[Only asked to those answering 'yes' to q.85]*

88. During your pregnancy, were you diagnosed with depression? (Yes, no)

89. During your pregnancy, were you diagnosed with anxiety? (Yes, no)

90. The questions you have answered were designed to quantify specific information, and as such are necessarily generic. However, this is an area in which everyone's experience is importantly unique to them, so if you have any related thoughts or feelings you would like to express, please do so in the following space:

Page 15 – Checking email preference and covering ethics requirements by restating help avenues.

You have now completed the survey, thank you very much for sparing your precious time and energy at this challenging time in your life. Understanding the factors which impact maternal emotional health is incredibly important and your time and effort will go towards helping in this crucial task. There is one more follow up survey to be completed in 5 months' time. You will be sent an initial email and a reminder email with a link to the survey at the same address to which this was sent, if you would prefer it be sent to a different address please indicate an alternative in the box below.

You have just been asked to reflect on some sensitive issues, if you find yourself experiencing any emotional distress as a result, or would simply like to discuss things further with someone, please contact your GP, or alternatively you may find the following websites helpful:

http://www.mind.org.uk Mind – for better mental health

http://apni.org The Association for Postnatal Illness

http://www.pni-uk.com Perinatal Illness UK

http://www.rcpsych.ac.uk Royal College of Psychiatrists

http://www.counselling-directory.org.uk Counselling Directory

This research has received ethical approval from the University of Kent's School of Anthropology and Conservation. Should you have any queries or concerns please email them to motherhood@kent.ac.uk.

Perceptions of Pregnancy and Early Motherhood – Pregnancy Questionnaire Wave 3

Page 1 – Introduction and verification of email so data can be matched with previous answers.

This is the final survey of the study, thank you so much for continuing to show your support for this important research. Once again the main focus is your emotional experience of early motherhood, and it will take roughly 30 minutes to complete. You will notice that in a number of sections the questions are similar to those you have been asked to answer before. This is because we are also interested in how having a young baby in today's world impacts on a woman's sense of self. As with the other surveys your answers are strictly confidential so please feel free to be open and honest.

1. First, in order to match your responses to this survey with your previous ones please enter the email address to which this link was sent.

Page 2 – Ensuring that no one who suffered early infant death is subjected to further questioning. Anyone answering yes will be directed to page 3a, question of my own design.

You will be asked to reflect on some issues which may be sensitive. If you find yourself experiencing any emotional distress as a result, or would simply like to discuss things further with someone, please contact your GP, or alternatively you may find the following websites helpful:

http://www.mind.org.uk Mind – for better mental health

http://apni.org The Association for Postnatal Illness

http://www.pni-uk.com Perinatal Illness UK http://www.rcpsych.ac.uk Royal College of Psychiatrists

http://www.counselling-directory.org.uk Counselling Directory

2. It is very sadly the case that some mothers experience the loss of their baby. Before going any further, please indicate if this happened to you so that you do not receive any further unwanted questions or survey details at this terrible time. (No, my baby is alive, Yes, my baby passed away)

Page 3a – Assuring anyone returning to the survey even though they lost their infant that they will not be contacted further unless they would still like to receive a summary of the study result.

3a. Please accept our sincere condolences for your loss. Your email will now be removed from the mailing list and we will make no more intrusions on your time. However, we are offering all participants a summary of the results of the study, so if you would like to still receive this please indicate below (please note that this may take some time). (Yes, I would like to receive a summary, No, I do not wish to receive a summary)

Page 3b - To assess the perceptions surrounding the progression of emotional bonding, discrepancies between expectations and experiences of motherhood have been found to associated with postnatal depression in qualitative studies of the condition (Beck, 2002). Questions of my own design. Note where appropriate question wording will be altered to reflect the experience of having had a multiple birth.

Emotionally bonding with your baby is a process, women differ in the length of time it takes them to emotionally bond with their baby and there is no 'normal' timeframe in which this occurs. Please reflect on your developing emotional relationship with your baby and answer the following questions. There are no 'right' or 'wrong' answers.

3b. Would you say you have begun to feel emotionally bonded with your baby at this point in time? (Yes, no)

4. Would you say you feel strongly emotionally bonded to your baby at this point in time? Yes or no. *[Question only asked to those answering 'yes' to q.3b]*

5. What would you say is hindering your emotional bonding? (Open answer) *[Question only asked to those answering 'no' to either q.3.b or q.4]*

6. During which month from birth would you say you first felt strongly emotionally bonded to your baby? (1st, 2nd, 3rd, 4th, 5th) *[Question only asked to those answering 'yes' to q.4]*

7. How confident do you feel about the developing emotional bond between you and your baby? (Very confident, confident, moderately confident, slightly confident, not confident)

8. Have you found the emotional bonding process to be how you expected it to be? (Yes, no)

9. Is this difference in experience vs. expectation generally positive or negative? (Positive, negative) *[Question only asked if the answer to q.8 is 'no']*

Page 4 – Assessing bonding using Taylor et al.'s (2005) Mother-to-Infant Bonding Scale – scoring is reflected in the numbers in table, the lower the score the greater the bond.

Some adjectives are listed below which describe some of the feelings mothers have towards their baby in the first few months after they were born. Please make a tick against each word in the box which best describes how you have felt towards your baby in the LAST FEW WEEKS. There are no 'right' or 'wrong' answers.

	Very Much	A Lot	A Little	Not at All
10. Loving	0	1	2	3
11. Resentful	3	2	1	0
12. Neutral or felt nothing	3	2	1	0
13. Joyful	0	1	2	3
14. Dislike	3	2	1	0
15. Protective	0	1	2	3
16. Disappointed	3	2	1	0
17. Aggressive	3	2	1	0

Page 5 - Questions of my own design, aimed at garnering how immersed the woman is in her mothering, where her concerns lie, how potentially exposed she is to messages of intensive mothering, and what this has done for her confidence.

There are many sources of information about parenting and childcare available to women today, the following questions are about your use of these sources.

18. During your late pregnancy did you do any research into pregnancy or parenting? (Yes, no)

19. What sort of things were you mainly seeking advice on? (Open textbox, responses to be coded) *[Question asked if answer to q.18 is 'yes']*

20. Which resources did you use? Select all that apply (pregnancy/parenting books, websites aimed at pregnant women/parents, the internet more generally, talking to friends or family, talking to a doctor or nurse, other) *[Question asked if answer to q.18 is 'yes']*

21. How many different books did you read? *[Question asked if 'parenting books' is selected in q.20]*

22. How many different websites did you visit? *[Question asked if 'websites aimed at parents' is selected in q.20]*

23. What effect has this had on your confidence? (Very positive, positive, neutral, negative, very negative.) *[Question asked if answer to q.18 is 'yes']*

24. Was any of the advice you received conflicting? (Not at all, a little, moderately, very, extremely.) *[Question asked if answer to q.18 is 'yes']*

25. Have you done any research into parenting since giving birth? (Yes, no)

26. What sort of things were you mainly seeking advice on? (Open textbox, responses to be coded) *[Question asked if answer to q.25 is 'yes']*

27. Which resources have you used? Select all that apply (parenting books, websites aimed at parents, the internet more generally, talking to friends or family, talking to a doctor or nurse, other) *[Question asked if answer to q.25 is 'yes']*

28. How many different books have you read? *[Question asked if 'parenting books' is selected in q.27]*

29. How many different websites have you visited? *[Question asked if 'websites aimed at parents' is selected in q.27]*

30. What effect has this had on your confidence? (Very positive, positive, neutral, negative, very negative.) *[Question asked if answer to q.25 is 'yes']*

31. Has any of the advice you received been conflicting? (Not at all, a little, moderately, very, extremely.) *[Question asked if answer to q.25 is 'yes']*

Page 6 – Assessing shame surrounding maternal emotions using an abbreviated version of the modified Andrew's et al. (2002) Experience of Shame Scale (ESS) used in stage 1.

Everybody at times can feel embarrassed, self-conscious or ashamed. These questions are about such feelings if they have occurred at any time SINCE GIVING BIRTH, although they may be continuing or new. There are no 'right' or 'wrong' answers.

32. Have you felt ashamed of any aspect of your emotions and feelings towards your baby or the relationship you have with it? (Not at all, a little, moderately, quite a lot, very much)

33. Have you worried about what other people think of your emotions and feelings towards your baby or the relationship you have with it? (Not at all, a little, moderately, quite a lot, very much)

34. Have you avoided thinking or talking about your emotions and feelings towards your baby or the relationship you have with it? (Not at all, a little, moderately, quite a lot, very much)

35. Have you wanted to hide or conceal your emotions and feelings towards your baby or the relationship you have with it? (Not at all, a little, moderately, quite a lot, very much)

Page 7 - Questions of my own design, aimed at garnering the mother's attitudes surrounding risk, following Lee et al. (2010).

The following questions are about the extent to which you feel you and your baby are subject to risk.

36. How much risk do you feel your baby has been exposed to so far in life? (No risk, a little risk, moderate risk, a lot of risk, extreme risk)

37. Do you feel under pressure to protect your baby from risk? (Not at all, quite, moderately, very, extremely)

38. How confident are you in your ability to protect your baby from risk? (Not at all, quite, moderately, very, extremely)

Page 8-13 – Controlling for infant temperament, previously found to be a risk factor for postnatal depression (Beck, 2001). Sanson et al's (1987) short infant temperament questionnaire (SITQ) designed as a self-report tools for mothers to rate infants at 4-8 months of age. Used by Austen et al. (2005) in their study of maternal anxiety, depression and infant temperament. While won't allow for independent corroboration of mothers perceptions, this is in common with many studies of infant temperament (Austen et al., 2005) and moderate agreement between ratings by mothers and fathers and mothers and independent observers suggests there is some validity in just recording maternal reports (Sanson et al., 1987). Scoring 1-6; almost never, not often, variable usually does not, variable usually does, frequently, almost always. These are then converted to place infants on an Easy/Difficult Scale. The scale was designed in Australia, and as a result the spelling of nappy has been altered to reflect the UK spelling and the phrase 'infant welfare sister' replaced by 'health visitor.'

39. The baby is fretful on waking up and/or going to sleep (frowns, cries). (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

40. The baby accepts straight away any change in place or position of feeding, or person giving the feed. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

41. The baby is shy, (turns away or clings to mother) on meeting another child for the first time. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

42. The baby continues to fret during nappy change in spite of efforts to distract him/her with game, toy or singing, etc. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

43. The baby amuses self for ½ hour or more in cot of playpen (looking at mobile, playing with toy, etc.). (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

44. The baby moves about a lot (kicks, grabs, squirms) during nappy-changing and dressing. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

45. The baby makes happy sounds (coos, smiles, laughs) when being changed or dressed. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

46. The baby is pleasant (smiles, laughs) when first arriving in unfamiliar places (friend's house, shop). (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

47. The baby gets sleepy at about the same time each evening (within ½ hour). (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

48. The baby accepts regular procedures (hair brushing, face washing, etc) at any time without protest. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

49. The baby moves a lot (squirms, bounces, kicks) while lying awake in cot. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

50. For the first few minutes in a new place or situation (new shop or home) the baby is fretful. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

51. The baby continues to cry in spite of several minutes of soothing. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

52. The baby keeps trying to get a desired toy, which is out of reach, for 2 minutes or more. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

53. The baby greets a new toy with a loud voice and much expression of feeling (whether positive or negative). (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

54. The baby's first reaction (at home) to approach of strangers is acceptance. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

55. The baby wants daytime naps at differing times (over 1 hour difference) from day to day. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

56. The baby cries when left to play alone. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

57. The baby's daytime naps are about the same length from day to day (less than ½ hour difference). (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

58. The baby displays much feeling (strong laugh or cry) during changing or dressing. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

59. The baby wants and takes feedings at about the same time (within 1 hour) from day to day. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

60. The baby is content (smiles, coos) during interruptions of milk or solid foods. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

61. The baby accepts within a few minutes a change in place of bath or person giving the bath. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

62. The baby's time of waking in the morning varies greatly (by 1 hour or more) from day to day. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

63. The baby reacts strongly to strangers: laughing or crying. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

64. The baby’s period of greatest activity comes at the same time of day. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

65. The baby is irritable or moody throughout at cold or a stomach virus. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

66. The baby can be distracted from fretting or squirming during a procedure (nail cutting, hair brushing, etc.) by a game, singing, TV, etc. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

67. The baby’s first reaction to seeing doctor or health visitor is acceptance (smiles, coos). (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

68. The baby lies still during procedures like hair brushing or nail cutting. (Almost never, not often, variable – usually does not, variable – usually does, frequently, almost always)

Page 14 - Based on Pinel’s (1999) Stigma Consciousness Questionnaire for Women as in stage 1.

This next section focuses on your experience of social pressure regarding maternal emotions and how this has made you feel. Please read the following statements and select the option which best represents the extent to which you agree or disagree.

69. Stereotypes about how mothers feel towards their babies have affected me personally. (Strongly disagree, moderately disagree, mildly disagree, neither agree nor disagree, mildly agree, moderately agree, strongly agree)

70. I worry that my feelings towards my baby will be judged. (Strongly disagree, moderately disagree, mildly disagree, neither agree nor disagree, mildly agree, moderately agree, strongly agree)

71. When interacting with others, I feel like they interpret all my behaviours in terms of the fact that I am a mother. (Strongly disagree, moderately disagree, mildly disagree, neither agree nor disagree, mildly agree, moderately agree, strongly agree)

72. Most people judge mothers on the basis of the emotional bond they have with their baby. (Strongly disagree, moderately disagree, mildly disagree, neither agree nor disagree, mildly agree, moderately agree, strongly agree)

73. My being a mother influences how women act with me. (Strongly disagree, moderately disagree, mildly disagree, neither agree nor disagree, mildly agree, moderately agree, strongly agree)

74. I almost always think about the fact that I am a mother when I interact with others. (Strongly disagree, moderately disagree, mildly disagree, neither agree nor disagree, mildly agree, moderately agree, strongly agree)

75. My being a mother influences how men act with me. (Strongly disagree, moderately disagree, mildly disagree, neither agree nor disagree, mildly agree, moderately agree, strongly agree)

76. Most people have a lot more judgemental thoughts about how mothers should feel than they actually express. (Strongly disagree, moderately disagree, mildly disagree, neither agree nor disagree, mildly agree, moderately agree, strongly agree)

77. I often think women are unfairly judged regarding their feelings towards babies. (Strongly disagree, moderately disagree, mildly disagree, neither agree nor disagree, mildly agree, moderately agree, strongly agree)

78. Most happy mothers have a problem viewing less happy mothers as equals. (Strongly disagree, moderately disagree, mildly disagree, neither agree nor disagree, mildly agree, moderately agree, strongly agree)

Page 15 - Page 9 - Based on question 14 of Corning's (2000) Perceived Social Inequity-Women's Form as in stage 1.

The following questions relate to some potential sources of social pressure on women during pregnancy and early motherhood. Please select the answer option which best reflects your personal opinion.

79. Do you feel affected by the way maternal feelings and emotions are portrayed by medical professionals?

80. Do you want to be affected by the way maternal feelings and emotions are portrayed by medical professionals?

81. Are other women affected by the way maternal feelings and emotions are portrayed by medical professionals?

82. Should you have to feel affected by the way maternal feelings and emotions are portrayed by medical professionals?

83. Do you feel affected by the way maternal feelings and emotions are portrayed in pregnancy and childcare manuals/websites?

84. Do you want to be affected by the way maternal feelings and emotions are portrayed in pregnancy and childcare manuals/websites?

85. Are other women affected by the way maternal feelings and emotions are portrayed in pregnancy and childcare manuals/websites?

86. Should you have to feel affected by the way maternal feelings and emotions are portrayed in pregnancy and childcare manuals/websites?

87. Do you feel affected by the way other mothers feel and emotionally engage with their babies?

88. Do you want to be affected by the way other mothers feel and emotionally engage with their babies?

89. Are other women affected by the way other women mothers feel and emotionally engage with their babies?

90. Should you have to feel affected by the way other mothers feel and emotionally engage with their babies?

91. Do you feel affected by the way maternal feelings and emotions are portrayed on TV or in magazines and the news?

92. Do you want to be affected by the way maternal feelings and emotions are portrayed on TV or in magazines and the news?

93. Are other women affected by the way maternal feelings and emotions are portrayed on TV or in magazines and the news?

94. Should you have to feel affected by the way maternal feelings and emotions are portrayed on TV or in magazines and the news?

Page 16 - Perceived availability of emotional support, questions of my own design.

Early motherhood is a time during which a woman needs a lot of support, both practical and emotional, from those around her. The following section concerns the level of emotional support available to you since giving birth to your baby.

95. How would you rate the level of emotional support available to you from the father of your child? (Very high, high, moderate, low, very low, not applicable)

96. How would you rate the level of emotional support available to you from your own family? (Very high, high, moderate, low, very low)

97. How would you rate the level of emotional support available to you from the father of your child's family? (Very high, high, moderate, low, very low, not applicable)

98. How would you rate the level of emotional support available to you from your friends? (Very high, high, moderate, low, very low)

99. How would you rate the level of emotional support available to you from GP? (Very high, high, moderate, low, very low)

100. How would you rate the level of emotional support available to you from the health workers you have encountered since giving birth? (Very high, high, moderate, low, very low)

Page 17 - Availability of practical support, questions of my own design expect q.103 which is taken from Kitsinger's (1989) study of baby crying in which it was found that a large proportion of mothers were alone for long periods, and those that were found crying infants harder to deal with.

The following section concerns the level of practical support available to you.

101. How would you rate the level of practical support available to you from the father of your child? (Very high, high, moderate, low, very low)

102. How would you rate the level of practical support available to you from your own family? (Very high, high, moderate, low, very low)

103. How would you rate the level of practical support available to you from the father of your child's family? (Very high, high, moderate, low, very low)

104. How would you rate the level of practical support available to you from friends? (Very high, high, moderate, low, very low)

105. How would you rate the level of practical support available to you from GP? (Very high, high, moderate, low, very low)

106. How would you rate the level of practical support available to you from the health workers you have encountered since giving birth? (Very high, high, moderate, low, very low)

107. Do you make use of the local facilities and support groups available for mothers and babies? (Yes, no)

108. Do you have easy transport access to these facilities? (Yes, no)

109. Do you have the financial means to comfortably access these facilities? (Yes, no)

110. Have you returned to paid employment since giving birth? (Yes, no)

111. On weekdays, how long are you usually alone at home without another adult? (Less than 2 hours, 2-4 hours, 4-8 hours, 8-12 hours, 12-24 hours)

Page 18 – Assessing postnatal depression using the Edinburgh Postnatal Depression Scale Cox et al. (1987).

The following section is devoted to your feelings and your opinions and expectations of yourself. Some of the questions may seem rather similar but they are part of scales assessing slightly different things so your patience is much appreciated.

Please read to following statements and then select the option which comes closest to how you have felt *in the past 7 days*:

112. I have been able to laugh and see the funny side of things
- As much as I always could
- Not quite so much now
- Definitely not so much now
- Not at all

113. I have looked forward with enjoyment to things
- As much as I ever did
- Rather less than I used to
- Definitely less than I used to
- Hardly at all

114. I have blamed myself unnecessarily when things went wrong
- Yes, most of the time
- Yes, some of the time

- Not very often
- No, never

115. I have been anxious or worried for no good reason
- No, not at all
- Hardly ever
- Yes, sometimes
- Yes, very often

116. I have felt scared of panicky for no very good reason
- Yes, quite a lot
- Yes, sometimes
- No, not much
- No, not at all

117. Things have been getting on top of me
- Yes, most of the time I haven't been able to cope
- Yes, sometimes I haven't been coping as well as usual
- No, most of the time I have coped quite well
- No, I have been coping as well as ever

118. I have been so unhappy that I have had difficulty sleeping
- Yes, most of the time
- Yes, sometimes
- Not very often
- No, not at all

119. I have felt sad or miserable
- Yes, most of the time
- Yes, quite often
- Not very often
- No, not at all

120. I have been so unhappy that I have been crying
- Yes, most of the time
- Yes, quite often
- Only occasionally
- No, never

121. The thought of harming myself has occurred to me
- Yes, quite often
- Sometimes
- Hardly ever
- Never

Page 19 - Emotional capital: Emotional well-being measured by Bradburn's Affect Balance Scale (van Schuur and Kruijtbosch, 1995), scoring yes or no.

Please read the following statements and answer yes or no as to whether you have ever felt like this in the past few weeks.

122. Particularly excited or interested in something

123. So restless you couldn't sit long in a chair

124. Proud because someone had complimented you on some-thing you had done

125. Very lonely or remote from other people

126. Pleased about having accomplished something

127. Bored

128. On top of the world/feeling that life is wonderful

129. Depressed or very unhappy

130. That things were going your way

131. Upset because somebody criticized you

Page 20-25 - Emotional capital: Emotional intelligence accessed using Petrides's Trait Emotional Intelligence Short-form (Petrides and Furnham, 2006).

Please read the following statements and select the answer option which best applies to you. Don't think too long about the exact meaning of the statements, there are no right or wrong answers. There are seven possible responses to each statement ranging from 'Completely Disagree' (number 1) to 'Completely Agree' (number 7).

1 . . . . 2 . . . . 3 . . . . 4 . . . . 5 . . . . 6 7

Completely Disagree **Completely Agree**

132. Expressing my emotions with words is not a problem for me.	1	2	3	4	5	6	7
133. I often find it difficult to see things from another person's viewpoint.	1	2	3	4	5	6	7
134. On the whole, I'm a highly motivated person.	1	2	3	4	5	6	7
135. I usually find it difficult to regulate my emotions.	1	2	3	4	5	6	7
136. I generally don't find life enjoyable.	1	2	3	4	5	6	7
137. I can deal effectively with people.	1	2	3	4	5	6	7
138. I tend to change my mind frequently.	1	2	3	4	5	6	7
139. Many times, I can't figure out what emotion I'm feeling.	1	2	3	4	5	6	7
140. I feel that I have a number of good qualities.	1	2	3	4	5	6	7
141. I often find it difficult to stand up for my rights.	1	2	3	4	5	6	7

142. I'm usually able to influence the way other people feel.	1	2	3	4	5	6	7
143. On the whole, I have a gloomy perspective on most things.	1	2	3	4	5	6	7
144. Those close to me often complain that I don't treat them right.	1	2	3	4	5	6	7
145. I often find it difficult to adjust my life according to the circumstances.	1	2	3	4	5	6	7
146. On the whole, I'm able to deal with stress.	1	2	3	4	5	6	7
147. I often find it difficult to show my affection to those close to me.	1	2	3	4	5	6	7
148. I'm normally able to "get into someone's shoes" and experience their emotions.	1	2	3	4	5	6	7
149. I normally find it difficult to keep myself motivated.	1	2	3	4	5	6	7
150. I'm usually able to find ways to control my emotions when I want to.	1	2	3	4	5	6	7
151. On the whole, I'm pleased with my life.	1	2	3	4	5	6	7
152. I would describe myself as a good negotiator.	1	2	3	4	5	6	7
153. I tend to get involved in things I later wish I could get out of.	1	2	3	4	5	6	7
154. I often pause and think about my feelings.	1	2	3	4	5	6	7
155. I believe I'm full of personal strengths.	1	2	3	4	5	6	7
156. I tend to "back down" even if I know I'm right.	1	2	3	4	5	6	7
157. I don't seem to have any power at all over other people's feelings.	1	2	3	4	5	6	7
158. I generally believe that things will work out fine in my life.	1	2	3	4	5	6	7
159. I find it difficult to bond well even with those close to me.	1	2	3	4	5	6	7
160. Generally, I'm able to adapt to new environments.	1	2	3	4	5	6	7
161. Others admire me for being relaxed.	1	2	3	4	5	6	7

Page 26-31 - Emotional capital: Emotional personality assessed using the Brief Affective Neuroscience Personality Scale (BANPS) (Barret et al., 2013), developed from Davies and Panksepp's (2011) Affective Neuroscience Personality Scales (ANPS). Scoring scale 1 Strongly disagree, 2 Disagree, 3 Neither agree nor disagree, 4 Agree, 5 Strongly agree, with those marked (R) reverse scored.

Please read the following statements and select the answer option which best applies to you.

162. People who know me would say I am a very fun-loving person.

163. When I am frustrated, I usually get angry.

164. I am usually not highly curious. (R)

165. I am the kind of person that likes to touch and hug people.

166. I rarely get angry enough to want to hit someone. (R)

167. I rarely worry about my future. (R)

168. I rarely become sad. (R)

169. I seldom experience sadness or despair. (R)

170. I am very playful.

171. I often have the feeling that I am going to cry.

172. My friends would probably describe me as hotheaded.

173. I do not feel lonely very often. (R)

174. I like to kid around with other people.

175. I often feel the urge to nurture those closest to me.

176. I often worry about the future.

177. I am not particularly affectionate. (R)

178. There are very few things that make me anxious. (R)

179. I often feel lonely.

180. I am a person who is easily amused and laughs a lot.

181. People who know me well would say I almost never become angry. (R)

182. I am usually not interested in solving problems and puzzles just for the sake of solving them. (R)

183. I do not particularly enjoy kidding around and exchanging “wisecracks.” (R)

184. I sometimes cannot stop worrying about my problems.

185. I hardly ever become so angry at someone that I feel like yelling at them. (R)

186. I am not an extremely inquisitive person. (R)

187. When someone makes me angry, I tend to remain fired up for a long time.

188. I do not especially want people to be emotionally close to me. (R)

189. My curiosity drives me to do things.

190. My friends would probably describe me as being too serious.

191. I have very few fears in my life. (R)

192. I enjoy finding new solutions to problems.

193. I often feel sad.

194. I like to think outside of the box.

Page 32 – To gather information on factors previously found to impact the emotional interactions between mother and infant and/or the risk of postnatal depression; infant health (Mann, 1992), the birth experience (Elmir et al., 2010), and breastfeeding behaviour (Lee, 2008).

Thank you, you have now reached the last section. The final questions concern you, your baby, and events in your life which may have some bearing on your emotional health.

195. Which of the following options best characterises the physical experience of this labour and birth? (Major complications which required an extended recovery time, major complications but no extended recovery time, minor complications which required an extended recovery time, minor complications but no extended recovery time, without complication)

196. Which of the following best characterises how you found the emotional experience of this labour and birth? (Extremely positive, positive, mixed emotions, negative, extremely negative)

197. Which of the following best describes the birth weight of your baby? (Low, normal, high)

198. Has your baby had any serious health issues? (Yes or no)

199. Did you breastfeed your baby for any amount of time? (Yes or no)

200. How long did you continue to give breastmilk, of any amount? (Less than 1 month, 1-2 months, 3-4 months,4-5 months, 5-6months) *[Question only asked if answering 'yes' to q.191]*

Page 33 – Assessing for incongruence between expectations and experience and feelings of loss which have been associated with postnatal depression (Beck, 2002).

201. Are you finding motherhood to be what you expected it to be? Yes or no

202. Is this difference in experience vs. expectation generally positive or negative? *[Only asked if the answer q.193 is 'no']*

203. Have you experienced feelings of loss since becoming a mother (for instance loss of status, sense of self, identity, career, etc.)?

Page 34 - Controlling for life event stress as in stage 1 and seeking information regarding actual mental health diagnoses since birth, questions of my own design.

204. In the time since giving birth, have you had any major stresses, changes or loses (e.g., separation, bereavement, moving house, domestic violence)? (Yes, no)

205. How would you rate the extent this stress affected your emotional well-being? (Very little, a little, moderately, quite a lot, very much) *[Question asked in answering 'yes' to q.196]*

206. Have you received a diagnosis of postnatal depression? (Yes, no)

207. Have you received a diagnosis of anxiety since giving birth? (Yes, no)

208. Have you received a diagnosis of any other mental health issue since giving birth? (Yes, no)

Page 35 – The following section is optional and forms part of a side study to test Gallup et al's (2002) hypothesis that semen has antidepressant properties and may affect the course of postnatal depression, questions of my own design.

OPTIONAL QUESTIONS

The following questions are about your sexual behaviour before, during, and after birth. These questions will inform only a very small section of the main study are obviously of a different nature to the previous sections, if you do not wish to answer them please hit the next button to reach the last page of the survey.

It has been suggested that exposure to semen effects female emotional health, but there is currently very little data with which to test this idea. The information you provide here will be combined with previous responses to investigate this somewhat unusual proposition. As the questions are designed to investigate the effects of semen, only data from women having active sexual relationships with men prior to pregnancy are of interest, so please skip this section if you do not fall into this category.

209. Before becoming pregnant, did you use condoms as a regular form of contraception? (Yes, no)

210. How long were you not using condoms for before becoming pregnant? (Once, less than 1 month, 1-2 months, 3-4 months, 5-6 months, over 6 months) *[Question only asked to those answering 'yes' to q.209]*

211. Did you continue to use condoms during your pregnancy? (Yes, no) *[Question only asked to those answering 'yes' to q.209]*

212. Did you cease having sexual intercourse with your partner during pregnancy? (Yes, no)

213. During which month did you cease having sexual intercourse? (1^{st}, 2^{nd}, 3^{rd} etc.) *[Question only asked to those answering 'yes' to q.212]*

214. Have you resumed having sexual intercourse with your partner since giving birth? (Yes, no)

215. In which month did you start having sexual intercourse again? (1^{st}, 2^{nd}, 3^{rd} etc.) *[Question only asked to those answering 'yes' to question 214]*

216. Are you using condoms as a regular form of contraception? (Yes, no) *[Question only asked to those answering 'yes' to question 214]*

Page 36 – Exit page thanking respondents and offering them the option of receiving a summary of the study's results.

217. The questions you have answered were designed to quantify specific information, and as such are necessarily generic. However, this is an area in which everyone's experience is importantly unique to them, so if you have any related thoughts or feelings you would like to express, please do so in the following space:

You have now completed the survey and the study. Thank you so much for your time, understanding the emotions which surround pregnancy and early motherhood and the factors that influence them are a significant issue and crucial to helping future generations of mothers have a happier, healthier experience. Your valuable contribution of time and effort to this important subject is very much appreciated.

218. Would you like to be emailed a summary of the results of this study once finalised (please note this may take some time)? (Yes, no)

You have just been asked to reflect on some sensitive issues, if you find yourself experiencing any emotional distress as a result, or would simply like to discuss things further with someone, please contact your GP, or alternatively you may find the following websites helpful:

http://www.mind.org.uk Mind – for better mental health

http://apni.org The Association for Postnatal Illness

http://www.pni-uk.com Perinatal Illness UK

http://www.rcpsych.ac.uk Royal College of Psychiatrists

http://www.counselling-directory.org.uk Counselling Directory

Appendix F – Time Spent Alone Variants

Variable	AICc	Rank
Binary (0-8 vs 8-24)	56.018	2
Categorical (0-4, 4-8, 8-24)	57.132	3
Categorical (0-2, 2-4, 4-8, 8-12, 12-24)	58.871	4
Binary (0-4, 4-24)	60.875	5
Continuous	55.537	1

AICc comparisons of variations of the time spent alone variable predicting PND.

Appendix G – Perceptions Regarding Emotional Bonding

	Frequency (N = 206)	Percentage	Cumulative Percentage
It should be instant	24	11.7	11.7
1 day	12	5.8	17.5
2-3 days	17	8.3	25.7
4-6 days	12	5.8	31.6
1 week	21	10.2	41.7
2 weeks	10	4.9	46.6
3 weeks	4	1.9	48.5
1 month	19	9.2	57.8
1-3 months	19	9.2	67.0
4-6 months	13	6.3	73.3
6-12 months	5	2.4	75.7
There isn't one	50	24.3	100.0

The distribution of responses to the question 'Women differ in the length of time it takes them to emotionally bond with their baby. How long do you think the maximum normal time is?' The sample size is larger than for other data taken from *wave 1* because this was the first question asked and not all respondents went on to complete the full survey.

	Frequency (N = 47)	Percentage	Cumulative Percentage
1st month	29	61.7	61.7
2nd month	9	19.1	80.9
3rd month	6	12.8	93.6
4th month	2	4.3	97.9
5th month	1	2.1	100.0

The distribution of responses to the question 'During which month from birth would you say that you first felt strongly emotionally bonded to your baby?' asked in *wave 3*.

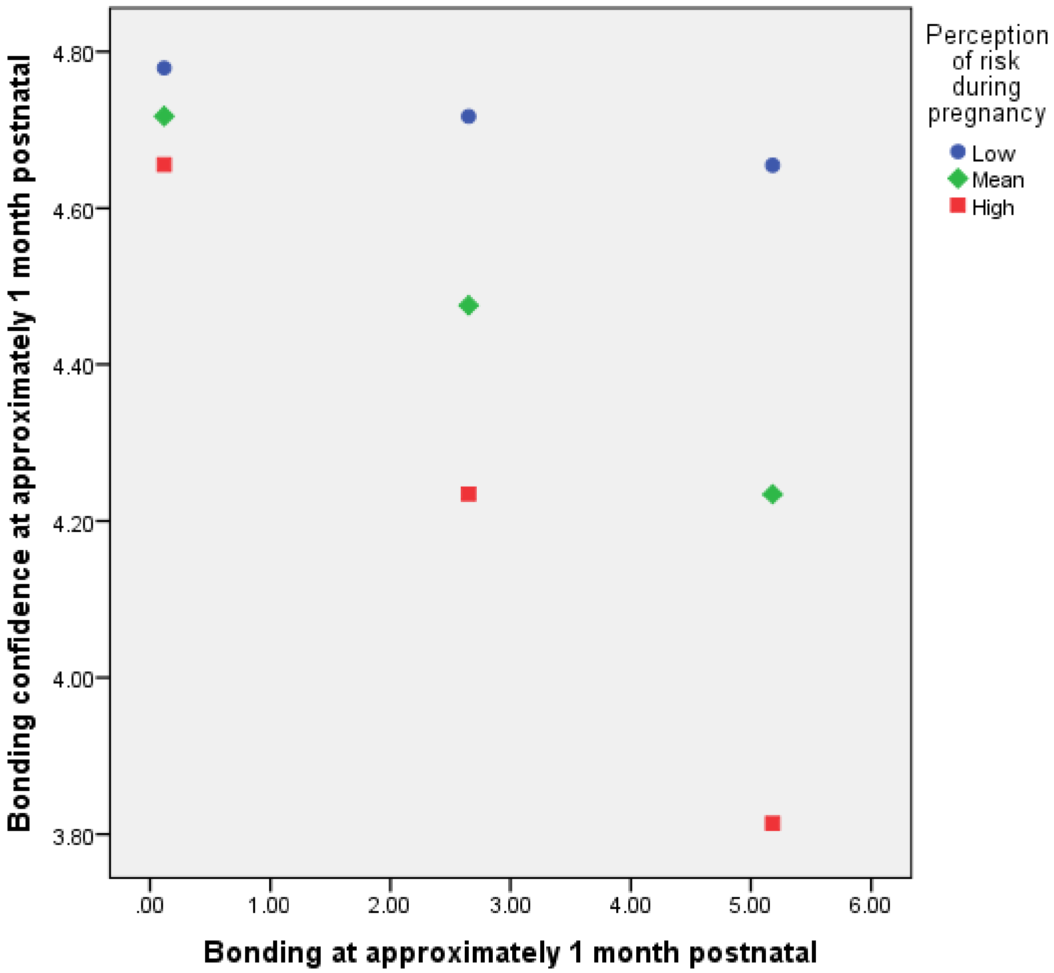
	Frequency (N = 47)	Percentage
Yes	26	54.2
No	22	45.8

The distribution of responses to the question 'Have you found the emotional bonding process to be how you expected it to be?' asked in *wave 3*.

	Frequency (N = 22)	Percentage
Positive	13	59.1
Negative	9	40.9

The distribution of responses to the question 'Is this difference in experience vs. expectation generally positive or negative?' asked in *wave 3*.

Appendix H – The Influence of Risk Perception on the Relationship Between Bonding Strength and Bonding Confidence



Simple slopes equations of the regression of strength of *bonding* (higher score = lower bonding) at approximately 1 month postnatally on *bonding confidence* at approximately 1 month (positive score = higher confidence) at three levels of *perception of risk* during pregnancy. Values for *perception of risk* are the mean and +/- one standard deviation of the mean. Interaction $p = 0.043$.

Appendix I – Priming Study Questionnaires

Design

The study will consist of two parts: with Part 1 measuring desires regarding investment in infants and emotional capital (a composite of emotional wellbeing, emotional intelligence, and emotional personality in line with measures taken in the pregnancy study), and Part 2 taking place 1-2 weeks later in which the same participants with be exposed either to a prime condition, consisting of questions regarding thoughts about parenting preceded by passages of text to be read taken from popular and social media, or a control condition consisting of just questions regarding thoughts about parenting. It is assumed participants will have a generally low exposure to messages surrounding parenting in popular and social media but this will be assessed with questions about their recent exposure.

The prime texts will be split into two sections: the first section designed to prime for physical, social and emotional threat surrounding motherhood, and the second to prime for guilt, shame, and social threat surrounding the level of investment desire expressed (irrespective of the actual level). After reading each set of prime texts participants will be asked some basic questions about what they have read to check that they have paid attention (with anyone scoring poorly excluded). Following the first section participants desires regarding investment in infants will be measured using the same questions posed in Part 1. The second prime will then be administered and participants will be measured for guilt or shame in relation to their newly stated investment desires. Participants in the prime condition will also be asked their feelings on the texts they have read to see if they deem media representations of motherhood to be positive or negative.

Visual analogue scales (VASs) will be used to measure investment desire and differences between responses in Part 1 and Part 2 assessed; VASs are a non-verbal instrument preferentially used over Likert scales for repeat measures in priming studies because participants can’t simply remember their previous answer.

It is hypothesised that exposure to the first prime condition, designed to prime for physical, social and emotional threat surrounding motherhood, will alter the levels of desired investment, although the direction this change will take is uncertain. Exposure to the second prime, designed to prime for guilt, shame, and social threat surrounding the level of investment desire expressed (irrespective of the actual level) is hypothesised to lead those primed to feel more negative emotions when asked to reflect on their previous answers than those in the control group. Participants of high emotional capital, it is hypothesised, will express greater levels of investment desire and also be more susceptible to priming for guilt, shame, and social threat surrounding the level of investment desire.

Part 1

Page 1

Participants will be told the following:

This is a study into the effect popular and social media has young women’s thoughts about parenting. In Part 1 will take approximately X minutes, you will be asked some questions about your thoughts on parenting and also complete some measures of your general emotional state for control purposes. Part 2 will take approximately X minutes and will be emailed to you in 1 weeks' time. In Part 2 you will either be asked to read some information taken from various popular and social media sources and then asked again about your thoughts on parenting, or you will be assigned to a control group and just asked some more questions about your thoughts on parenting. The time gap is there so you don't respond similarly to the two sets of parenting questions just because they came in quick succession.

You will be asked to provide an email address to which to send Part 2 – this won't form part of the analysis and will be deleted from the data set once your responses in Part 1 have been matched to Part 2. Aside from this your answers are anonymous so please answer honestly.

Because this study is being conducted online and you are completing it at your leisure please try not to talk about it with anyone else until you have received the debriefing email after completing Part 2 – talking about it with others taking part may bias the results. Once you start there is an option to save and continue later if you need to pause. A very small percentage of people may find the questions about emotional state cause distress, should this be the case a list of places from which to seek help can be found before and after them in the survey. This research has received ethical approval from the University of Kent's School of Anthropology and Conservation.

Many thanks.

Page 2

Measuring reproductive desires *– overall desire and strength of desire, questions of my own design.*

How many children would you ideally like to have? (Number)

How likely would you be to consider having children if you weren't in a stable romantic relationship? (Sliding scale from 'Not at all' to 'Extremely')

If you weren't in a stable relationship how likely would this be to lower the number of children you would ideally have? (Sliding scale from 'Not at all' to 'Extremely')

How likely would you be to consider having children if you weren't well off financially? (Sliding scale from 'Not at all' to 'Extremely')

If you weren't well off financially how likely would this be to lower the number of children you would ideally have? (Sliding scale from 'Not at all' to 'Extremely')

Page 3

Measuring investment desires *– questions of my own design. The list of childcare activities based on Hill and DelPriore (2013). Sleep and feeding estimates taken from Baby Center (2014), feeding shortest option based on 10x 5min bouts (purposefully unrealistic) and longest based on 12x 30mins.* indicate emotional investment related behaviours as opposed to care behaviours.*

Imagine you have a 1 month old infant with your romantic partner. On average 1 month olds sleep for 8 hours during the night, and 8 hours at inconsistent times during the day.

Below is a list of baby care activities that you may encounter on a daily basis, along with some rough estimates of the length of time each activity can consume over a day. Please indicate the *maximum* time you would be happy to devote to this activity:

Playing with the baby* (Sliding scale ‘0 hrs’ to ‘8 hrs’)
Holding the baby* (Sliding scale ‘0 hr’ to ‘8 hrs’)
Keeping an eye on the baby around the home (Sliding scale ‘0 hr’ to ‘24 hrs’)
How many nappy changes (Sliding scale ‘x0’ to ‘x20’)
Pushing the baby around in a pushchair (Sliding scale ‘0 hrs’ to ‘3 hrs’)
Feeding the baby (via breast or bottle, includes night time feeds) (Sliding scale ‘0 hrs’ to ‘6 hrs’)
Handwashing the baby’s clothes, blankets, bottles (Sliding scale ‘0 mins’ to ‘2 hrs’)
Bathing the baby (Sliding scale ‘0 mins’ to ‘1 hr’)
Talking to the baby* (Sliding scale ‘0 hrs’ to ‘8 hrs’)
Getting up at night with the baby when he or she cries (Sliding scale ‘0 hrs’ to ‘6 hrs’)
Singing to the baby* (Sliding scale ‘0 mins’ to ‘3 hrs’)
Tending to the baby when it is sick (Sliding scale ‘0 hrs’ to ‘24 hrs’)
Soothing the baby to put him or her to sleep* (Sliding scale ‘0 mins’ to ‘2 hrs’)
Calming the baby when he or she is upset* (Sliding scale ‘0 mins’ to ‘5 hrs’)

Page 4

Measuring investment desires – *questions of my own design. Concentration time estimated from Leckman et al. (1999)*

How many hours a day would you be happy concentrating your thoughts on your baby (assuming you sleep for 8 hours)? (Sliding scale ‘0 hrs’ to ‘16 hrs’)

How many hours a day would you be happy to be alone with your baby on a weekday? (Sliding scale ‘0 hrs’ to ‘12 hrs’)

Page 5

Measuring anticipated cost/benefits – *questions of my own design based on Matthews and Sear (2008).*

How costly or beneficial do you think the consequence of having a baby is in the following fields?

Financially (Sliding scale ‘Very costly’ to ‘Very beneficial’)

Employment opportunities (Sliding scale ‘Very costly’ to ‘Very beneficial’)

Socially (Sliding scale ‘Very costly’ to ‘Very beneficial’)

Emotional wellbeing (Sliding scale ‘Very costly’ to ‘Very beneficial’)

Page 6

Measuring sensitivity to risk – *questions of my own design.*

Do you think the UK is a safe environment in which to be pregnant? (Sliding scale ‘Very dangerous’ to ‘Very safe’)

Do you think the UK is a safe environment in which to raise a baby? (Sliding scale ‘Very dangerous’ to ‘Very safe’)

Do you think the UK is a safe place to raise children? (Sliding scale ‘Very dangerous’ to ‘Very safe’)

Page 7

Measuring Emotional capital - *Emotional well-being measured by Bradburn’s Affect Balance Scale (van Schuur and Kruijtbosch, 1995), scoring yes or no.*

The following section is devoted to your feelings and your opinions and expectations of yourself. Some of the questions may seem rather similar but they are part of scales assessing slightly different things so your patience is much appreciated.

Please read the following statements and answer yes or no as to whether you have ever felt like this in the past few weeks.

108. Particularly excited or interested in something

109. So restless you couldn't sit long in a chair

110. Proud because someone had complimented you on some-thing you had done

111. Very lonely or remote from other people

112. Pleased about having accomplished something

113. Bored

114. On top of the world/feeling that life is wonderful

115. Depressed or very unhappy

116. That things were going your way

117. Upset because somebody criticized you

Page 8-10

Measuring Emotional capital - *Emotional intelligence accessed using Petrides’s Trait Emotional Intelligence Short-form (Petrides and Furnham, 2006).*

Please read the following statements and select the answer option which best applies to you. Don't think too long about the exact meaning of the statements, there are no right or wrong answers. There are seven possible responses to each statement ranging from ‘Completely Disagree’ (number 1) to ‘Completely Agree’ (number 7).

1 . . . . 2 . . . . 3 . . . . 4 . . . . 5 . . . . 6 7
Completely Disagree **Completely Agree**

118. Expressing my emotions with words is not a problem for me.	1	2	3	4	5	6	7
119. I often find it difficult to see things from another person's viewpoint.	1	2	3	4	5	6	7
120. On the whole, I'm a highly motivated person.	1	2	3	4	5	6	7
121. I usually find it difficult to regulate my emotions.	1	2	3	4	5	6	7
122. I generally don't find life enjoyable.	1	2	3	4	5	6	7
123. I can deal effectively with people.	1	2	3	4	5	6	7
124. I tend to change my mind frequently.	1	2	3	4	5	6	7
125. Many times, I can't figure out what emotion I'm feeling.	1	2	3	4	5	6	7
126. I feel that I have a number of good qualities.	1	2	3	4	5	6	7
127. I often find it difficult to stand up for my rights.	1	2	3	4	5	6	7
128. I'm usually able to influence the way other people feel.	1	2	3	4	5	6	7
129. On the whole, I have a gloomy perspective on most things.	1	2	3	4	5	6	7
130. Those close to me often complain that I don't treat them right.	1	2	3	4	5	6	7
131. I often find it difficult to adjust my life according to the circumstances.	1	2	3	4	5	6	7
132. On the whole, I'm able to deal with stress.	1	2	3	4	5	6	7
133. I often find it difficult to show my affection to those close to me.	1	2	3	4	5	6	7
134. I'm normally able to "get into someone's shoes" and experience their emotions.	1	2	3	4	5	6	7
135. I normally find it difficult to keep myself motivated.	1	2	3	4	5	6	7
136. I'm usually able to find ways to control my emotions when I want to.	1	2	3	4	5	6	7
137. On the whole, I'm pleased with my life.	1	2	3	4	5	6	7
138. I would describe myself as a good negotiator.	1	2	3	4	5	6	7
139. I tend to get involved in things I later wish I could get out of.	1	2	3	4	5	6	7

140. I often pause and think about my feelings.	1	2	3	4	5	6	7
141. I believe I’m full of personal strengths.	1	2	3	4	5	6	7
142. I tend to “back down” even if I know I’m right.	1	2	3	4	5	6	7
143. I don’t seem to have any power at all over other people’s feelings.	1	2	3	4	5	6	7
144. I generally believe that things will work out fine in my life.	1	2	3	4	5	6	7
145. I find it difficult to bond well even with those close to me.	1	2	3	4	5	6	7
146. Generally, I’m able to adapt to new environments.	1	2	3	4	5	6	7
147. Others admire me for being relaxed.	1	2	3	4	5	6	7

Page 11-13

Measuring Emotional capital - *Emotional personality assessed using the Brief Affective Neuroscience Personality Scale (BANPS) (Barret et al., 2013), developed from Davies and Panksepp’s (2011) Affective Neuroscience Personality Scales (ANPS). Scoring scale 1 Strongly disagree, 2 Disagree, 3 Neither agree nor disagree, 4 Agree, 5 Strongly agree, with those marked (R) reverse scored.*

Please read the following statements and select the answer option which best applies to you.

148. People who know me would say I am a very fun-loving person.

149. When I am frustrated, I usually get angry.

150. I am usually not highly curious. (R)

151. I am the kind of person that likes to touch and hug people.

152. I rarely get angry enough to want to hit someone. (R)

153. I rarely worry about my future. (R)

154. I rarely become sad. (R)

155. I seldom experience sadness or despair. (R)

156. I am very playful.

157. I often have the feeling that I am going to cry.

158. My friends would probably describe me as hotheaded.

159. I do not feel lonely very often. (R)

160. I like to kid around with other people.

161. I often feel the urge to nurture those closest to me.

162. I often worry about the future.

163. I am not particularly affectionate. (R)

164. There are very few things that make me anxious. (R)

165. I often feel lonely.

166. I am a person who is easily amused and laughs a lot.

167. People who know me well would say I almost never become angry. (R)

168. I am usually not interested in solving problems and puzzles just for the sake of solving them. (R)

169. I do not particularly enjoy kidding around and exchanging “wisecracks.” (R)

170. I sometimes cannot stop worrying about my problems.

171. I hardly ever become so angry at someone that I feel like yelling at them. (R)

172. I am not an extremely inquisitive person. (R)

173. When someone makes me angry, I tend to remain fired up for a long time.

174. I do not especially want people to be emotionally close to me. (R)

175. My curiosity drives me to do things.

176. My friends would probably describe me as being too serious.

177. I have very few fears in my life. (R)

178. I enjoy finding new solutions to problems.

179. I often feel sad.

180. I like to think outside of the box.

Page 14

Measuring Basic Demographics *– questions of my own design. All participants will be students the sample may be assumed to be of similar SES. Ethnicity measured following HMSO (2003).*

What is your date of birth?

What country were you born in?

What ethnicity would you describe yourself to be?

Page 15

Thank you page

Thank you for taking part, it is very much appreciated! The second part of the survey will be emailed to you in 1-2 weeks. Until then please refrain from talking about the contents of this survey with fellow students so as not to bias the result. You'll get a debrief once I'm done and a summary of the results once they're ready. Many thanks!

Part 2 – Prime Condition

Page 1

Participants will be told the following:

I am interested in the sources of information about parenting young women have available to them and the effect this information has on their thoughts and behaviour. You will be asked to read some information taken from various popular and social media sources and then asked about what you have read, your thoughts on parenting, and how you feel about your opinions.

It will take approximately X minutes to complete this survey. Because I am interested in your immediate reactions to what you will read this survey is designed to be completed all in one go, and as such there is no 'save and continue later' option. However, if you do get interrupted you can start again from the beginning, but if you do this please to take care to re-read all of the text. Many thanks!

Please enter the email address to which this link was sent (this is to match up your answers here with your previous responses):

Page 2

Measuring exposure to messages regarding parenting – *controlling for the potential recent exposure to popular and social media messaging in daily life.*

Thinking about the news stories you have read or listened to in the last few weeks, how many would you say have related to any aspect of parenting? (None at all, very few, quite a few, quite a lot, a lot)

Thinking about the popular articles you have read in magazines or on websites in the last few weeks, how many would you say have related to any aspect of parenting? (None at all, very few, quite a few, quite a lot, a lot)

Thinking about the academic articles you have read in the last few weeks, how many would you say have related to any aspect of parenting? (None at all, very few, quite a few, quite a lot, a lot)

Have you ever visited any pregnancy/parenting advice websites? (Yes, no)

Have you ever read any pregnancy/parenting advice books? (Yes, no)

Page 3

Prime text

The pieces of text you are about to read have been taken from popular and social media sources. Although multiple themes often appear within one text, they can be roughly grouped into the following subject areas: information about the risks involved in parenting; information about the experience of being a mother, both physical and emotional, and; the opinions people express towards parents.

All of the sources you will see taken from popular media have been selected due to their being based on actual research by experts. For reasons of time and space sections of article are presented rather than the full text, however care has been taken not to alter the message of the original and everything presented is a direct quote.

The text taken from social media can only be viewed as the opinion of the authors (whose names/user ids have been altered for reasons of privacy). Minor alterations have been made to the text to make it clear to readers not accustomed to the abbreviations and colloquialisms used, but care has been taken not to alter the meaning.

Page 3

The risks involved in parenting:

A chapter heading from the contents list of a bestselling pregnancy manual:
"**YOUR NEWBORN BABY…WHAT YOU MAY BE CONCERNED ABOUT**…Birthweight – Bonding…Weight loss – Baby's Looks – Eye Colour – Bloodshot Eyes – Eye Ointment – Roomin-in…Pain Medication – Baby's Sleepiness – A Newborn State of Mind – Empty Breasts – Gagging and Choking – Sleeping Through Meals – Cracking The Crying Code – Non-stop Feeding…Quivering Chin – Startling – Birthmarks – Complexion Problems – Mouth Cysts or Spots – Early Teeth – Thrush – Jaundice – Newborn Security…Stool Colour – Going Home – Dummy Use…The First Month…What You May Be Concerned About…'Breaking Baby' – The Fontanels – Skinny Baby – Having Enough Breast Milk – Baby Getting Enough Breast Milk – Nursing Blisters – Feeding Schedule…Changing Your Mind About Breastfeeding – Too Much Formula – Timing is Everything – Supplementary Water – Vitamin Supplements – Supplement Sense – Spitting Up…Blood in Spit-up – Milk Allergy – Milk Allergy in Breastfed Babies – Bowel Movements – Explosive Bowel Movements – Passing Gas – Constipation – Sleeping Positions – Sleeping Patterns – Restless Sleep – Mixing Up Night and Day – Noise When Baby is Sleeping – Baby's Breathing – Better Sleep for Baby – Moving a Sleeping Baby to Bed – Crying – Colic – Surviving Colic – Prescription for Colic – Spoiling Baby – Coping with Crying – Dummy – Healing of the Umbilical Cord – Umbilical Hernia – Circumcision Care – Swollen Scrotum – Hypospadias – Swaddling – Keeping Baby the Right Temperature – Taking Baby Out – Exposure to Outsiders – Infant Acne – Skin Colour Changes – Hearing – Loud Music – Vision – Keeping Baby Safe – Photo Flashes – Crossed Eyes – Teary Eyes – Sneezing – First Smiles – Hiccups – Using Detergent on Baby's Clothes"

From a recent newspaper article with the headline **Four in ten children fail to connect with mum and dad: Poor parenting in first three years can hold children back at school and cause behavioural problems**. Some responses to this article from the public follow.
As many as four in ten young children have such a weak bond with their parents they are unable to tell them they are upset, new research shows.
This puts them at risk of problems including obesity and delayed speech.
Poor parenting in the first three years of life can hold children back at school and lead to behaviour problems such as hyperactivity.
Where mothers have weak bonds with their babies, research also suggests their children are more likely to be obese as they enter adolescence.
Conor Ryan, director of research at the Sutton Trust said: 'Better bonding between parents and babies could lead to more social mobility, as there is such a clear link to education, behaviour and future employment.

Responses:

Respondent 1: The cause - Poor parenting.........so this report is nothing new.. There will always be bad parents who for whatever reason don't have the skills or know how to envelope their children with all the love and care and emotional stability that children need.
Respondent 2: This is why encouraging young mums to work while they dump their babies into nurseries is a disastrous idea. So why is the government doing it's level best to force them with bribes?
Respondent 3: That's inevitable when you notice that 75% of adults have no parenting skills and no natural authority whatsoever, with their kids running amok.
Respondent 4: Sorry if I sound cynical but it seems we have two extremes. Parents who hover over the kids and smother them or else parents who do no parenting at all.

From a news report headlined **Bed-sharing 'raises cot death risk fivefold'** on findings of a BMJ article.

"Sharing a bed with a newborn increases the risk of sudden infant death syndrome fivefold…The risk applies even if parents avoid tobacco, alcohol and drugs - other factors firmly linked to cot deaths." However "Unicef UK is concerned that any guidance that recommends the total avoidance of bed-sharing could end up forcing parents into much riskier practices such as feeding in arm-chairs or sofas where the risk of suffocating the baby is far higher."

From a recent newspaper article headlined **ADHD and why we working mums need to look in the mirror**
Fascinating stuff in yesterday's…[issue] from paediatric neurologist Dr Richard Saul, who argues in a new book that Attention Deficit Hyperactivity Disorder is wildly over-diagnosed and that thousands of children are being identified as victims and treated with drugs they do not need.
Saul's analysis presents us with an inconvenient truth. He is telling the mums and dads of children diagnosed with ADHD (of which there are approximately 400,000 in Britain) what many of them perhaps suspect, but don't want to hear: the problems lie not with the children but with the paucity of their own parenting.
That, really, is the unspoken tragedy of the working mother. For all the financial and intellectual advantages we have by carrying on working, ours is also a story of benign neglect, of guilt, of children fighting for windows in our busy diaries — and of little ones left to their own (increasingly electrical) devices while we rush around frenetically, juggling priorities.
Can I really blame them, then, when they exhibit attention-seeking behaviour?

Newspaper interview with Conservative MP Andrea Leadsom who runs a parenting advice charity: The worst thing, however, is the parent who is inconsistent – you know: sometimes when I cry my mum hugs me and other times she hits me. That is where the baby develops an antisocial tendency. Kids who go and stab their best mate, or men who go out with a woman and rape and strangle her – these are the kinds of people who would have had very distorted early experiences.

Page 4

The experience of being a mother:

From a recent newspaper article headlined '**Super dads' now spend three hours a day looking after children: 92% claim they share family chores (but would their partners agree?)**
Modern-day fathers are a far cry from their own parents and now spend 22 hours 30 minutes a week looking after their children, according to a new study.

Findings from a popular parenting manual: A survey of mothers in the UK and Australia found that "38% of all…mothers were alone for between eight and twelve hours on weekdays, and a further 34% for four to eight hours each day. So nearly three quarters of them were stranded with their crying babies for much of the day, having to cope alone, bearing full responsibility and often trying one thing after another to soothe them for just a few minutes at a time…The phrases kept recurring: 'I felt so trapped', 'I couldn't get away from her', 'I felt completely useless', 'very guilty', 'exhausted', inadequate', 'bewildered'."

From another popular parenting manual: "Don't let those tears frighten you. And don't decide that because you are crying you must be unhappy. Tears of this sort spring partly from hormonal chaos as your body struggles to adapt to not being pregnant any more and to making milk. If you calmly let them flow - even weep luxuriously into your partner's neck - they will probably stop as suddenly as they began."

Page 5

The opinions people express towards parents:

From a recent newspaper article headlined **Working mothers suffer DOUBLE guilt because they worry about being a poor parent and poor employee** with readers responses below.
Mothers agonise more about their job outside work hours than fathers
They also worry more about family life while at work, say Israeli researchers
This may be because fathers know their partner will worry on their behalf

Responses:
Respondent 1: Worried about being a poor parent and poor employee, are they? Look at the youth problems these days linked to dysfunctional family backgrounds due to inadequate mothers. And DON'T keep blaming the fathers (assuming the mothers and the courts haven't already evicted them). Look at the opinions of employers, some struggling to stay afloat and encumbered by unreliable young(ish) female employees exercising their 'right' to employment (on THEIR terms) and rake in the cash despite NO sense of duty of loyalty towards their employers (cash cows). Are

they worried? Too right, they SHOULD be.

Respondent 2: I have no choice on working I have 2 small children and have worked for more years then they have been alive. I love my job but also love my children. The guilt that I feel on dropping my 2 small tired children at early breakfast clubs eat at me. I also have to pick them up late. Sometimes we only have an hour in the evening together. My boss makes me feel guilty for being 20 minutes late during the tube strike but due to childcare couldn't leave any earlier. I could give up work but don't want to claim benefits. I also see my boss's point of view.

Respondent 3: Having a child is a privilege, not a right. People should not be having kids if they can't afford to raise them, and that means doing the job yourself instead of firing out a baby and immediately farming it off to someone else to look after while you fool yourself that you're being a productive member of society.

Respondent 4: Years ago women didnt have the choice to work at all. They just didnt do it. And they didnt have the same benefits available then as they do now. For example, they only got child benefit when a 2nd child came along (correct me if I'm wrong here but my Mum told me this). Yes without working you wont have the same standard of living or possibly social status but you have to decide whats most important for YOU. And forget the notion that you can have it all. You can't without consequences.

Respondent 5: A child under 3 has no concept of you striking a blow for women's rights and continuing your career 6 months after giving birth. It wants the love of it's mother, not a nursery key worker on the minimum wage.

Respondent 6: All women who use childcare and nurseries instead of being good mothers should be ashamed of themselves.

From a recent newspaper article headlined **I keep my healthy four-year-old in a buggy - because it's easier for me! Defiant mother scoffs at warnings that stopping children from walking is harmful - but is she wrong?**
My four-and-a-half-year-old son Sebastian quite often emerges from the school gate exhausted, irritable and impossible to reason with. Dragging his feet along the pavement, the ten-minute stroll home would take ten times longer if I let him go at his own pace. So I whisk him into his buggy and wheel him away.
There's nothing wrong with his legs. Sebastian is more than capable of walking and sometimes complains about being strapped in. But both of us are the better for him not being on foot.
Comment by Dr Ellie Cannon: I've read Lauren's [the mother] story and the opinion of neuropsychologist Sally Goddard Blythe. And I agree with the expert – that expert being Lauren.

Responses:

Respondent 1: I've taken care of my five nieces and nephews many times over the last 16years, myself I'm disable and have limited mobility but even I never put them into a buggy when there was nothing wrong with them.. My one nice suffered hip pain as a young child so yes i used the buggy for her to collect from school but no further then 4 1/2yr (so really nursery) Heaven forbid she spends 20min's with her son having a chat and seeing how his day went, not only that how embarrassed must this poor little boy be, we talk about stamping out bullying well don't put a target on your childs back either, why not take a bike or scooter down to the school gates for him ! Or why don't she cycle down with a trailer on the back two birds one stone.. But i don't agree with what she's doing ,he's a healthy child be glad of that there are thousands of parents who would love to see there child walk home as slow as they like from school, count your blessings.

Respondent 2: Oh my goodness!!! What is wrong with these mothers?? Between this and the mom who lets her 5 year old sleep in bed with her makes me want to puke

Respondent 3: 'He isn¿t badly behaved. But he is a typical four-year-old.' No, he is badly behaved. Sitting down in the middle of the pavement or running off into peoples' gardens is simply bad behaviour, she is mitigating the symptoms instead of dealing with the cause.

Respondent 4: Has anyone else noticed that this story is really only about what is best for the mother and her needs? Also the comment that at 32 no one can tell her what to do comes across as very childish. It's the type of comment a teenager throws at a parent whilst stamping their feet because they can't get their own way. I'm not sure that with a comment like that she is mature enough to be a parent. I wonder how she reacts at work as a manager if things don't go her way? If her attitude is the same at work as it is in this article, all defiant and I know best then I'm really glad she isn't my manager. I'm not sure that this article will have done her any favours. In time I suspect she will become to regret that she ever agreed to its being published.

Page 3

Attention check and prime reinforcement *– questions of my own design to check participants have paid attention to the previous text, with the additional function of reinforcing the prime.*

Thinking about what you have just read, please answer the following questions:

Antisocial babies are a danger to society, who is to blame for them? (Parents/mother, inconsistent parents/mother)

How many hours a day do dads spend looking after their kids? (3)

What emotion to working mothers experience double of? (Guilt)

Finish to following sentence: Nearly three quarters of mothers and their baby's spend a large part of their day (alone)

Page 4

Measuring reproductive desires *– overall desire and strength of desire, questions of my own design.*

How many children would you ideally like to have? (Number)

How likely would you be to consider having children if you weren't in a stable romantic relationship? (Sliding scale from 'Not at all' to 'Extremely')

If you weren't in a stable relationship how likely would this be to lower the number of children you would ideally have? (Sliding scale from 'Not at all' to 'Extremely')

How likely would you be to consider having children if you weren't well off financially? (Sliding scale from 'Not at all' to 'Extremely')

If you weren't well off financially how likely would this be to lower the number of children you would ideally have? (Sliding scale from 'Not at all' to 'Extremely')

Page 5

Measuring investment desires – *questions of my own design. The list of childcare activities based on Hill and DelPriore (2013). Sleep and feeding estimates taken from Baby Center (2014), feeding shortest option based on 10x 5min bouts (purposefully unrealistic) and longest based on 12x 30mins.* indicate emotional investment related behaviours as opposed to care behaviours.*

Imagine you have a 1 month old infant with your romantic partner. On average 1 month olds sleep for 8 hours during the night, and 8 hours at inconsistent times during the day.

Below is a list of baby care activities that you may encounter on a daily basis, along with some rough estimates of the length of time each activity can consume over a day. Please indicate the *maximum* time you would be happy to devote to this activity:

Playing with the baby* (Sliding scale '0 hrs' to '8 hrs')
Holding the baby* (Sliding scale '0 hr' to '8 hrs')
Keeping an eye on the baby around the home (Sliding scale '0 hr' to '24 hrs')
How many nappy changes (Sliding scale 'x0' to 'x20')
Pushing the baby around in a stroller (Sliding scale '0 hrs' to '3 hrs')
Feeding the baby (via breast or bottle, includes night time feeds) (Sliging scale '0 hrs' to '6 hrs')
Handwashing the baby's clothes, blankets, bottles (Sliding scale '0 mins' to '2 hrs')
Bathing the baby (Sliding scale '0 mins' to '1 hr')
Talking to the baby* (Sliding scale '0 hrs' to '8 hrs')
Getting up at night with the baby when he or she cries (Sliding scale '0 hrs' to '6 hrs')
Singing to the baby* (Sliding scale '0 mins' to '3 hrs')
Tending to the baby when it is sick (Sliding scale '0 hrs' to '24 hrs')
Soothing the baby to put him or her to sleep* (Sliding scale '0 mins' to '2 hrs')
Calming the baby when he or she is upset* (Sliding scale '0 mins' to '5 hrs')

Page 6

Measuring investment desires – *questions of my own design. Concentration time estimated from Leckman et al. (1999)*

How many hours a day in the first few months would you be happy concentrating your thoughts on your baby (assuming you sleep for 8 hours)? (Sliding scale '0 hrs' to '16 hrs')

How many hours a day in the first few months would you be happy to be alone with your baby on a weekday? (Sliding scale '0 hrs' to '12 hrs')

Page 7

Measuring anticipated cost/benefits – *questions of my own design based on Matthews and Sear (2008).*

How costly or beneficial do you think the consequence of having a baby is the following fields?

Financially (Sliding scale 'Very costly' to 'Very beneficial')

Employment opportunities (Sliding scale ‘Very costly’ to ‘Very beneficial’)

Socially (Sliding scale ‘Very costly’ to ‘Very beneficial’)

Emotional wellbeing (Sliding scale ‘Very costly’ to ‘Very beneficial’)

Page 8

Measuring sensitivity to risk – *questions of my own design.*

Do you think the UK is a safe environment in which to be pregnant? (Sliding scale ‘Very dangerous’ to ‘Very safe’)

Do you think the UK is a safe environment in which to raise a baby? (Sliding scale ‘Very dangerous’ to ‘Very safe’)

Do you think the UK is a safe place to raise children? (Sliding scale ‘Very dangerous’ to ‘Very safe’)

Page 9

Prime text *– priming for guilt, shame, and social threat surrounding the level of investment desire expressed.*

You are about to read some more text taken from popular or social media, this time the themes are the dangers of poor parenting, the opinions mothers express towards each other, and the feeling of being a mother.

The dangers of poor parenting:

In a BBC interview Tony Blair (2006) called for “pre-birth even” intervention in families on the grounds that “you can predict reasonably accurately, although nothing is 100%, but reasonably accurately – the kids and the families that are going to be difficult for the future”.

Newspaper interview with Conservative MP Andrea Leadsom who runs a parenting advice charity: What happens between conception and the age of two shapes the adult a child will become.

The greatest health challenge of our time is securing good mental health for our nation. To achieve good mental health, we should look no further than where it all begins – the conception of a baby.

Secure early bonding is the difference between the baby that grows up a secure, emotionally capable adult, and a baby that will become a depressive, anxious child, who will not cope well with life's ups and downs. In the most difficult cases, this baby is more likely to later experience criminality, substance abuse or depressive problems.

Human babies are unique in the animal kingdom in the extent of their underdevelopment at birth. But the physical underdevelopment is only a tiny part of it. The human brain is only partially formed when you are born. The earliest experiences of the human baby have a lifelong impact on their mental and emotional health.

The "social" part of the brain only starts to develop at around six months. Where a baby does not receive any attention, this part of the brain does not grow and may never grow.

It ought to be natural to form that secure bond. But post-natal depression, problems with conception or the birth experience, domestic violence and issues of poverty can all get in the way

Page 10

The opinions mothers express towards each other:

A recent conversation on Mumsnet, one of the most popular parenting websites.

Mother 1: I have 4 children. My youngest is 17 months and I really don't enjoy him. I don't thinking have ever bonded with him and if I'm honest I wish we had stopped at 3 children. He has moaned and whinged since he was born. He has been so much harder than my older children. It's not as if he is denied attention as the others are at school. I am really starting to dislike him.
I'm not sure if I didn't bond with him as a baby. He almost died at birth and my husband and I had marriage difficulties throughout his first year, which I don't think helped. Things are getting better now, but I don't seem to want to be with child 4.
I probably enjoy his company about 10% of the time, but the rest if the time I hate it. Could I be suffering from postnatal depression? Have I had it since child 4 and not realised? How can I fix things?

Mother2: If he's whinging and being needy it's probably because he sensing how you feel. You really need to seek help over this asap, or you risk damaging his self esteem for ever over it.

Mother 3: Oh this has made me really sad. You could well be suffering from PND.
Poor baby

Mother 4: Your poor child.

Honestly you don't sound well. He nearly died at birth - that alone must have triggered something. Please please please for the sake of you and your family, speak to a GP or HV. This will affect your 4th child, **and** your other children as they will pick up on your feelings. My mum had a similar issue with my sister and I can't really understand my mum and find it awful of her.

Re-written: Conversation on Mumsnet:

Is it just me who feels guilty??

Mother 1: Or does anyone else feel they haven't spent enough time with their baby?

I have my baby everyday as still on maternity leave but in the evenings I get overwhelmed with guilt, feeling like I haven't spent enough time with my baby!! This is stupid right?

I do play with her during the day when she's awake, take her walks, swimming etc but when I put her down in the evening I always feel I could have done more. I can't play all the time obviously as I need to do the housework, am I being silly or is this normal?

I feel as though I am failing her. God knows how I will feel when I go back to work. My mum was over for a long weekend and I felt like I was failing her because she had her with her for 2 nights so I could get a good sleep and lie in.

Please tell me I am being stupid and this is normal. My mum and partner say I am being ridiculous but I can't shift these feelings.

Mother 2: I'm glad you posted this as I feel exactly the same in the evening. Now that my son is at school (started in September) the guilt seems to get worse because I have even less time to play/ spend time with him and I feel guilty that my daughter gets more attention than him now.

I must admit, I feel guilty about most things I do. I wish I could just relax and just enjoy being a mum.

Mother 3: It gets me too. I think it's worse because when others are spending time with him (GPs, Daddy) they don't have anything else to be doing yet we have housework, cooking, dog walking, grocery shoppping...... (Dad can help too I know!)

Mother 1: Thank god it's not just me!!

I know what you mean, trying to juggle getting all the housework done, clothes ironed, meals cooked, shopping done and getting quality time with my daughter can be difficult. Never seem to get even 30mins to myself these days.

Mother 4: I've just started to get this... Still on maternity leave too. I've left him to do something in another room briefly, or been in the same room but occupied with something else, and I look up and his little face looks so unsure as to whether I'm interested in him (realise this is probably complete projection on my part). I can't even imagine how the bigger challenges are going to feel.

Page 10

Attention check and prime reinforcement *– questions of my own design.*

Thinking about what you have just read, please answer the following questions

What does secure early bonding lead to? (Good mental health, depression, criminality)

Which prime minister called for pre-birth interventions for problem families? (Tony Blair)

Which emotion do mothers feel for not spending enough quality time with their baby? (Guilt)

Page 11

Measuring guilt and shame regarding investment desires *– questions of my own design based on the methodology of Lickel et al. (2005) and Scarnier et al. (2009).* denotes emotions assessing shame and ** those assessing guilt, the others are fillers. The filler emotions are taken from Watson and Clark (1994) following Feldman Barrett (1998).VAS ranging from 'Not at all' to 'Very intensely'.*

Please reflect back for a moment on the answers you gave regarding your own parenting desires and thoughts and then rate how much of each of the following emotions you feel as a result.

Happy

Alone

Sorry**

Afraid

Irritable

Ashamed*

Downhearted

Angry

Humiliated*

Guilty**

Cheerful

Nervous

Embarrassed*

Sad

Delighted

Disgraced*

Scornful

Lonely

Remorse**

Frightened

Joyful

Disgusted

Scared

Regret**

Emotionally bonding with your baby can take a while. How long do you think it would be before you felt worried about not bonding with your baby? (Sliding scale ‘1 day’ to ‘3 months’)

How long do you think it would be before you felt guilty about not bonding with your baby? (Sliding scale ‘1 day’ to ‘3 months’)

Page 12

Assessing opinions of the portrayal of motherhood – *questions of my own design assessing feelings towards to the way mothering is portrayed in popular and social media.*

Thinking about the texts you have just read, please answer these final few questions:

How would you rate the portrayal of mothering/parenting in the media? (Very positive, positive, neutral, negative, very negative)

What effect do you think reading this sort of information would have on your confidence if you were pregnant or a new mother? (Very positive, positive, neutral, negative, very negative)

If you were pregnant or a new mother, do you think you'd find interacting with other mothers on social media helpful? (Very helpful, helpful, neutral, unhelpful, very unhelpful)

Page 13

Thank you page

You have now finished, thank you for taking part, it is very much appreciated! Once the survey is closed I will be sending out a debriefing email explaining the experiment you just took part in – I will be collecting responses for the next couple of weeks so please refrain from talking about the contents of the survey with fellow students until I send you get my email so as not to bias the results. Thanks once again!

Part 2 – Control Condition

Page 1

Participants will be told the following:

I am interested in the sources of information about parenting young women have available to them and the effect this information has on their thoughts and behaviour. You have been selected to complete the control condition and as such will be asked to reiterate your thoughts on parenting and answer some additional questions on how you feel about your answers and your perception of parenting in the media. It will take approximately X minutes to complete this survey.

Please enter the email address to which this link was sent (this is to match up your answers here with your previous responses):

Page 2

Measuring exposure to messages regarding parenting *– controlling for the potential recent exposure to popular and social media messaging in daily life.*

Thinking about the news stories you have read or listened to in the last few weeks, how many would you say have related to any aspect of parenting? (None at all, very few, quite a few, quite a lot, a lot)

Thinking about the popular articles you have read in magazines or on websites in the last few weeks, how many would you say have related to any aspect of parenting? (None at all, very few, quite a few, quite a lot, a lot)

Thinking about the academic articles you have read in the last few weeks, how many would you say have related to any aspect of parenting? (None at all, very few, quite a few, quite a lot, a lot)

Have you ever visited any pregnancy/parenting advice websites? (Yes, no)

Have you ever read any pregnancy/parenting advice books? (Yes, no)

Page 3

***Measuring reproductive desires** – overall desire and strength of desire, questions of my own design.*

How many children would you ideally like to have? (Number)

How likely would you be to consider having children if you weren't in a stable romantic relationship? (Sliding scale from 'Not at all' to 'Extremely')

If you weren't in a stable relationship how likely would this be to lower the number of children you would ideally have? (Sliding scale from 'Not at all' to 'Extremely')

How likely would you be to consider having children if you weren't well off financially? (Sliding scale from 'Not at all' to 'Extremely')

If you weren't well off financially how likely would this be to lower the number of children you would ideally have? (Sliding scale from 'Not at all' to 'Extremely')

Page 3

***Measuring investment desires** – questions of my own design. The list of childcare activities based on Hill and DelPriore (2013). Sleep and feeding estimates taken from Baby Center (2014), feeding shortest option based on 10x 5min bouts (purposefully unrealistic) and longest based on 12x 30mins.* indicate emotional investment related behaviours as opposed to care behaviours.*

Imagine you have a 1 month old infant with your romantic partner. On average 1 month olds sleep for 8 hours during the night, and 8 hours at inconsistent times during the day.

Below is a list of baby care activities that you may encounter on a daily basis, along with some rough estimates of the length of time each activity can consume over a day. Please indicate the *maximum* time you would be happy to devote to this activity:

Playing with the baby* (Sliding scale '0 hrs' to '8 hrs')
Holding the baby* (Sliding scale '0 hr' to '8 hrs')
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How many nappy changes (Sliding scale 'x0' to 'x20')
Pushing the baby around in a stroller (Sliding scale '0 hrs' to '3 hrs')
Feeding the baby (via breast or bottle, includes night time feeds) (Sliging scale '0 hrs' to '6 hrs')

Handwashing the baby's clothes, blankets, bottles (Sliding scale '0 mins' to '2 hrs')
Bathing the baby (Sliding scale '0 mins' to '1 hr')
Talking to the baby* (Sliding scale '0 hrs' to '8 hrs')
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Tending to the baby when it is sick (Sliding scale '0 hrs' to '24 hrs')
Soothing the baby to put him or her to sleep* (Sliding scale '0 mins' to '2 hrs')
Calming the baby when he or she is upset* (Sliding scale '0 mins' to '5 hrs')

Page 4

***Measuring investment desires** – questions of my own design. Concentration time estimated from Leckman et al. (1999)*

How many hours a day in the first few months would you be happy concentrating your thoughts on your baby (assuming you sleep for 8 hours)? (Sliding scale '0 hrs' to '16 hrs')

How many hours a day in the first few months would you be happy to be alone with your baby on a weekday? (Sliding scale '0 hrs' to '12 hrs')

Page 5

***Measuring anticipated cost/benefits –** questions of my own design based on Matthews and Sear (2008).*

How costly or beneficial do you think the consequence of having a baby is the following fields?

Financially (Sliding scale 'Very costly' to 'Very beneficial')

Employment opportunities (Sliding scale 'Very costly' to 'Very beneficial')

Socially (Sliding scale 'Very costly' to 'Very beneficial')

Emotional wellbeing (Sliding scale 'Very costly' to 'Very beneficial')

Page 6

***Measuring sensitivity to risk –** questions of my own design.*

Do you think the UK is a safe environment in which to be pregnant? (Sliding scale 'Very dangerous' to 'Very safe')

Do you think the UK is a safe environment in which to raise a baby? (Sliding scale 'Very dangerous' to 'Very safe')

Do you think the UK is a safe place to raise children? (Sliding scale 'Very dangerous' to 'Very safe')

Page 7

Measuring guilt and shame regarding investment desires *– questions of my own design based on the methodology of Lickel et al. (2005) and Scarnier et al. (2009).* denotes emotions assessing shame and ** those assessing guilt, the others are fillers. The filler emotions are taken from Watson and Clark (1994) following Feldman Barrett (1998).VAS ranging from 'Not at all' to 'Very intensely'.*

Please reflect back for a moment on the answers you gave regarding your own parenting desires and thoughts and then rate how much of each of the following emotions you feel as a result.

Happy

Alone

Sorry**

Afraid

Irritable

Ashamed*

Downhearted

Angry

Humiliated*

Guilty**

Cheerful

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Sad

Delighted

Disgraced*

Scornful

Lonely

Remorse**

Frightened

Joyful

Disgusted

Scared

Regret**

Emotionally bonding with your baby can take a while. How long do you think it would be before you felt worried about not bonding with your baby? (Sliding scale ‘1 day’ to ‘3 months’)

How long do you think it would be before you felt guilty about not bonding with your baby? (Sliding scale ‘1 day’ to ‘3 months’)

Page 8

Assessing opinions of the portrayal of motherhood *– questions of my own design assessing feelings/assumptions towards to the way mothering is portrayed in popular and social media.*

Women in the West currently have an unprecedented level of access to information via popular and social media. Thinking about this for a moment, please answer these final few questions:

What effect do you think having access large amounts of information would have on your confidence if you were pregnant or a new mother? (Very positive, positive, neutral, negative, very negative)

If you were pregnant or a new mother, do you think you’d find interacting with other mothers on social media helpful? (Very helpful, helpful, neutral, unhelpful, very unhelpful)

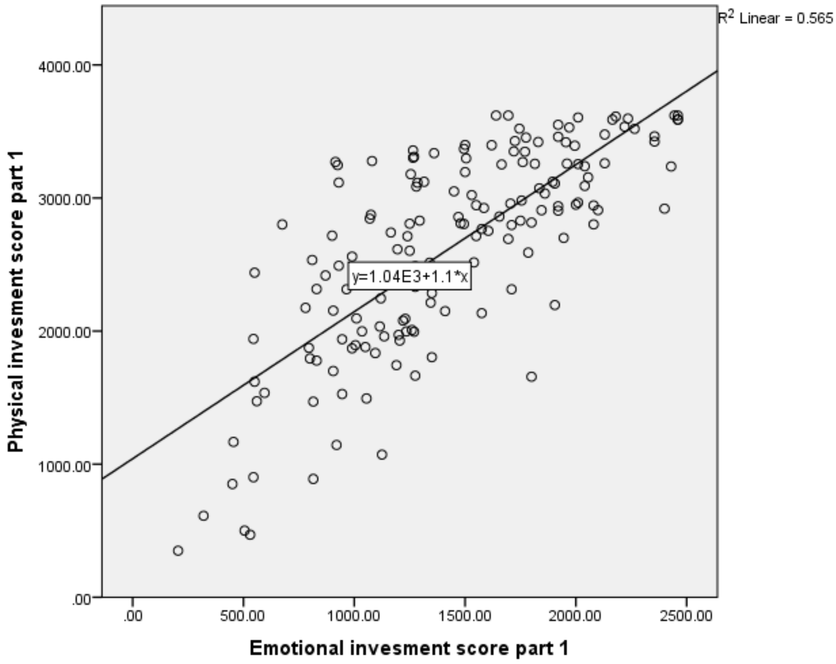
How would you rate the portrayal of mothering/parenting in the media? (Very positive, positive, neutral, negative, very negative, don’t know)

Page 9

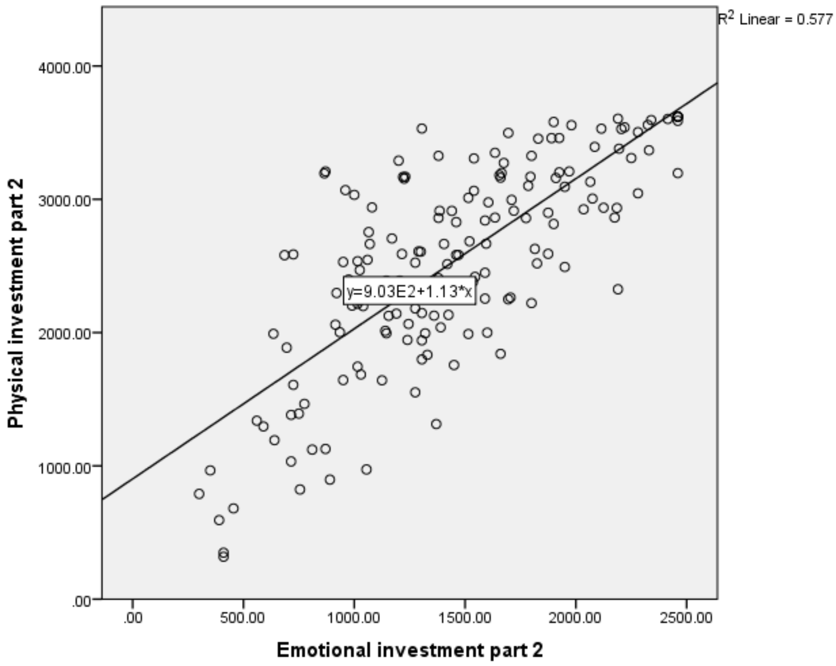
Thank you page

You have now finished, thank you for taking part, it is very much appreciated! Once the survey is closed I will be sending out a debriefing email explaining the experiment you just took part in – I will be collecting responses for the next couple of weeks so please refrain from talking about the contents of the survey with fellow students until I send you get my email so as not to bias the results. Thanks once again!

Appendix J – Justifying Priming Study Data Usage



Graph showing the regression of *emotional investment* against *physical investment* measured in *Part 1* of the priming study.



Graph showing the regression of *emotional investment* against *physical investment* measured in *Part 2* of the priming study.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	5103.429	122.386		41.700	.000	4861.717	5345.140
	Do you have any children?	510.929	415.030	.097	1.231	.220	-308.755	1330.612
a. Dependent Variable: Total investment score part 1								

Result of regression analysis assessing the influence of having had children on *total investment* reported in *Part 1* of the priming study.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	2.141	.087		24.705	.000	1.970	2.313
	Do you have any children?	.251	.298	.066	.842	.401	-.338	.841
a. Dependent Variable: How many children would you ideally like to have?								

Result of regression analysis assessing the influence of having had children on *ideal number of children* reported in *Part 1* of the priming study.

Appendix K – Creating Maternal Shame Cut-offs

Maternal shame cut-off of 8 postnatally for predicting PND within 6 months postnatally:

Classification Table[a]					
Observed			Predicted		
			PND according to any measure by the last stage which was completed		Percentage Correct
			No	Yes	
Step 1	PND according to any measure by the last stage which was completed	No	36	6	85.7
		Yes	7	8	53.3
	Overall Percentage				77.2

a. The cut value is .500

Percentage of correct classifications when *maternal shame* is used as a categorical independent variable in a binary logistic regression where *PND ever* acts as the dependent variable.

Variables in the Equation									
		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Shame	8 or above	1.925	.680	8.018	1	.005	6.857	1.809	25.996
	Below 8 (ref)	-	-	-	-	-	-	-	-
	Constant	-1.638	.413	15.716	1	.000	.194		

Results of binary logistic regression analysis assessing the impact of *maternal shame* on *PND ever*. Cox & Snell = 0.137, Nagelkerke = 0.200

Maternal shame cut-off of 9 during pregnancy for predicting PND within 6 months postnatally:

Classification Table[a]					
Observed			Predicted		
			PND according to any measure by the last stage which was completed		Percentage Correct
			No	Yes	
Step 1	PND according to any measure by the last stage which was completed	No	41	10	80.4
		Yes	9	10	52.6
	Overall Percentage				72.9
a. The cut value is .500					

Percentage of correct classifications when *maternal shame* is used as a categorical independent variable in a binary logistic regression where *PND ever* acts as the dependent variable.

Variables in the Equation									
		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Shame	9 or above	1.516	.579	6.853	1	.009	4.556	1.464	14.177
	Below 9								
	Constant	-1.516	.368	16.969	1	.000	.220		

Results of binary logistic regression analysis assessing the impact of *maternal shame* on *PND ever*. Cox & Snell = 0.095, Nagelkerke = 0.138