DOCTOR OF PHILOSOPHY

Links between parental affect, cognitions, parenting, and child outcomes

Simcock, Naomi

Award date:
2013

Awarding institution:
Bangor University

Link to publication

Review

Impact of postnatal maternal depression on child cognitive development

Naomi S. Simcock and Helen Healy

[1]North Wales Clinical Psychology Programme

[2]North Wales Clinical Psychology Programme

Word count (exc. figures/tables): 6,699

*Requests for reprints should be addressed to Naomi Simcock, North Wales Clinical Psychology Programme, School of Psychology, Bangor University, 43 College Road, Bangor, Gwynedd, North Wales, LL57 2DG, United Kingdom (e-mail: n.simcock@yahoo.co.uk).

Abstract

The impact of postnatal depression on child cognitive development from 12 months to 16 years was reviewed. PsycInfo, Medline, and Embase databases were searched with key terms for English language abstracts from 2000 onwards, and a hand-search of references, citations, key journals and authors was conducted. 20 studies were reported in detail. Inconsistencies in the evidence were apparent between the studies examined, with some indicating that postnatal depression is a significant risk factor for child cognitive development, while others found that this was the case only when an accumulation of postnatal depression and other risk factors occurred, such as chronicity of depression, security of attachment, and socioeconomic status. However, some studies utilising clinical samples indicated that severity of depression may increase the impact of postnatal depression on child cognitive development. The results of this review highlight the importance of screening for maternal mental health both pre- and postnatally. Potential interventions may include preventative approaches, treatment, or alternative caregivers, but evidence is strongest for interventions which target mother-child interaction, rather than maternal depression alone.

Introduction

This review is focussed on the impact of postnatal depression (PND) on child cognitive development (CCD), but reference is made to studies of younger children due to the importance of parenting and mother-child interaction. Brief reference is also made to some general effects of PND on socio-emotional and other aspects of development. Possible mediators and moderators of the impact of PND on CCD are also discussed, before consideration is given to potential prevention of and interventions for PND.

Optimising child development is essential for reducing health and social inequalities throughout life (Hertzman, 1998; Hertzman, 2009). Over recent decades, interest has increased in the long-term impact of risks occurring during the perinatal period on child development. The Marmot Review proposed an increase in support for parents, starting in pregnancy and continuing through primary school (Marmot, 2010). The World Health Organization's Commission of Social Determinants (2008) likewise attaches importance to maternal health during the perinatal period for child health and development:

> "Implementing a more comprehensive approach to early life includes … comprehensive support to and care of mother before, during and after pregnancy – including interventions that help to address prenatal and postnatal maternal mental health problems." (p. 53)

This aim of improving child outcomes through maternal mental health, and particularly perinatal mental health, has lead to a focus on maternal depression. Depression is common among women of child-bearing age (McManus, Meltzer, Brugha, Bebbington, & Jenkins, 2009), and PND is found in 10 – 15% of mothers during the postnatal year in developed countries (Gaynes, Gavin, Meltzer-Brody, et al. 2005), with even higher rates found in developing countries (Wachs, Black & Engle, 2009). The depressive symptoms experienced during the postnatal period are similar to those experienced at any other time, with duration varying from a single, brief episode to depression lasting throughout and beyond the first year following childbirth (Murray, Halligan, & Cooper, 2010). The risks for developing PND are similar to depression occurring at other times, such as social isolation, a lack of support, disadvantaged socioeconomic status (SES; Boyce, 2003), marital difficulties, and stressful life events (Da Costa, Larouche, Dritsa, & Brender, 2000; O'Hara & Swain, 1996). Research suggests that certain infant characteristics (even in neurologically normal samples) such as irritability and motor delay, may increase the risk of PND, although the direction of causality is somewhat difficult to establish (Murray, Stanley, Hooper, King, & Fiori-Cowley, 1996; Murray & Cooper, 1997).

Previous Reviews

Previous literature reviews have focussed on the importance of mother-child relationships, and the security of attachment in order to understand how the early environment supports and enhances child development. Research indicates that PND impacts on child development through a reduction in the quality of mother-infant interaction. Field, Cohn, Tronick and colleagues (eg. Field, 1984; Field, Sandberg, Garcia, Vega-Lahr, Goldstein & Guy, 1985; Field et al. 1988; Cohn, Matias, Tronick, Connell, & Lyons-Ruth, 1986) found that during mother-infant interactions depressed mothers deviated from normal patterns of interacting, responding insensitively, demonstrating either intrusive and hostile communication, or flat, withdrawn and disengaged behaviour. Other samples found maternal depression resulted in reduced maternal sensitivity and responsiveness to their infant's signals (Murray, Stanley et al. 1996; Stanley, Murray, & Stein, 2004). Research links reduced maternal sensitivity to disrupted attention and behavioural regulation in the infant (Murray, Fiori-Cowley, et al., 1996) particularly for male infants (Weinberg et al., 2006).

As attachment theory (Bowlby, 1988) highlights the importance of responsiveness and sensitivity to the infant's cues in the development of attachment, maternal depression likely has an impact on attachment security. Meta-analyses examining the impact of maternal depression on attachment security have found modest effects. Atkinson et al. (2000) found a modest effect among community samples, but a large effect among clinical samples. Martins and Gaffan (2000) examined a sample of studies relatively free from risk factors other than depression, and found variable effect sizes, but the effect of maternal depression on attachment security remained significant. Campbell et al. (2004) and McMahon, Barnett, Kowalenko, and Tennant (2006) highlight how greatly maternal functioning varies as a result of depression, linking this to the degree of contextual risk, while this variability determined the security of the developing attachment. Campbell et al. (2004) found that the chronicity, rather than the existence of maternal depression predicted child insecurity, and that increased maternal sensitivity had a positive impact on attachment despite depression. McMahon et al. (2006) additionally found that the security of the mother's own attachment style could protect child attachment security from the negative impact of maternal depression. Insecure attachment has its own consequences for child development, in terms of neurological networks (e.g. Coan, 2008), psychosocial and emotional well-being (e.g. Murray, et al., 1999), and behaviour (e.g. Clarke, Ungerer, Chahoud, Johnson & Stiefel, 2002; Torres, Maia, Veríssimo, Fernandes, & Silva, 2012).

The impact of PND on Behavioural and Socio Emotional Development:

Although research indicates that PND has an impact on global, behavioural, socio-emotional, psychomotor, and cognitive development in infants (see, Kingston, Tough, & Whitfield, 2012), there is also evidence that the impact extend from infancy to adolescence in terms of socio-emotional and mental health, behaviour, and cognitive development (Grace, Evindar, & Stewart, 2003; Goodman et al., 2011; Halligan, Murray, Martins, & Cooper, 2007). Some inconsistencies exists as to whether the postnatal period is an especially sensitive one with regards to the long term impact on child development, or whether the negative effects are due to chronicity or recurrent maternal depressive episodes, or an accumulation of risk factors (see Murray, Halligan & Cooper, 2010).

PND has been associated with increased child behavioural difficulties at 18 months (Murray, 1992; Alpern & Lyons-Ruth, 1993); 20 months (Cicchetti, Rogosch, & Toth, 1998), though mediated by general contextual risk; 42 months, though concurrent maternal depression appeared to mediate this (Ghodsian, Zajicek, & Wolkind, 1984); three years (Wrate, Rooney, Thomas, & Cox, 1985); four years (Caplan et al., 1989) although this was primarily accounted for by contextual risk factors co-occurring with PND; five years (Alpern & Lyons-Ruth, 1993; Murray, Sinclair et al., 1999); six years (Essex, Klein, Miech, & Smider, 2001); and 8 years (Wright, George, Burke, Gelfand, & Teti, 2000).

PND is also associated with socio-emotional difficulties, including increased fearfulness, with teacher reports of children as more withdrawn and anxious at age five (Alpern & Lyons-Ruth, 1993); internalising symptoms aged six (Essex et al. 2001); peer difficulties (Murray, Sinclair et al. 1999; Wright et al. 2000); depressive thinking, including hopelessness, pessimism, self-denigration (Murray, Woolgar, Cooper & Hipwell, 2001); and low self-competence (Maughan, Cicchetti, Toth, & Rogosch, 2007).

Although the above developmental areas are of considerable interest, both clinically, and theoretically, a broad focus on all areas of child development is beyond the scope of this review. This review is focussed on more recent research with a particular focus on longer-term cognitive development outcomes. The objectives of this review are to: a) assess the relationship between PND and CCD from 12 months to 16 years of age; b) explore the quality of the evidence for this relationship; c) identify any existing gaps in the evidence base; d) outline implications of the review findings.

Method:

Inclusion and exclusion criteria and definitions:

Studies were included in this review if the: a) exposure was maternal depression occurring in the 12 months postnatally; b) outcome was a measure of CCD that was assessed from 12 months to 16 years of age; c) study recruited participants from developed countries; d) study was published in English; e) study was a primary paper study published between 2000 and 2013.

Studies were excluded from this review if: a) the study focused on interventions for PND; b) depression was not postnatal specific; c) maternal depression co-occurred with other mental health problems; infants suffered from congenital abnormalities or other conditions likely to impact on their cognitive abilities, for example, preterm birth.

Search Strategy:

Three electronic databases were searched, including Embase, Ovid MEDLINE, and PsycInfo. Reference lists, citations, review papers, and book chapters were reviewed and key journals hand-searched. Searches were conducted on recent publications by key authors, including Lynne Murray, Peter Cooper. The search took place from March to April 2013.

Search terms:

postnatal depression OR post-natal depression OR post natal depression OR postpartum depression OR post-partum depression OR post partum depression

AND

child* development OR infant development OR intellectual development OR cognit* development OR brain development OR language development OR perceptual development OR psychological development

(Figure 1 here)

Results:

Overview:

The database search strategy yielded a total of 923 studies, of which 18 were identified for inclusion (Figure 1; Table 1 & 2). Studies were excluded on the basis of: duplication; not a primary paper - review, or results reported elsewhere; unpublished studies, or published in a language other than English; studies about interventions for PND; paternal PND, or data of mothers and fathers not reported separately; infant/congenital abnormalities; antenatal rather than postnatal depression; child age <12 months; no measure of cognitive development; depression not postnatal specific; comorbid maternal mental health problems other than PND, or PND results not reported separately to other mental health problems.

Participants were recruited from a number of different countries, including UK/England (n=6), Australia (n=4), USA (n=2), Brazil (n=1), China (n=1), France (n=1), Greece (n=1), Netherlands (n=1), and Switzerland (n=1). All studies were longitudinal, except for 1 cross-sectional study (Zajicek-Farber, 2010), and 9 were long-term (>3 years). The majority (n=14) were community-based samples; whereas 3 focused on clinical populations, including mothers who were recruited from a centre for infant problems (Cornish et al. 2005), from mental health centres (Kersten-Alvarez et al. 2012), and from a mother and baby psychiatric unit (Milgrom, Westley, & Gemmill, 2004), while 1 (Zajicek-Farber, 2010) examined a particularly high-risk population. The majority of studies (n=13) were published over the past 6 years (2008 – 2013). Sample sizes ranged greatly, from 56 to 5 029 (Total N= 14,181). In terms of the quality of journal which studies originated from, impact factors ranged from 1.118 to 6.444, with a mean of 2.829. The mean child age included in studies was 4.68 (SD=4.93), ranging from 12 months to 16 years, with only 2 studies looking at >11 year-olds.

Studies were quantitative rather than qualitative, and defined PND primarily through elevated scores on symptomatic measures such as the EPDS, although several conducted clinical interviews to formally diagnose depression (Cornish et al. 2005; Hay et al. 2001; Hay, Pawlby, Waters, & Sharp, 2008; Murray, Arteche, et al. 2010; McMahon, Trapolini, Cornish, & Ungerer, 2008; Sutter-Dallay et al. 2011; Conroy et al. 2012) occurring in the postnatal period (12 months following childbirth).

Outcome measures of cognitive development:

In terms of CCD, the majority of studies looked at global cognitive development (n=11), while others assessed aspects of cognitive development, including the mental scale of the BSID-II, object concept, academic attainment, attention, and language development. A wide variety of cognitive measures were used in the identified studies, with many studies utilising more than one assessment tool. The most frequently used measures were the three versions of the Bayley Scales of Infant (and Toddler) Development (BSID-II, BSITD-III, Bayley, 1993, 2006) and the Mental Development Index (Bayley, 1969) (n=7). A range of the Wechsler assessments were utilised, including the Wechsler Intelligence Scale for Children - III (Wechsler, 1992), the Wechsler Preschool Primary Scale of Intelligence (Wechsler, 1989), the Wechsler Objective Reading Dimensions (Rust, 1993); the Wechsler Objective Numerical Dimensions (Rust, 1995), and the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999) (n=6). Five other measures of cognitive development were each utilised by one study each, including the McCarthy Scale of Children's Abilities General Cognitive Index (McCarthy, 1972); the Early Screening Profiles (Harrison et al. 1990); the Object Concept Task (Uzgiris & Hunt, 1975); the Chinese Child Development Inventory (Hsu et al. 1978); and Mullen Scales of Early Learning (Mullen, 1995).

One study also utilised a measure of attention, the Continuous Performance Test (Erlenmeyer-Kimling & Cornblatt, 1978; Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956), and one (Murray, Arteche, et al., 2010) also used adolescents' academic achievement as a measure of cognitive ability, reporting results on the General Certificate of Secondary Education.

Seven assessment instruments related specifically to language development, including the Peabody Picture Vocabulary Test-Revised (Dunn & Dunn, 1981); the Receptive-Expressive Emergent Language Test (Bzoch & League, 1991); the MacArthur Communicative Development Inventories (Fenson et al. 2000); the Reynell Developmental Language Scale (Reynell 1990); and the Denver Developmental Screening Test (Frankenburg & Dodds, 1967).

Study results:

The studies identified for inclusion address the impact of maternal PND on CCD up to 16 years of age, only two of which were identified on adolescent development. Studies are divided into those utilising general cognitive measures, and those assessing language development only. Studies are organised according to whether they utilised a clinical or community sample, and whether the sample is high-, or low-risk. Studies which identified significant associations between PND and CCD are discussed initially, followed by studies where little direct association was found. Results will be discussed in terms of theoretical and clinical implications.

Clinical samples:

Two clinical samples examined general cognitive development. Milgrom et al. (2004) found that PND was associated with reduced IQ scores in 3.5 year-old children of women with PND in a clinical sample, which appeared to be mediated through lowered maternal responsiveness at 6 months. In this sample, boys were more vulnerable to this effect. In contrast, in their 15-month longitudinal study of a clinical population, Cornish et al. (2005) adjusted for key potential confounders and found that chronic depression rather than PND had a significant impact on CCD, while no effect was found for language development.

Community samples:

11 studies looked at general cognitive development in community samples, of which, 7 studies found evidence of a significant association between PND and CCD. In a disadvantaged SES community sample, Hay et al. (2001) found that PND was significantly associated with reduced child IQ scores at 11 years of age, with greater effects for boys than girls, particularly on performance IQ. Children of mothers with PND were also 12 times as likely to have some special educational needs. Child behaviour, chronicity of depression, parental IQ and SES were not found to mediate these associations. In the follow-up to this study, Hay et al. (2008) found that the main effect of PND on adolescent IQ remained, and, again, this was particularly noticeable for boys. This effect remained once other episodes of depression were controlled. In a sample with a high proportion of non-English-speaking backgrounds, Conroy et al. (2012) controlled for potentially influential variables, including maternal sensitivity and chronicity of maternal depression, and found that 18-month old children of mothers with PND had significantly reduced cognitive development in comparison with non-depressed mothers, and that PND predicted child cognitive scores.

In a relatively low-risk population, Koutra, et al. (2012) controlled for child and maternal characteristics associated with neurodevelopment or maternal stress, and found PND to be negatively associated with CCD, independent of antenatal depression. Similarly, Righetti-Veltema, Bousquet, and Manzano (2003) looked at the development of 18-month-olds, and found that PND was associated with reduced performance on object concept tasks, and a failure to execute two or three instructions. McMahon et al. (2008) found that four-year-old children of mothers who had suffered from PND had moderately lower verbal IQ scores, but no differences were apparent on the Performance scale. Subsequent depressive episodes were not found to have a significant effect, nor were gender differences. In their long-term study of a relatively privileged sample, Murray, Arteche, et al. (2010) found that boys of mothers with PND received poorer GCSE results 16 years later. Using measurements made longitudinally throughout children's lives, they found a strong continuous impact of PND on cognitive functioning from infancy. This association was mediated by mother-child interactions at both five and eight years of age. No significant effects were found for chronic or recent maternal depression.

Four studies found little or no direct association between PND and CCD once other variables were taken into account, most notably chronicity or recurrent episodes of maternal depression. A very large scale, long-term cohort study by Evans et al. (2012) examined the impact of PND on child IQ scores at 8 years. While depression was significantly associated with CCD, only antenatal exposure to maternal depression appeared to be a more sensitive period than any other time point, and to have a greater impact than chronicity of depression. PND did not have a significant effect on child IQ independently of other depressive episodes, nor was an interaction found with child gender, maternal education, SES or household disposable income. Similarly, Sutter-Dallay et al. (2011) found that depressive symptoms at six weeks were associated with poor CCD at two years of age, but again, this became non-significant when adjusted for the chronicity of depressive symptoms. In their relatively small sample, Wang, Chen, Chin, & Lee (2005) found no significant association between PND and CCD once confounding variables were controlled for. Utilising a number of independently rated measures of CCD, Keim et al (2011) also found no apparent direct association between PND and CCD once a large number of confounding variables were taken into account, including income, maternal education, presence of a spouse/partner, and any maternal trait anxiety, or perceived stress. They obtained an apparently negative result, in that PND symptoms appeared to be associated with expressive language in a non-linear fashion.

Language development:

Five studies assessed language development in particular. In a relatively small clinical sample, Kersten-Alvarez et al. (2012) found that PND was associated with reduced verbal intelligence in early school-aged girls. Their analysis controlled for a number of potentially influential variables, but, perhaps crucially, did not control for subsequent depressive episodes. Zajicek-Farber (2010) examined language development in a cross-sectional study utilising a high-risk sample. They found that PND combined with parenting knowledge had an impact on language development, which was mediated by involvement in literacy-oriented stimulation activities. They found a greater effect for boys. However, PND was not found to have a significant direct association with language development.

In terms of community samples, Quevedo et al. (2012) found that PND had a significant negative impact on infant language development. This effect was intensified with increased chronicity of depression. Stein, Malmberg, Sylva, Barnes, & Leach (2008) assessed the language development of 3 year old children in a community sample, and found that PND, and not concurrent maternal depression, was associated with language development when data was analysed by bivariate analysis, but when Structural Equation Modelling (SEM) was used, depression occurring postnatally and at 36 months was associated with language development, mediated by poorer caregiving. Their large sample allowed the sample to be split by SES, and they found this effect was greater in the context of disadvantaged SES.

In their large cohort sample, Brennan et al. (2000) found that depression severity, chronicity, and timing were not significantly associated with vocabulary scores at five years of age once potential confounding variables were taken into consideration. A high attrition rate may have reduced effect sizes shown, as non-completers were significantly higher risk, with greater severity of depression.

Mechanisms, Moderators and Mediators:

Moderators:

Some inconsistencies are apparent in the above studies, and as such, the impact of confounding variables should be considered carefully. Several, but not all, studies identified a difference in the way that PND impacts on the cognitive development of boys versus girls. While girls appeared to be more impacted by PND in one study (Kersten-Alvarez et al. 2012), the effect of PND on CCD appeared to be either limited to, or exacerbated for boys in other studies (Milgrom et al., 2004; Hay et al. 2001, 2008; Murray, Arteche, et al. 2010; Zajicek-Farber, 2010). This is consistent with previous research, which indicates that boys are more vulnerable to the adverse effects of PND. For example, Sharp et al. (1995) found that boys, but not girls of mothers with PND, had reduced cognitive performance in the first year. While it is not clear exactly why, there is some evidence of an interaction between PND, gender, and mother-infant interactions, with depressed mothers' interactions with their sons less positive than with their daughters (Cohn et al., 1990; Hart et al. 1998; Murray et al. 1993; Blatt-Eisengart et al. 2009), and Murray et al. (1993) also found that boys were more negatively impacted on by maternal speech patterns. Hay (1997) proposes that infant boys may be viewed as already developmentally delayed in comparison with girls, and that they may rely more heavily on help from a sensitive and healthy caregiver to regulate their attention and emotions. Additionally, evidence suggests that boys depend more on their mother for emotion regulation (Weinberg and Tronick, 1998), and that their neurodevelopmental response to their mother's illness is different form girls (Dawson et al. 1997). Perhaps crucially, even controlling for concurrent maternal depression boys were 3.6 times more likely to be classified as having an insecure attachment when their mothers suffered from PND (Murray, 1992).

Maternal SES also appeared to moderate the impact of PND on CCD. Studies whose samples were predominantly high-risk, with disadvantaged SES, appeared more likely to observe an association between PND and CCD, while other studies which incorporated SES into their analysis found that PND was more likely to be significantly associated with CCD in high-risk, SES disadvantaged groups (e.g. Stein et al. 2008). However, it remains the case that several studies conducted in relatively low-risk, privileged SES groups observed a significant association between PND and CCD (Righetti-Veltema, 2003; McMahon et al., 2006; Murray, Arteche, et al. 2010).

Another potential moderator is depression severity. Previous research indicates the importance of severity of maternal depression on child outcomes (e.g. Petterson and Burke-Albers, 2001), however, a minority of studies identified here relied on a clinical diagnosis of depression, or analysed CCD by severity of maternal depression (e.g. Brennan et al. 2000). As such, it is not clear whether severity of PND may account for part of the inconsistency between different studies. Comparisons of study completers versus non-completers also indicated that in some instances, mothers with increased depression severity were less likely to complete the study (e.g. Evans et al. 2012) which may minimise the results obtained.

(Figure 2 here)

Mechanisms and Mediators:

Several of the studies reported above indicate that PND may impact on CCD through its effect on the quality of some aspect of mother-child interaction, while other potentially important mechanisms include genetic effects (Bartels, et al., 2003; Plomin, DeFries, Craig, McGuffin, 2003), and antenatal exposure to depression (Field et al,. 2004; O'Connor et al., 2005). Figure 2 shows a theoretical model of mediation paths form the impact of PND on CCD. PND may also have an effect on child development through its impact on maternal cognitions and attributions. Preoccupation is a particular kind of cognition symptomatic of depression, which Stein et al. (2009) propose, interferes with specific aspects of mental functioning, including attention and responsivity. Dix and Meunier (2009) also review the cognitive, affective, and motivational processes which impact on parenting competence as a result of parental depression. They found that depressive symptoms impact on parenting through reducing: child-oriented goals, attention to child input, and positive emotion; and increasing: negative appraisals of child and self-competence, positive evaluations of coercive parenting, and negative emotion. The strong evidence base linking parenting styles to child outcomes (e.g. Spera, 2005; Aunola & Nurmi, 2005; Paulussen-Hoogeboom, Stams, Hermanns, & Peetsma, 2007; Ermisch, 2008) may also indicate another way in which PND impacts on child development. The following mediators have been examined with CCD in particular in mind:

General responsiveness:

Research indicates that the quality of child-centred maternal responsiveness, in terms of contingency during mother-child interactions, is important for CCD (Eshel, Daelmans, Cabral, de Mello, & Martines, 2006). Reduced contingent responsiveness during mother-child interactions in the early postnatal period have been found to predict infant performance on operant learning tasks (Stanley, Murray, & Stein, 2004), and the effects are evident at 18 months postnatally on boys' functioning (Murray, Fiori-Cowley, et al. 1996), and at 3.5 years for both genders (Milgrom et al. 2004). Children whose mothers remained responsive despite depression appeared more able to benefit from future improvements in maternal well-being and functioning (Murray, Hipwell, Hooper, Stein & Cooper, 1996). A large scale longitudinal study (NICHD, 1999) found variability in maternal responsiveness linked to further adversity, with poor maternal responsiveness associated with increased risk of poor CCD, while children of mothers who remained responsive despite depression were protected somewhat from the negative effects of PND.

Attention Regulation: the ability to sustain attention during infancy is a strong indicator of cognitive performance during later childhood (Slater, 1995), and as such, differences in mother-child interactions which impact on attention regulation likely contribute towards CCD. Patterns of infant-directed maternal speech appear important in obtaining and preserving infant attention (Stern, Spieker, & MacKain, 1982). While the speech of non-depressed mothers was found to promote infant learning, the speech patterns of PND mothers failed to promote associative learning (Kaplan, Bachorowski, & Zarlengo-Strouse, 1999).

Dysregulation of emotion: Dysregulated affect has been shown to impair attention and disrupt information retrieval in infants (Fagen, Ohr, Fleckenstein, & Ribner, 1985). Postnatally depressed mothers' withdrawal and lack of emotion-regulation has been associated with increased cortisol levels in infants and children (Field et al., 1988). This may impact on cognition, as increased cortisol levels of 3-month-old infants appear linked to impaired memory and learning (Thompson & Trevathan, 2008).

Summary:

The findings from the above studies suggest that PND poses a risk for CCD and long-term functioning. This link appears inconsistent across different studies, however, and the association appears clearer in the context of broader SES difficulties and chronicity of depression. The long-term impact of PND on CCD in low-risk community samples appears primarily negligible or restricted to subgroups subjected to further risk factors, although there are some exceptions to this. PND alone appears to lack predictive power for CCD in the way which chronicity and, perhaps severity of maternal depression may.

Discussion:

In line with earlier research, it appears that PND may present a risk for reduced CCD and functioning, however, this effect is much more noticeable and consistent when depression is chronic or recurrent. While some studies found an association between PND and CCD seemingly irrespective of other factors, in the other cases it appears that an accumulation of risks including chronicity of maternal depression, attachment insecurity, child gender, and socioeconomic disadvantage impacted on CCD, which fits models of cumulative risk by Downey and Coyne (1990), and Goodman and Gotlib (1999). Some studies found that this association was mediated by mother-child interaction. It is notable that in a number of cases where PND was not found to be independently associated with CCD, this was frequently related to the impact of chronic or recurrent depression. As such, the results of this review suggest that PND may form a significant risk for CCD, but that this effect is likely to be greater in particular subgroups exposed to additional risks.

Methodological limitations:

Several methodological limitations should be considered when interpreting the results presented in this review. Particular caution should be exercised in interpreting the results due to the small sample size, and the heterogeneity of the studies included in the review. While only three studies utilised a clinical sample, only two of these assessed general cognitive development, with the majority of studies being low-risk community samples. A wide variety of different outcome measures were used, limiting the comparison of results between studies. Rather crucially, only two studies assessed the cognitive development of children aged above 11. This particularly limits what conclusions can be drawn about how PND may impact on CCD during adolescence. Limitations of the search strategy utilised should also be considered, in that an exhaustive search of all potentially relevant databases was not conducted, with the search limited to three databases.

A number of methodological limitations of the studies examined should also be considered. Perhaps most crucially, many studies did not report any details regarding the severity of depression, nor consider depression severity in the analyses conducted. Atkinson et al.'s (2000) meta-analysis indicates that depression in clinical samples was strongly associated with attachment security. As attachment security is thought to be a potential mediator of the impact of PND on CCD, increased depression severity is likely to strengthen any existing associations, which may also account for some inconsistencies in findings between studies. However, Brennan et al. (2000), who did examine the impact of depression severity, found that it was not significantly associated with the vocabulary scores of five-year-old children once potential confounding variables were controlled. Depression severity appears to co-occur with chronicity (Campbell & Cohn, 1997; Cornish et al. 2005; Sohr-Preston & Scaramella 2006), which is interesting considering the seemingly strong associations between chronicity of depression and CCD (e.g. Evans et al. 2012). While a substantial proportion of studies assessed maternal depression at multiple time points, and utilised this as a measure for chronicity of depression, this does not account for the possibility that mothers recovered from PND symptoms, and then experienced a recurrence of depression at the second time of measurement. In addition to this, chronicity or recurrence of depression may have a different impact from concurrent depressive symptoms, which could bias parental reports of child development.

A limitation in the ability of this review to make generalisations across the defined age span relates not only to the lack of studies examining adolescents, but concerns the weak correlation between measures of infant development and later measures of CCD (Columbo, 1993). This may account for some inconsistency between studies assessing CCD at different ages. In line with this, cognitive development is difficult to assess reliably in very young children of 12 months old (Quevedo et al., 2012). Interestingly, all studies assessing general cognitive development of children aged 12 months found no direct association between PND and CCD. As measures of development across childhood vary in exactly what abilities they measure, it is possible that those measuring the abilities of very young children lack the sensitivity to detect changes associated with PND. However, three studies conducted with children only slightly older (18 months) did detect significant differences. The development of measures of CCD which are more comparable across childhood would help clarify this issue.

Psychometrically evaluated measures of PND and CCD were used in all studies, however, some utilised part of evaluated measures only (e.g. Stein et al. 2008). In terms of sample sizes, five studies had <100 participants, while five studies had >500 participants, and only two studies had >1000. In studies with small sample sizes, there may have been insufficient power to detect subtle differences. In a number of studies (e.g. Kersten-Alvarez et al., 2012; Evans et al., 2012; Sutter-Dallay et al., 2011) participants who did not complete the study had significantly increased risk factors, including more severe depression from those that remained which could have resulted in more conservative effect sizes. In several studies it was unclear whether depression was confined to the postnatal period, was recurring, or chronic (Brennan et al., 2000; Kersten-Alvarez et al., 2012; Koutra et al., 2012; Milgrom et al., 2004; Quevedo et al,. 2012). As well as this, several studies relied on measures of symptom severity rather than formal clinical diagnoses of depression (e.g. Keim et al., 2011; Koutra et al., 2012; Stein et al., 2008; Sutter-Dallay et al., 2011) which may have resulted in differing exposure to depressive symptomatology for infants in different studies. Potential confounders were not taken into account in a number of studies, for example, maternal IQ, or paternal characteristics or care-giving (e.g. Sutter-Dallay et al., 2011; Stein et al., 2008).

Key observations about the studies included in this review may provide support for an association between PND and CCD. The studies reported each controlled for an extensive and varied set of potential confounders. As few of these potential confounders (particularly maternal IQ, and maternal responsiveness) were found to be significantly associated with CCD, PND was one of the most consistent factors found. Additionally, although this review focused on studies conducted in developed countries, the association between maternal PND and CCD has previously been shown across a range of countries and different cultures. The majority of studies reported significant differences between study completers and non-completers, with non-completers generally being exposed to greater risk factors. This indicates that studies may have a conservative estimate of the association, which may have been attenuated to trend levels on occasion, rather than reaching significance. Finally, the majority of studies recruited from community populations, with a notable proportion of low-risk samples, and as a result, the associations found may be generalizable to the wider population of childbearing women.

While it is important to recognise the seemingly inconsistent effect of PND on CCD in the above studies, it may also be important to recognise that almost all the above samples which found little or no direct effect (except for Cornish et al., 2005, and Brennan et al., 2000) were relatively low risk, and caution should be exercised when making generalisations to higher risk populations.

Clinical implications:

The apparent links between PND and CCD, particularly in conjunction with other risk factors, provides evidence for an upstream, preventative approach to child development difficulties through maternal mental health. These results were found in community and clinical samples, which suggests that psycho-social care and assessment are important as part of routine perinatal care. The strongest predictor of PND is antenatal depression (Beeghly et al. 2002), but mental health problems are commonly undetected during routine antenatal care. During the perinatal period, women are unlikely to discuss their mental health problems with others, particularly professionals (Woolhouse, Brown, Krastev, Perlen, & Gunn, 2009), therefore routine assessment of maternal mental health is essential both pre- and postnatally, and should include psychosocial assessment followed by referral or intervention as appropriate.

Psychotherapeutic interventions including cognitive behavioural therapy, interpersonal therapy, nondirective counselling, social support, and psychoanalytic therapy have been found to be moderately effective and beneficial in treating PND (Dennis & Hodnett, 2007; Cuijpers, Branmark & van Straten, 2008), however the majority of trials conducted are limited by short-term follow-up. Sockol et al.'s (2011) meta-analysis of treatments for perinatal depression established that treatment resulted in significant improvements in depressive symptomatology.

Due to the apparent impact of PND on child development, potential treatment is also being evaluated through its impact on mother-child interactions, and child development outcomes. A number of studies (Cooper, Murray, Wilson, & Romaniuk, 2003; Murray, Cooper, Wilson, & Romaniuk, 2003; Forman et al., 2007) have found that neither cognitive behavioural therapy, counselling, psychoanalytic, or interpersonal therapy had a consistently positive impact on infant outcomes, nor on mother-child interactions, and security of attachment, despite some improvement in depressive symptoms. Therapeutic input which focuses directly on improving parenting and mother-child interactions through prolonged psychotherapy (Cicchetti, Rogosch, & Toth, 2000), focusing on the mother-child interactions, interactive coaching (Horowitz et al., 2001), relationship facilitation (Hart, et al.,1998), and infant massage (Glover, Onozawa, & Hodgkinson, 2002; Onozawa, Glover, Adams, Modi, & Kumar, 2001) have all shown positive short-term effects in terms of cognitive development and mother-child interaction. Poobalan et al. (2007) conducted a meta-analysis which indicates that treatment of maternal postnatal depression can improve mother-child interactions and infant outcomes.

An alternative may be to attempt preventing PND occurring in at risk groups. A recent review of preventative interventions by the Cochrane Collaboration (Dennis & Dowswell, 2013) found that women who received either psychological or psychosocial intervention were significantly less likely to develop PND. These interventions included intensive, individualised postnatal home visits by midwives or nurses, telephone-based peer support, and interpersonal psychotherapy. They emphasised the importance of identifying women at risk of developing PND. Other research has examined the impact of PND interventions for reducing negative outcomes for child development. McLennan and Offord (2002) evaluated interventions targeting PND as a part of large-scale prevention for child developmental problems, and concluded that this had some potential as a prevention strategy, with several caveats related to the state of the evidence base at that time. Kingston et al. (2012) conclude that their systematic review addresses these caveats, supporting the above strategy further.

A viable alternative to treatment and preventative interventions may be to promote alternative caregivers, as infants of mothers with PND have been found to respond positively to their fathers (Hossain, Field, Gonzalez, Malphurs, & Del Valle, 1994), and levels of internalizing behaviour have been found to improve at 24 and 36 months when children received alternative care (Lee, Halpern, Hertz-Picciotto, Martin, & Suchindran, 2006). It is important, however, that alternative caregiving is provided prior to generalisation of negative interaction patterns to others (6-9 months) and is provided by a consistent other(s) so as to allow the development of secure attachments.

A preventative approach is particularly important for child cognitive development outcomes when considering the challenges apparent in detecting and treating child developmental problems. Service utilization by children with developmental issues is particularly low (<50%) (Tough et al. 2008), and preventative and treatment services for development and mental health are seldom available, or are difficult to access (Waddell, Hua, McEwan, Garland, & Peters, 2007). Maternal mental health may form one of the most modifiable influences on a young child's life, particularly when considering other developmental risk factors proximal to the child, including family-based factors, and those in the wider "meso"-environment, such social, economic, and political (Hertzman & Boyce, 2010). Interventions targeting PND may have a beneficial effect on overall family functioning, extending to the wider context.

While developmental assessments form a part of routine care up to the age of 18 months, a large proportion of children may not be identified as being at risk, nor appropriately referred for appropriate services (Tough et al., 2008). Primary care practitioners may benefit from further training in identifying developmental delay (Achenbach, 1991). Longer term follow-up of the infants of mothers who suffer from PND may also be helpful to allow early intervention for cognitive developmental delay.

Implications for Research:

Due to the increased risk of PND impacting on the cognitive development of children from disadvantaged SES groups, this group may be targeted for interventions, both prevention and treatment of PND. However, socioeconomically disadvantaged groups may be particularly difficult to engage. More research is needed to establish the relative efficacy of interventions for different at risk groups, but also in terms of improving engagement. General research into factors proximal to the child may be relevant here, in improving the acceptability of and engagement in interventions for hard-to-reach groups (e.g. Chorpita et al., 2008; Herschell et al., 2004; Silverman & Hinshaw, 2008). Further exploration of the mediational pathways between maternal PND and CCD would also contribute toward this area. Explicitly addressing pathways of influence from PND to CCD would inform intervention approaches. This would require longitudinal designs, which could also consider family and wider contextual factors which may protect children from developmental problems, or exacerbate the effects of PND (Kingston et al., 2012). These questions could best be addressed in large cohort studies, such as Evans et al. (2012), which would allow the sample size sufficient to consider a wide range of family and contextual factors, as well as such questions as depression chronicity and severity.

Research has begun to address the issue of paternal PND (Goodman, 2004), with evidence suggesting that paternal PND may also predict negative child outcomes, including increased rates of behavioural problems at three-and-a-half and seven years of age, particularly for boys (Ramchandani, Stein, Evans, O'Connor, et al., 2005; Ramchandani, et al. 2008). This association was independent of maternal depression, and other potential confounding factors, and appeared to be mediated through environmental rather than genetic factors (Ramchandani, et al., 2008). It is important, therefore, that paternal depression or care-giving is researched and considered both in its own right, but also in research examining the impact of maternal PND on child development, as it may be a crucial moderator.

An important area for future research concerns the role of depression severity on CCD, which could be important in identifying and managing risk (Kingston et al., 2012). Larger sample sizes would allow the sample to be split according to severity, while still retaining power for statistical analysis. Another potential moderator, and area for future research is child gender. As boys appear to be at greater risk for being negatively impacted on by PND, research which elucidates the causes for this would allow interventions to be more effectively targeted to address this risk factor.

References:

Achenbach, T.M. (1991). *Manual for the child behavior check list.* University of Vermont, Vermont.

Alpern, L., & Lyons-Ruth, K. (1993). Preschool children at social risk: Chronicity and timing of maternal depressive symptoms and child behavior problems at school and at home. *Development and Psychopathology, 5,* 371-387.

Amorim, P. (2000) Mini International Neuropsychiatric Interview (MINI): validação de entrevista breve para diagnóstico de transtornos mentais. *Revista Brasileira de Psiquiatria, 22,* 106–115.

Atkinson, L., Paglia, A., Coolbear, J., Niccols, A., Parker, K.C.H., & Guger, S. (2000). Attachment security: A meta-analysis of maternal mental health correlates. *Clinical Psychology Review, 20,* 1019-1040.

Aunola, K., & Nurmi, J. E. (2005). The role of parenting styles in children's problem behavior. *Child development, 76,* 1144-1159.

Bartels, M., Van den, B.M., Sluyter, F., Boomsma, D.I., de Geus, E.J. (2003): Heritability of cortisol levels: Review and simultaneous analysis of twin studies. *Psychoneuroendocrinology, 28,* 121–137.

Bayley, N. (1969). *Bayley Scales of Infant Development Manual.* University of California, Berkely. New York: The Psychological Corporation. Institute of Human Development.

Bayley, N. (1993). *Bayley Scales of Infant Development Manual.* San Antonio, TX: Psychological Corporation. Provost, Heimerl. and Lopez, 35.

Bayley, N. (2006). *Bayley Scales of Infant and Toddler Development, 3rd Edition*. The Psychological Corporation, San Antonio, TX.

Beck, A.T., Rush, A.J., Shaw, B.F., & Emery, G. (1979). *Cognitive therapy of depression.* Wiley, New York.

Bedford, A., & Foulds, G. (1978). Delusions-Symptoms-States Inventory of Anxiety and Depression. Windsor, England: National Foundation for Educational Research.

Beeghly, M., Weinberg, M.K., Olson, K.L., Kernan, H., Riley, J., & Tronick, E.Z. (2002). Stability and change in level of maternal depressive symptomatology during the first postpartum year. *Journal of Affect Disorders, 71,* 169–180

Blatt-Eisengart, I., Drabick, D. A., Monahan, K. C., & Steinberg, L. (2009). Sex differences in the longitudinal relations among family risk factors and childhood externalizing symptoms. *Developmental Psychology, 45,* 491.

Bowlby, J. (1988). *A secure base.* New York: Basic Books.

Boyce, P.M. (2003). Risk factors for postnatal depression: a review and risk factors in Australian populations. *Archives of Women's Mental Health, 6,* s43-s50

Brennan, P.A., Hammen, C., Andersen, M.J., Bor, W., Najman, J.M., & Williams, G.M. (2000). Chronicity, severity, and timing of maternal depressive symptoms: Relationships with child outcomes at age 5. *Developmental Psychology, 36,* 759–766.

Bzoch, K., & League, R. (1991). *Receptive-Expressive Emergent Language Scale Examiner's Manual* (2nd ed.). Austin: Pro-Ed.

Campbell, S. B., Brownell, C. A., Hungerford, A., Spieker, S. J., Mohan, R., & Blessing, J. S. (2004). The course of maternal depressive symptoms and maternal sensitivity as predictors of attachment security at 36 months. *Development and Psychopathology, 16,* 231-252.

Campbell, S.B. & Cohn, J.F. (1997). The timing and chronicity of postpartum depression: Implications for infant development. In L. Murray & Cooper, P. (Eds.), *Postpartum depression and child development* (pp. 165-197). New York: Guilford Press.

Caplan, H.L., Coghill, S.R., Alexandra, H., Robson, K.M., Katz, R., & Kumar, R. (1989). Maternal depression and the emotional development of the child. *British Journal of Psychiatry, 154,* 818-822.

Chorpita, B. F., Bernstein, A., & Daleiden, E. L. (2008). Driving with roadmaps and dashboards: Using information resources to structure the decision models in service organizations. *Administration and Policy in Mental Health, 35*, 114–123.

Cicchetti, D., Rogosch, F. A., & Toth, S. L. (1998). Maternal depressive disorder and contextual risk: Contributions to the development of attachment insecurity and behavior problems in toddlerhood. *Development and Psychopathology, 10*, 283–300.

Cicchetti, D., Rogosch, F.A., & Toth, S.L. (2000). The efficacy of toddler-parent psychotherapy for fostering cognitive development in offspring of depressed mothers. *Journal of Abnormal Child Psychology*, *28*, 135-148.

Clarke, L., Ungerer, J., Chahoud, k., Johnson, S., & Stiefel, I. (2002). Attention deficit hyperactivity disorder is associated with attachment security. *Journal of Clinical Child Psychology & Psychiatry, 7*, 179. DOI: 10.1177/1359104502007002006

Coan, J.A. (2008). Toward a neuroscience of attachment. In Cassidy, J. & Shaver, P.R. (Eds). *The Handbook of Attachment: Theory, Research and Clinical Implications, 2, 241-265.*

Cohn, J.F., Matias, R., Tronick, E.Z., Connell, D., & Lyons-Ruth, K. (1986). Face-to-face interactions of depressed mothers and their infants. In E.Z. Tronick & Field, T. (Eds.), *Maternal depression and infant disturbance* (pp. 31-46). San Francisco: Jossey-Bass.

Cohn, J.F., Campbell, S.B., Matias, R., & Hopkins, J. (1990). Face-to-face interactions of postpartum depressed and nondepressed mother-infant pairs at 2 months. *Developmental Psychology, 26*, 15-23.

Colombo, J. (1993). *Infant cognition: Predicting later intellectual functioning* (pp. 30-81). Newbury Park, CA: Sage publications.

Commission on Social Determinants of Health (2008). Closing the gap in a generation: health equity through action on the social determinants of health. *Final Report of the Commission on Social Determinants of Health*. World Health Organization, Geneva.

Conroy, S., Pariante, C.M., Marks, M.N., Davies, H.A., Farrelly, S., Schacht, R. & Moran, P. (2012). Maternal psychopathology and infant development at 18 months: The impact of maternal personality disorder and depression. *Journal of the American Academy of Child & Adolescent Psychiatry, 51*, 51-61.

Cooper, P.J., Murray, L., Wilson, A., & Romaniuk, H. (2003). Controlled trial of the short- and long-term effect of psychological treatment of post-partum depression. I. Impact on maternal mood. *British Journal of Psychiatry, 182*, 412-419.

Cornish, A.M., McMahon, C.A., Ungerer, J.A., Barnett, B., Kowalenko, N., Tennant, C. (2005). Postnatal depression and infant cognitive and motor development in the second postnatal year: the impact of depression chronicity and infant gender. *Infant Behavior and Development, 28*, 407–417.

Cox, J. L., Holden, J. M. & Sagovsky, R. (1987) Detection of postnatal depression: development of the 10-item Edinburgh Postnatal Depression Scale. *British Journal of Psychiatry, 150,* 782–786.

Cuijpers, P., Branmark, J.G., & van Straten, A. (2008). Psychological treatment of postpartum depression: A meta-analysis. *Journal of Clinical Psychology, 64,* 103-118.

Da Costa, D., Larouche, J., Dritsa, M., Brender, W. (2000). Psychosocial correlates of prepartum and postpartum depressed mood. *Journal of Affective Disorders, 59*, 13–40.

Dawson, G., Frey, K., Panagiotides, H., Self, J., Hessl, D., & Yamada, E. (1997). *Atypical frontal brain activity in infants of depressed mothers: The role of maternal behaviour.* Poster presented at the 1997 Meeting of the Society for Research in Child Development. Washington, D.C.

Dennis, C.L., & Dowswell, T. (2013). Psychosocial and psychological interventions for preventing postpartum depression (Review). *The Cochrane Collaboration. Wiley*.

Dennis, C.L., & Hodnett, E. (2007).Psychosocial and psychological interventions for treating postpartum depression. *Cochrane Database of Systematic Reviews* CD006116.

Downey, G., & Coyne, J. C. (1990). Children of depressed parents: An integrative review. *Psychological Bulletin, 108,* 50–76.

Dix, T. & Meunier, L.N. (2009). Depressive symptoms and parenting competence: An analysis of 13 regulatory processes. *Developmental Review, 29,* 45-68.

Dunn, L., & Dunn, L. M. (1981). *The Peabody Picture Vocabulary Test—Revised.* Circle Pines, MI: American Guidance Services.

Endicott, J., Spitzer, R. L., Fleiss, J. L.,& Cohen, J. (1976). The Global Assessment Scale. A procedure for measuring overall severity of psychiatric disorders. *Archives of General Psychiatry, 33,* 766-771.

Erlenmeyer-Kimling, L., & Cornblatt, B. (1978). Attentional measures in a study of children at high risk for schizophrenia. *Journal of Psychiatric Research, 14,* 93-98.

Ermisch, J. (2008). Origins of social immobility and inequality: parenting and early child development. *National Institute Economic Review, 205,* 62-71.

Eshel, N., Daelmans, B., Cabral de Mello, M., & Martines, J. (2006). Responsive parenting: Interventions and outcomes. *Bulletin of the World Health Organization, 84,* 992-998.

Essex, M.J., Klein, M., Miech, R., & Smider, N.A. (2001). Timing of initial exposure to maternal major depression and children's mental health symptoms in kindergarten. *British Journal of Psychiatry, 179,* 151-156.

Evans, J., Melotti, R., Heron, J., Ramchandani, P., Wiles, N., Murray, L., & Stein, A. (2012). The timing of maternal depressive symptoms and child cognitive development: A longitudinal study. *The Journal of Child Psychology and Psychiatry, 53,* 632-640. doi:10.1111/j.1469-7610.2011.02513.x

Fagen, J.W., Ohr, P.S., Fleckenstein, L.K., & Ribner, D.R. (1985). The effect of crying on long-term memory in infancy. *Child Development, 56,* 1584-1592.

Fenson, L., Pethick, S., Renda, C., Cox, J. L., Dale, P. S., & Reznick, J. S. (2000). Short form versions of the MacArthur communicative development inventories. *Applied Psycholinguistics, 21,* 95–115.

Field, T.M. (1984). Early interactions between infants and their postpartum depressed mothers. *Infant Behaviour and Development, 7,* 517-522.

Field, T., Diego, M., Hernandez-Reif, M., Vera, Y., Gil, K., Schanberg, S., et al. (2004). Prenatal predictors of maternal and newborn EEG. *Infant Behavior and Development, 27,* 533-536.

Field, T.M., Sandberg, D., Garcia, R., Vega-Lahr, N., Goldstein, S., & Guy, L. (1985). Pregnancy problems, postpartum depression, and early mother-infant interactions. *Developmental Psychology, 21,* 1152-1156.

Field, T., Healy, B., Goldstein, S., Perry, S., Bendell, D., Schamberg, S., Zimmerman, E., & Kuhn, G. (1988). Infants of depressed mothers show ‘‘depressed’’ behavior even with non-depressed adults. *Child Development, 60,* 1569–1579.

First, M.B., Spitzer, R.L., Gibbon, M., Williams, J.B.W. (2001). *Structured Clinical Interview for DSM-IV-TR Axis I Disorders, Research Version, Non-Patient Edition (SCID-I/NP).* New York: Biometrics Research.

Forman, D.R., O'Hara, M.W., Stuart, S., Gorman, L.L., Larson, K.E., & Coy, K.C. (2007). Effective treatment for postpartum depression is not sufficient to improve the developing mother-child relationship. *Development and Psychopathology, 19,* 585-602.

Frankenburg, W.K., & Dodds, J.B. (1967). The Denver Developmental Screening Test. *The Journal of Pediatrics, 71,* 181–191.

Gaynes, B.N., Gavin, N., Meltzer-Brody, S., Lohr, K.N., Gartlehner, G., Brody, S., & Miller, W.C. (2005). Perinatal depression: prevalence, screening accuracy, and screening outcomes. *AHRQ Evidence Report Summaries, 119,* 1–8.

Ghodsian, M., Zajicek, E., & Wolkind, S. (1984). A Longitudinal-Study of Maternal Depression and Child-Behavior Problems. *Journal of Child Psychology and Psychiatry, 25,* 91-109.

Glover, V., Onozawa, K., & Hodgkinson, A. (2002). Benefits of infant massage for mothers with postnatal depression. *Seminars in Neonatology, 7,* 495-500.

Goldberg, D. (1982). *General Health Questionnaire Manual.* National Foundation for Educational Research, Windsor, UK.

Goldberg,D., Cooper, B., Eastwood, M. T., Kedward,H. B., & Shepherd, M. (1970). A standardised psychiatric interview for use in community surveys. *British Journal of Preventive Social Medicine, 24,* 18-23.

Goodman, S.H. & Gotlib, I.H. (1999). Risk for Psychopathology in Children of Depressed Mothers: A Developmental Model for Understanding Mechanisms of Transmission. *Psychological Review, 106,* 458-90.

Goodman, J.H. (2004). Postpartum depression beyond the early postpartum period. *Journal of Obstetric, Gynecologic, & Neonatal Nursing in Review, 33, 410-420*. DOI: 10.1177/0884217504266915

Goodman, S.H., Rouse, M.H., Connell, A.M., Broth, M.R., Hall, C.M., & Heyward, D. (2011). Maternal depression and child psychopathology: A meta-analytic review. *Journal of Clinical Child and Family Psychology Review, 14*, 1-27. DOI 10.1007/s10567-010-0080-1

Grace, S.L., Evindar, A., & Stewart, D.E. (2003). The effect of postpartum depression on child cognitive development and behaviour: A review and critical analysis of the literature. *Archives of Women's Mental Health, 6,* 263-274.

Halligan, S.L., Murray, L., Martins, C., & Cooper, P.J. (2007). Maternal depression and psychiatric outcomes in adolescent offspring: A 13-year longitudinal study. *Journal of Affective Disorders, 97,* 145-154.

Hamilton, M. (1976). Hamilton Depression Scale. In W. Guy, *ECDEU assessment manual for psychopharmacology* (revised ed., pp. 179–192). Rockville, MD: National Institute for Mental Health.

Harrison, P. L., Kaufman, A. S., Kaufman, N. L., Bruininks, R. H., Rynders, J., Ilmer, S., et al. (1990). AGS early screening profiles. *Journal of Psychoeducational Assessment, 13*, 101–104.

Hart, S., Field, T., & Nearing, G. (1998). Depressed mothers' neonates improve following the MABI and a Brazelton demonstration. *Journal of Pediatric Psychology, 23*, 351-356.

Hay, D. F. (1997). Postpartum depression and cognitive development. In L. Murray & P. Cooper (Eds.), *Postpartum depression and child development* (pp. 85-110). New York: Guilford Press.

Hay, D.F., Pawlby, S., Sharp, D., Asten, P., Mills, A., & Kumar, R. (2001). Intellectual problems shown by 11-year-old children whose mothers had postnatal depression. *Journal of Child Psychology and Psychiatry, 42,* 871–889.

Hay, D.F., Pawlby, S., Waters, C.S., & Sharp, D. (2008). Antepartum and postpartum exposure to maternal depression: Different effects on different adolescent outcomes. *Journal of Child Psychology and Psychiatry, 49,* 1079–1088.

Herschell, A. D., McNeil, C. B., & McNeil, D. W. (2004). Clinical child psychology's progress in disseminating empirically supported treatments. *Clinical Psychology: Science and Practice, 11,* 267–288.

Hertzman, C. (1998). The case for child development as a determinant of health. *Canadian Journal of Public Health, 89,* S14–S21.

Hertzman, C. (2009). The state of child development in Canada: are we moving toward, or away from, equity from the start? *Paediatric Child Health, 14,* 673–676.

Hertzman, C., Boyce, T. (2010). How experience gets under the skin to create gradients in developmental health. *Annual Review of Public Health, 31*, 329–347

Horowitz, J.A., Bell, M., Trybulski, J., Munro, B.H., Moser, D., Hartz, S.A. et al. (2001). Promoting responsiveness between mothers with depressive symptoms and their infants. *Journal of Nursing Scholarship, 33,* 323-329.

Hossain, Z., Field, T., Gonzalez, J., Malphurs, J., & Del Valle, C. (1994). Infants of "depressed" mothers interact better with their non-depressed fathers. *Infant Mental Health, 15,* 348-357.

Hsu, C. C., Su, S., Shao, S. J., Lin, C. C., Soong, W. T., & Chang, C. (1978). Chinese child development inventory: a tentative normative data. *Acta Paediatrica Sinica, 19,* 142-152.

Kaplan, P. S., Bachorowski, J.-A., & Zarlengo-Strouse, P. (1999). Child-directed speech produced by mothers with symptoms of depression fails to promote associative learning in four-month old infants. *Child Development, 70,* 560–570.

Keim, S.A., Daniels, J.L., Dole, N., Herring, A.H., Siega-Riz, A.M. & Scheidt, P.C. (2011). A prospective study of maternal anxiety, perceived stress, and depressive symptoms in relation to infant cognitive development. *Early Human Development, 87,* 373-380.

Kersten-Alvarez, L.E., Hosman, C.M.H., Riksen-Walraven, J.M., van Doesum, K.T.M., Smeekens, S., & Hoefnagels, C. (2012). Early school outcomes for children of postpartum depressed mothers: comparison with a community sample. *Child Psychiatry and Human Development,* 43, 201–218. DOI 10.1007/s10578-011-0257y

Kingston , D., Tough , S. & Whitfield, H. (2012) Prenatal and postpartum maternal psychological distress and infant development: A systematic review. *Child Psychiatry and Human Development. 43,* 683–714. DOI 10.1007/s10578-012-0291-4

Koutra, K., Chatzi, L., Bagkeris, M., Vassilaki, M., Bitsios, P., & Kogevinas, M. (2012). Antenatal and postnatal maternal mental health as determinants of infant neurodevelopment at 18 months of age in a mother–child cohort (Rhea Study) in Crete, Greece. *Social Psychiatry and Psychiatric Epidemiology*, 1-11.

Lee, L. C., Halpern, C. T., Hertz-Picciotto, I., Martin, S. L., & Suchindran, C. M. (2006). Child care and social support modify the association between maternal depressive symptoms and early childhood behaviour problems: a US national study. *Journal of Epidemiology and Community Health, 60,* 305-310.

Marmot, M. (2010). *Fair society, healthy lives.* Department of Health, London.

Martins, C., & Gaffan, E. A. (2000). Effects of early maternal depression on patterns of infant-mother attachment: a meta-analytic investigation. *Journal of Child Psychology and Psychiatry, 41*, 737-746.

Maughan, A., Cicchetti, D., Toth, S. L., & Rogosch, F. A. (2007). Early-occurring maternal depression and maternal negativity in predicting young children's emotion regulation and socioemotional difficulties. *Journal of Abnormal Child Psychology, 35,* 685-703.

McCarthy, D. (1972). *McCarthy Scales of Children's Abilities.* New York: Psychological Corporation.

McLennan, J. D., & Offord, D. R. (2002). Should postpartum depression be targeted to improve child mental health? *Journal of the American Academy of Child & Adolescent Psychiatry, 41,* 28-35.

McMahon, C. A., Barnett, B., Kowalenko, N. M., & Tennant, C. C. (2006). Maternal attachment state of mind moderates the impact of postnatal depression on infant attachment. *Journal of Child Psychology and Psychiatry, 47,* 660-669.

McMahon, C., Trapolini, T., Cornish, A., & Ungerer, J. (2008). The impact of postnatal depression on child cognitive functioning at four years. *The Australian Educational and Developmental Psychologist, 25,* 49-61.

McManus, S., Meltzer, H., Brugha, T., Bebbington, P., & Jenkins, R. (2009). *Adult psychiatric morbidity in England, 2007: Results of a household survey.* London, UK: NHS Information Centre for Health and Social Care.

Milgrom, J., Westley, D. T., & Gemmill, A. W. (2004). The mediating role of maternal responsiveness in some longer term effects of postnatal depression on infant development. *Infant Behavior and Development, 27,* 443-454.

Mullen, E. (1995). *Mullen Scales of Early Learning.* Circle Pines, MN: American Guidance Service, Inc.

Murray. L, (1992). The impact of postnatal depression on infant development. *Journal of Child Psychology & Psychiatry & Allied Disciplines, 33,* 543–561.

Murray, L., Arteche, A., Fearon, P., Halligan, S., Croudace, T., & Cooper, P. (2010). The effects of maternal postnatal depression and child sex on academic performance at age 16 years: A developmental approach. *Journal of Child Psychology and Psychiatry, 51,* 1150–1159.

Murray, L. & Cooper, P. (1997). The role of infant and maternal factors in postpartum depression, mother-infant interactions and infant outcomes. In L. Murray & P. Cooper (Eds.) *Postpartum depression and child development.* The Guilford Press: London.

Murray, L., Cooper, P. J., Wilson, A., & Romaniuk, H. (2003). Controlled trial of the short- and long-term effect of psychological treatment of post-partum depression 2. Impact on the mother—child relationship and child outcome. *The British Journal of Psychiatry, 182,* 420-427.

Murray, L., Fiori-Cowley, A., Hooper, R., & Cooper, P. (1996). The impact of postnatal depression and associated adversity on early mother-infant interactions and later infant outcome. *Child Development, 67,* 2512–2526.

Murray, L., Halligan, S., & Cooper, P.J. (2010). Effects of postnatal depression on mother-infant interactions, and child development. In T. Wachs, & G. Bremmer (Eds.), *Wiley-Blackwell handbook of infant development* (pp. 192–220). Oxford, UK: Wiley-Blackwell.

Murray, L., Hipwell, A., Hooper, R., Stein, A., & Cooper, P. (1996). The cognitive development of 5-year-old children of postnatally depressed mothers. *Journal of Child Psychology and Psychiatry, 37,* 927–935.

Murray, L., Kempton, C., Woolgar, M., & Hooper, R. (1993). Depressed mothers' speech to their infants and its relation to infant gender and cognitive development. *Journal of Child Psychology & Psychiatry & Allied Disciplines, 34,* 1083–1101.

Murray, L., Sinclair, D., Cooper, P., Ducournau, P., Turner, P., & Stein, A. (1999). The socioemotional development of 5-year-old children of postnatally depressed mothers. *Journal of Child Psychology and Psychiatry, 40,* 1259-1271.

Murray, L., Stanley, C., Hooper, R., King, F., & Fiori-Cowley, A. (1996). The role of infant factors in postnatal depression and mother-infant interactions. *Developmental Medicine and Child Neurology, 38,* 109-119.

Murray, L., Woolgar, M., Cooper, P., & Hipwell, A. (2001). Cognitive Vulnerability to Depression in 5-year-old Children of Depressed Mothers. *Journal of Child Psychology and Psychiatry, 42,* 891-899.

NICHD, Early Child Care Research Network. (1999). Chronicity of maternal depressive symptoms, maternal sensitivity and child functioning at 36 months. *Developmental Psychology, 35,* 1297-1310.

O'Hara, M., & Swain, A. (1996). Rates and risk of postpartum depression – A meta-analysis. *International Review of Psychiatry, 8,* 37-54.

Onozawa, K., Glover, V., Adams, D., Modi, N., & Kumar, R. (2001). Infant massage improves mother infant interaction for mothers with postnatal depression. *Journal of Affective Disorders, 63,* 201-207.

Paulussen-Hoogeboom, M. C., Stams, G. J. J., Hermanns, J., & Peetsma, T. T. (2007). Child negative emotionality and parenting from infancy to preschool: A meta-analytic review. *Developmental Psychology, 43,* 438.

Petterson, S. M., & Albers, A. B. (2001). Effects of poverty and maternal depression on early child development. *Child Development, 72,* 1794–1813.

Plomin, R., DeFries, J.C., Craig, I.W., & McGuffin, P. (2003). *Behavioral Genetics in the Postgenomic Era.* American Psychological Association: Washington.

Poobalan, A. S., Aucott, L. S., Ross, L., Smith, W. C. S., Helms, P. J., & Williams, J. H. (2007). Effects of treating postnatal depression on mother–infant interaction and child development Systematic review. *The British Journal of Psychiatry, 191,* 378-386.

Quevedo, L. A., Silva, R. A., Godoy, R., Jansen, K., Matos, M. B., Tavares Pinheiro, K. A., & Pinheiro, R. T. (2012). The impact of maternal post-partum depression on the language development of children at 12 months. *Child: Care, Health and Development, 38,* 420-424.

Radloff, L. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement, 1,* 385-401.

Ramchandani, P., Stein, A., Evans, J., & O'Connor, T. G. (2005). Paternal depression in the postnatal period and child development: a prospective population study. *Obstetrical & Gynecological Survey, 60,* 789-790.

Ramchandani, P.G., Stein, A., O'Connor, T.G., Heron, J., Murray, L., & Evans, J. (2008). Depression in men in the postnatal period and later child psychopathology: A population cohort study. *Journal of the American Academy of Child and Adolescent Psychiatry, 47,* 390–398.

Reynell, J. (1990). *Reynell Developmental Langauge Scales (U.S. Edition).* Western Psychological Services, Los Angeles, CA, USA.

Righetti-Veltema, M., Bousquet, A. & Manzano, J. (2003). Impact of postpartum depressive symptoms on mother and her 18-month-old infant. *European Child & Adolescent Psychiatry, 12,* 75–83. DOI 10.1007/s00787-003-0311-9

Rosvold, H. E., Mirsky, A. F., Sarason, I., Bransome, E. D., & Beck, L. H. (1956). A continuous performance test of brain damage. *Journal of Consulting Psychology, 20,* 343-350.

Rust, J. (1993). *Wechsler Objective Reading Dimensions (WORD).* London: The Psychological Corporation.

Rust, J. (1995). *Wechsler Objective Numerical Dimensions (WOND).* London: The Psychological Corporation.

Sharp, D., Hay, D.F., Pawlby, S., Schmucker, G., Allen, H., & Kumar, R. (1995). The impact of postnatal depression on boys' intellectual development. *Journal of Child Psychology and Psychiatry, 36,* 1315–1336.

Slater, A. (1995). Individual differences in infancy and later IQ. *Journal of Child Psychology and Psychiatry, 36*, 69-112.

Sockol, L. E., Epperson, C. N., & Barber, J. P. (2011). A meta-analysis of treatments for perinatal depression. *Clinical Psychology Review*, *31,* 839-849.

Sohr-Preston, S. L. (2006). Implications of timing of maternal depressive symptoms for early cognitive and language development. *Clinical Child & Family Psychology Review, 9,* 65-83.

Silverman, W. K., & Hinshaw, S. P. (2008). The second special issue on evidence-based psychosocial treatments for children and adolescent: A 10-years update. *Journal of Clinical Child and Adolescent Psychology, 37*, 1–7.

Spera, C. (2005). A review of the relationship among parenting practices, parenting styles, and adolescent school achievement. *Educational Psychology Review, 17,* 125-146.

Spitzer, R. L., Endicott, J., & Robbins, E. (1978). *The Schedule for Affective Disorders and Schizophrenia-Lifetime version* (SADS-L; 3rd ed.). New York: Biometric Research.

Spitzer, R., Williams, J., & Gibbon, M. (1995). *Structured Clinical Interview for DSM-IV (SCID).* New York: New York State Psychiatric Institute, Biometrics Research

Spitzer, R. L., Williams, J. B., Kroenke, K., Linzer, M., Hahn, S. R., Brody, D., & Johnson, J. G. (1994). Utility of a new procedure for diagnosing mental disorders in primary care. *JAMA: the journal of the American Medical Association*, *272*, 1749-1756.

Stanley, C., Murray, L., & Stein, A. (2004). The effect of postnatal depression on mother-infant interaction, infant response to the still-face perturbation, and performance on an instrumental learning task. *Development and Psychopathology, 16,* 1-18.

Stein, A., Malmberg, L. E., Sylva, K., Barnes, J., & Leach, P. (2008). The influence of maternal depression, caregiving, and socioeconomic status in the post-natal year on children's language development. *Child: Care, Health and Development, 34,* 603-612.

Stern, D.N., Spieker, S., & MacKain, K. (1982). Intonation contours as signals in maternal speech to prelinguistic infants. *Developmental Psychology, 18*, 727-735.

Sutter-Dallay, A. L., Murray, L., Dequae-Merchadou, L., Glatigny-Dallay, E., Bourgeois, M. L., & Verdoux, H. (2011). A prospective longitudinal study of the impact of early postnatal vs. chronic maternal depressive symptoms on child development. *European Psychiatry, 26(8),* 484-489.

Thompson, L. A., & Trevathan, W. R. (2008). Cortisol reactivity, maternal sensitivity, and learning in 3-month-old infants. *Infant Behavior and Development, 31,* 92-106.

Torres, N., Maia, J., Veríssimo, M., Fernandes, M., & Silva, F. (2012). Attachment security representations in institutionalized children and children living with their families: links to problem behaviour. *Clinical Psychology & Psychotherapy, 19,* 25-36.

Tough, S.C., Siever, J.E., Leew, S., Johnston, D.W., Benzies, K., & Clark, D. (2008). Maternal mental health predicts risk of developmental problems at 3 years of age: follow up of a community based trial. *BMC Pregnancy Childbirth 8*, 16.

Uzgiris, I.C., & Hunt, J. (1975) *Assessment in Infancy. Ordinal Scales of Psychological Development*. University of Illinois Press: Urbana; Chicago; London

Wachs, T.D., Black, M.M., & Engle, P. (2009). Maternal depression: A global threat to children's health, development, and behaviour and to human rights. *Child Development Perspectives, 3*, 51-59.

Waddell, C., Hua, J.M., McEwan, K., Garland, O., Peters, R. (2007). Preventing mental disorders in children. *Canadian Journal of Public Health, 98,* 174–178..

Wang, S.Y., Chen, C.H., Chin, C.C., & Lee, S.L. (2005). Impact of Postpartum Depression on the Mother-Infant Couple. *Birth, 32,* 39-44.

Wechsler, D. (1989). *Wechsler Preschool and Primary Scale of Intelligence—Revised manual.* San Antonio: The Psychological Corporation.

Wechsler, D. (1992). *The Wechsler Intelligence Scale for Children (WISC-IIIUK).* London: The Psychological Corporation.

Wechsler, D. (1999). *The Wechsler Abbreviated Scale of Intelligence (WASI).* New York: The Psychological Corporation.

Weinberg, M.K., Olson, K.L., Beeghly, M., & Tronick, M.Z. (2006). Making up is hard to do, especially for mothers with high levels of depressive symptoms and their infant sons. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 47,* 670-683.

Weinberg, M. K., & Tronick, E. Z. (1998). The impact of maternal psychiatric illness on infant development. *Journal of Clinical Psychiatry, 59,* 53-61.

Woolhouse, H., Brown, S., Krastev, A., Perlen, S., & Gunn, J. (2009). Seeking help for anxiety and depression after childbirth: results of the maternal health study. *Archive of Women's Mental Health, 12,* 75–83.

World Health Organisation (1997). *Composite International Diagnostic Interview (CIDI).*

Wrate, R.M., Rooney, A.C., Thomas, P.F., & Cox, J.L. (1985). Postnatal depression and child development: A three-year follow-up study. *British Journal of Psychiatry, 146*, 622-627.

Wright, C.A., George, T.P., Burke, R., Gelfand, D.M., & Teti, D.M. (2000). Early maternal depression and children's adjustment to school. *Child Study Journal, 30,* 153-168.

Zajicek-Farber, M. L. (2010). The contributions of parenting and postnatal depression on emergent language of children in low-income families. *Journal of Child and Family Studies*, *19*, 257-269.

Tables:

Table 1: Key aspects of studies assessing the impact of maternal postnatal depression (PND) on global child cognitive development (CCD) (n=13)

Study	Design and sample	Participants & recruitment	Measures	Results	Strengths	Limitations
Clinical Populations:						
Milgrom et al. (2004) Journal: Infant Behavior and Development Impact Factor: 1.669	3.5-year Longitudinal Clinical sample (mother-baby psychiatric unit, Australia) Controls recruited from community health centres.	N=56 (n=23 PND & n=33 controls). Broad socio-geographic range.	**Maternal:** Hamilton Depression Rating Scale (HDRS, Hamilton, 1976); (6, 12, 24, and 42 months). **Child:** Wechsler Preschool Primary Scale of Intelligence (WPPSI-R; Wechsler, 1989); (42 months) The Early Screening Profiles (ESP) (Harrison et al. 1990)	Reduced IQ was found for children of PND mothers at 42 months, $F(1,50) = 5.59$, $p = 0.022$; with boys more vulnerable to this effect than girls $F(1,50) = 3.99$, $p = 0.05$. Lowered maternal responsiveness at 6 months mediated this association.	No apparent differences between completers and non-completers.	Based in Australia, limiting applicability to UK population. No assessment of prenatal depression High attrition rate – 65% completed, but no significant difference found between completers and non-completers. Small sample size. Depressed group non-typical, as admitted to inpatient facility.
Cornish et al. (2005) Journal: Infant Behavior	11-month Longitudinal Australia Clinical population	N=112 (n=39 PND, n=38 Chronic depression, n=35 controls)	**Maternal:** Centre for Epidemiological Studies Depression Scale (CES-D; Radloff, 1977) (4, 12 &15 months); The Composite International	Chronic maternal depression was associated with lower infant cognitive scores, $t(1)=6.61$, $p<.025$. Brief depression had no significant effect on cognitive development.	Adjusted for key potential confounders of gender, education, maternal age, mother bilingual. High retention of participants. PND formally diagnosed rather than	Based in Australia, limiting applicability to the UK population. Relatively low risk sample, limiting generalizability.

and Development Impact Factor: 1.669	(Centre for infant problems)	Non-poverty sample.	Diagnostic Interview (CIDI; World Health Organisation, 1997); (4, & 12 months) **Child:** Receptive-Expressive Emergent Language Test (REEL-2; Bzoch & League, 1991) (12 months) Bayley Scales of Infant Development (BSID-II; Bayley, 1993) (15 months).	There was no effect found for language development.	reliance on symptomatic measures. PND assessed on three separate occasions.	
Community Samples (High-Low Risk)						
Hay et al. (2001) Journal: Journal of Child Psychology and Psychiatry Impact Score: 4.281	11-year Longitudinal UK Community sample	N=132 mothers and their children (n=29 PND, n=103 controls) Disadvantaged SES.	**Maternal:** Clinical Interview Schedule (CIS; Goldberg, et al. 1970), (prenatally, 14 & 36 weeks, 3 & 12 months); the Schedule for Affective Disorders and Schizophrenia-Lifetime Version (SADS-L; Spitzer, Endicott, & Robbins, 1978); (4 and 11 years); the Global Assessment Scale (GAS; Endicott, Spitzer, Fleiss, & Cohen, 1976) (11 years) **Child:** Wechsler Intelligence Scale for Children (WISC-III; Wechsler, 1992)	PND significantly associated with lower IQ scores, $t(130)=3.0$, $p<.01$; attentional problems, R^2 change = .06, $F(1,122)=11.08$, $p<.001$. Children of postnatally depressed mothers were twelve times as likely to have some Special Educational Needs. Effects were greater for boys than girls, $F(1,128)+4.62$, $p<.04$; particularly on Performance IQ, $B=18.00$ (95%CI: 5.23 to 30.77, $p<.006$). Child behaviour, parental later	Sample highly representative, increasing generalizability. High retention of participants. 71 fathers also took part. Controlled for maternal IQ, the father's IQ in some cases; chronic depression, SES, child's sex, mother's educational qualifications, social class, parity, family structure, and the assessor's report of child behaviour, maternal global functioning, breast-feeding duration, home environment factors, and teachers' reports of the child's	Relatively small sample, and small sample of PND mothers. No account taken of depression severity.

			(11 years); Wechsler Objective Reading Dimensions (WORD; Rust, 1993) (11 years); Wechsler Objective Numerical Dimensions (WOND; Rust, 1995) (11 years); Continuous Performance Test (CPT; Erlenmeyer-Kimling & Cornblatt, 1978; Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956) (11 years)	mental health, IQ and SES did not account for these associations.	behaviour. No significant differences between study completers and non-completers. PND assessed on two separate occasions.	
Hay et al. (2008) Follow-up of Hay et al. (2001) Journal: Journal of Child Psychology and Psychiatry Impact Score: 4.281	16-year Longitudinal UK Community sample.	121 (n=26 PND, & n=95 controls) Disadvantaged SES. High proportion of families from ethnic minorities.	**Maternal:** CIS (14, 20, & 36 weeks prenatally; 3 & 12 months); SADS-L (4, 11 & 16 years) Interviewed (11 & 16 years) **Child:** WISC-III (11 years) Wechsler Abbreviated Scale of Intelligence (WASI; 16 years)	PND still had a significant effect on adolescent IQ, for boys in particular, once antenatal and subsequent episodes of depression were controlled, $F(2,116) = 5.13$, $p < .001$, adjusted $R2 = .12$. Maternal anxiety, smoking and alcohol use, and intrauterine environment during pregnancy did not account for results.	No significant differences between study completers and non-completers. Sample representative of other disadvantaged urban populations. PND assessed on two separate occasions.	Insufficient statistical power to detect small differences.

Conroy et al. 2012 Journal: Journal of the American Academy of Child & Adolescent Psychiatry Impact Factor: 6.444	16 month-Longitudinal UK Community sample	N= 170 High proportion of non-English-speaking backgrounds.	**Maternal:** Patient Health Questionnaire (PHQ-9; Spitzer et al. 1994); Structured Clinical Interview to DSM-IV Axis I Disorders Non-Patient Edition (SCID-I NP; First et al. 2001) (2 & 18 months) **Child:** Mental Scale (MDI) of BSID-II (18 months)	Infants of women with PND had significantly reduced cognitive development in comparison with women with no depression, (mean =86.27 and SD = 19.47 versus 92.95 and SD = 16.81; t = 2.39, *p* =.02). Linear Regression models showed that PND predicted child cognitive development scores, b coefficient = -7.26, 95% CI= -13.04, -1.47), p<.05, independent of later depression.	Clinical diagnosis of depression. 85% retained at follow-up Measure of depression at two time points. Community sample may improves generalisability of findings. Controlled for occupational status, ethnicity, partner status, and maternal depression at time 2, infant gender and maternal sensitivity included.	High proportion of non-English speaking backgrounds may have impacted on infants' comprehension of the assessment. Severity of depression not taken into account. Non-random sample
Koutra et al. 2012 Journal: Social Psychiatry and Psychiatric Epidemiology Impact Factor: 2.696	18-month Longitudinal (Crete, Greece) Community sample	N=693 (n=223 antenatal depression, & 470 PND).	**Maternal:** Edinburgh Postnatal Depression Scale (Cox, Holden, & Sagovsky, 1987) (prenatally & 8 weeks) **Child:** Bayley Scales of Infant and Toddler Development (BSITD-III; Bayley, 2006).	PND associated with decreased cognitive development, independent of antenatal depression, β coefficient --7.51, 95 % CI: -15.46, 0.44. Antenatal depression associated with decreased cognitive development independent of PND, β coefficient -5.94, 95 % CI: -11.83, -0.05.	Large number of potential confounding variables considered, including child gender, behaviour during assessment, delivery type, gestational age, breastfeeding duration, child care until 18th month, maternal education, maternal origin, parity, employment status. Relatively large sample. Population-based.	Based in Greece, limiting applicability to UK population. Chronicity or severity of depression not taken into account. No clinical diagnosis of depression. High attrition rate (47.4%).

					Multi-scale measures of infant development. No significant differences between study completers and non-completers.	
Righetti-Veltema et al. (2003) Journal: European Child & Adolescent Psychiatry Impact Factor: 2.821	18-month Longitudinal Switzerland Community sample	N= 70 (n=35 PND & n=35 controls) 50% had professional occupation.	**Maternal:** EPDS (last trimester, 3 months and 18 months) **Child**: Infant Behavior Record of the Bayley Scales of Infant Development (Bayley, 1969; (18 months); Object Concept Task (Uzgiris & Hunt, 1975); Denver Developmental Screening Test (Frankenburg & Dodds (1967); 18 months)	PND associated with reduced performance on object concept tasks, 42.9% of infants of PND mothers versus 77.1% of infants of well mothers achieving age appropriate level (p<.001). PND associated with failure to execute two or three orders (p=.008).	Controlled for infant sex, mother's age, socio-professional status, and antenatal birth preparation.	Based in Switzerland, limiting applicability to UK population. Small sample size, limiting generalisability. Significance may be due to chance findings due to small sample sizes in individual analysis. Midwives' qualitative evaluation of mothers did not correspond with EPDS scores above 12. Did not control for SES.
McMahon et al. (2008) Follow-up of Cornish et al.	4-year Longitudinal Community sample Australia	N=92 (n=26 PND, & n= 66 current depression and controls) High level of education & SES	**Maternal:** CES-D (4, 12 & 15 months); CIDI (4, 12, & 15 months, & 4 years) **Child:** WPPSI-R (4 years)	Independent of subsequent depression, children of mothers with PND had lower verbal IQ scores M=107.85; SD = 9.91 versus mothers without, M=113.97; SD=11.66; F(3,81) =5.16, p<.05, Cohen's d=.56.	Depression assessed at multiple time-points. Assessors of child development blind to mother's depression status. Variables taken into account: maternal education, non-English-	Based in Australia, limiting applicability to UK population. Mothers recruited from population experiencing difficulty managing their infants' unsettled behaviour, therefore non-depressed group may

Journal: The Australian Educational and Developmental Psychologist **No Impact Factor**				No significant effects were found for the performance scale. No gender differences were found.	speaking background, child gender.	also be experiencing some difficulties. This "parentcraft" hospital may represent an early intervention. Relatively small sample size. Fairly high attrition rate of 28%.
Murray, Arteche, et al. (2010) Journal: Journal of Child Psychology and Psychiatry Impact Factor: 4.281	16-year Longitudinal UK Community sample	N=89 (n=50 PND & n=39 controls). High SES.	**Maternal:** EPDS (6 weeks) Standardized Psychiatric Interview (SPI; Goldberg et al. 1970) (2 months); SADS-L (18 months; 5 years); the Structured Clinical Interview for DSM-IV (Spitzer, Williams, & Gibbon, 1995) (8, 13 & 16 years) **Child:** Bayley Scales Mental Development Index (MDI; Bayley, 1969) (18 months); the McCarthy Scale of Children's Abilities General Cognitive Index	Boys of mothers with PND received poorer GCSE results than controls, ($F = 4.18$, $p<.05$, $\eta^2 = 0.4$). Strong continuity of impact of PND on child cognitive functioning from infancy. Bayley r = .27, p<.05; McCarthy r = .41, p<.05; WISC r =.35, p<.05. The negative impact of PND on poorer GCSE performance was mediated by mother-child interactions, at 5 years (r = .34, p < .01) and 8 years (r = .31, p < .05). No significant effects of chronic or recent maternal depression exposure	High retention rate (94%). Repeated measures of child cognitive functioning and maternal mental health. Identified difficulties parenting as mediator. PND screening was followed by clinical diagnosis.	Relatively small sample size, Monte Carlo simulation indicated a larger sample size would be required to confirm the suspected negative association between PND and child IQ. Relatively low risk sample, potentially limiting generalizability.

			(GCI; McCarthy, 1972) (5 years); WISC-III (8 years); General Certificate of Secondary Education (GCSE)	on child cognitive functioning.		
Evans et al. (2012) Journal: Journal of Child Psychology and Psychiatry Impact Factor: 4.281	8-year Longitudinal UK Community sample (Avon Longitudinal Study of Parents and Children)	N= 5,029 mother/child pairs	**Maternal:** Edinburgh Postnatal Depression Scale (EPDS; Cox et al. 1987) (Weeks 18 & 32 of pregnancy, 8 weeks, 8, 21 or 33 months - 6 occasions up to 3 years) **Child:** WISC-III (8 years)	Only antenatal exposure had a more significant impact than any other depressive period, or simple accumulation of depressive episodes. No significant effect of PND on IQ was found independently of depression at other times, but a significant effect of antenatal depression was found, -3.19 (95% CI: -4.33 to -2.06, p<.001), but this effect was reduced following adjustment for potential confounding factors, -0.64 (95% CI: -1.68 to 0.40). No interaction was found between depression at any time point and child gender, maternal education, social class or household disposable income on child IQ.	Large sample size, allowing investigation of subgroups. 43 potential confounding variables considered, including, socioemotional environment of the household (e.g. aggression/affection scores; crowding; parental substance use, child educational attainment). Frequency of repeated depressive symptom measures.	Relatively high attrition rate. Mothers with missing data appeared to be more at risk of depression, which may underestimate effect size. No random allocation to period of exposure, therefore, definite conclusions regarding sensitive periods cannot be made. No diagnostic interviews. No measure of anxiety which frequently co-occurs with depression.

Sutter-Dallay et al. (2011) Journal: European Psychiatry Impact Factor: 2.766	2-year Longitudinal (France) Community sample	N=598 mother/child pairs	**Maternal**: Mini International Neuropsychiatric Interview (MINI; Amorim, 2000); (8th month of gestation) EPDS (3 days, 6 weeks, 3, 6, 12, 18 & 24 months) **Child:** the Neonatal Behavioural Assessment Scale (Brazelton, 1984) (3 days) BSID- II (3, 6, 12, 18 & 24 months)	Depressive symptoms at 6 weeks were associated with poorer child cognitive outcome, β coefficient -1.11, 95 % CI: -1.92, -0.30, $p = .007$; but this became non-significant once adjusted for chronicity of depressive symptoms, β coefficient -0.85, 95 % CI: -1.57, 0.05, $p =.07$.	Relatively large sample size. Frequent and repeated assessments of maternal mood, frequent, independent assessment of CCD. Controlled for adjusted for gender of the child, maternal age, educational level, mean income, and parity.	Based in France, limiting applicability to UK population. Some differences between study completers and non-completers. Non-completers were younger, had a lower educational level, and a lower income. Relatively low risk sample, may not be generalizable to high risk populations. No clinical interviews to diagnose depression. Influence of father not taken into account. No assessment of any new pregnancies during study follow-up.
Wang et al. 2005 Journal: Birth Impact Factor: 2.182	11-month Longitudinal China Community sample	N=60 (n=29 PND, & n=31 control)	**Maternal:** Beck Depression Inventory (BDI; Beck et al. 1979) (6 weeks after childbirth) **Child:** The Chinese Child Development Inventory (CCDI;	No significant association between PND and CCD.	High retention rate 83.78%.	Based in China, limiting applicability to UK population. Symptomatic measure used, no clinical diagnosis of depression. Small sample size. Mother-rated measure of infant

			adapted from Minnesota Child Development Inventory; Hsu et al., 1978) (12 months)			development, may be subject to bias. No measure of depression at any other time, not controlled for chronicity of depression.
Keim et al. (2011) Journal: Early Human Development Impact Factor: 2.046	1-year Longitudinal USA Community sample (Pregnancy, Infection, and Nutrition Study; PIN)	358 mother-infant dyads. Relatively high level of education and support	Maternal: CES-D (24-29 weeks prenatally) EPDS (4 months) Child: Mullen Scales of Early Learning (MSEL, Mullen, 1995) (12 months)	PND symptoms were positively associated with expressive language in a non-linear fashion.	First study to highlight u-shapes associations. Further studies may attempt to replicate this. Controlled income, pre-pregnancy body mass index (BMI), education, social support, self-esteem, maternal age, infant sex, gestational age, presence of a spouse/partner, and one or more of trait anxiety, and perceived stress. Assessed multiple aspects of infant development, which do not rely on maternal report, therefore less biased. Focus on measures assessing symptoms rather than diagnosis allow looking at associations across the whole spectrum.	Based in USA, limiting applicability to UK population. Relied on symptom screeners rather than formal clinical diagnosis. Women with greater depressive symptoms and risk factors were less likely to participate in follow-up. Lack of generalizability due to not being general population sample. Small sample size. Depression assessed at one time point postnatally. Relatively low risk population.

Table 2. Key aspects of studies assessing the impact of maternal postnatal depression (PND) on child language development (CCD) (n=5)

Study	**Design and sample**	**Participants & recruitment**	**Measures**	**Results**	**Strengths**	**Limitations**
Kersten-Alvarez et al. (2012) Journal: Child Psychiatry and Human Development Impact Factor: 1.934	4.7 year Longitudinal Netherlands Clinical (PND group) and community (control group) samples.	N=142 (n=29 PND clinical, & n=113 control)	**Maternal:** Pre-existing diagnosis of depression during the postnatal period, or scored above clinical cut-off on the BDI **Child:** the Peabody Picture Vocabulary Test-Revised (PPVT-R; Dunn & Dunn 1981) (5.7 years)	Girls of mothers who suffered from PND showed reduced verbal intelligence, (F = 6.50, p<.05, η_p^2 = 0.12).	Controlled for child age, child sex, maternal education, partner conflict, separation from father and number of stressful life events.	Based in Netherlands, limiting applicability to UK population. Study non-completers had significantly lower education level. Control/community mothers may not have been free of depression. Other risk factors not controlled for in this study, eg. chronicity, severity and comorbidity of mother's depression, or paternal characteristics. PND mothers and controls recruited from different populations, potentially influencing demographics of the samples in unknown ways. Small sample of PND mothers. 69% of PND participants retained, 90% of control sample retained.

Zajicek-Farber (2010) Journal: Journal of Child and Family Studies Impact Factor: 1.118	Cross-sectional USA High-risk population	N=198 (n=109 PND, n=81 control) High-risk Latino and African/American sample. 70% of mothers lacked basic education. 20% of mothers had learning difficulties. Low SES	**Maternal:** EPDS (16-18 months) **Child:** MacArthur Communicative Development Inventories (CDI; Fenson et al. 2000) (16-18 months)	PND and parenting knowledge had a direct and indirect interaction with risky parental practices $t(196)=-4.79$, $p=.001$; and exposure to literacy oriented activities, $t(196)=6.46$, $p=.001$; and language, $t(196)=3.01$, $p=.003$. The effects of parenting and maternal mental health on language development was mediated by involvement in literacy oriented stimulation activities (R2 = .43). The effect on boys was greater than on girls. Maternal depression was not found to have a significant direct effect on language.	High risk sample	Based in USA, limiting applicability to UK population. Child age ranged from 16 – 18 months of age. Retrospective EPDS may not be biased. Relatively small, self-selected sample which precludes generalizations. CDI has not been normed or examined as a measure in socioeconomically disadvantaged populations. Gender was the only potential confounding variable considered which may influence language development. No information was gathered about other caregivers.
Quevedo et al. (2012) Journal: Child: Care, Health and	11-month Longitudinal (Brazil) Community sample.	N=296 (n=21 PND, n= 275 current depression and controls)	**Maternal:** MINI (1 to 2 months and 12 months) **Child:** Bayley Scales of Infant and Toddler Development III (Bayley, 2006). (12	PND at both times was significantly associated with infant language development, and this effect was greater with increased chronicity, β coefficient -2.87, 95 % CI:	Controlled for SES, maternal age, whether the mother lives with her partner, infant birthweight, type of delivery, duration of breastfeeding, child illness during the past month,	Based in Brazil, limiting applicability to UK population. It was not possible to distinguish between recurrent and chronic depression.

Development Impact factor: 1.201			months)	-5.01, -0.64.	sex of the child, parity, primary caregiver and duration of maternal depression were taken into account.	Severity of depression was not taken into consideration in analysis, due to low number of mothers with severe depression.
Stein et al. (2008) Journal: Child: Care, Health and Development Impact factor: 1.201	2.75-year Longitudinal UK Community sample	N=944 mother/child pairs	**Maternal:** EPDS (3, & 10 months). General Health Questionnaire (GHQ) (Goldberg, 1982) (36 months) **Child:** Reynell Developmental Language Scale (RDLS (Reynell 1990), (36 months)	According to bivariate analysis, PND and not concurrent depression (36 months) was associated with child language development, at 3 (r = -0.10, $P < 0.01$) and 10 months (r = -0.10, $P < 0.01$). Structural Equation Modelling showed depression at 10 and 36 months was associated with poorer care-giving, (b = -0.09; $P < 0.05$) and (b = -0.14; $P < 0.001$), but not directly with language. Poor quality care-giving was associated with lower language scores, bunstand = 4.08; se = 0.57; standardized bs were 0.09 ($P < 0.001$) and 0.29 ($P < 0.001$). The effects of depression on caregiving were more pronounced in SES disadvantaged groups, (b = -	Large sample size, allowing the sample to be split on SES. Maternal depression measured repeatedly, and twice during postnatal year. Demographically diverse sample. SEM utilised information on child gender, birth order and bilingualism; partnership/marital status; education; income prior to maternity leave and postnatally; and mothers and their partner's occupational status.	No clinical interview to diagnose depression. Measure of maternal IQ was not obtained. Father's care-giving was not assessed.

				0.21; *P* < 0.01), than in the advantaged group (b = -0.13; *P* < 0.05).		
Brennan et al. (2000) Journal: Developmental Psychology Impact Factor: 3.214	5-year Prospective Longitudinal (Australia) Community Cohort	N=4,953 mothers of children born between 1981 and 1984 in public hospital. Low SES	**Maternal:** Interviews conducted and Delusions-Symptoms-Status Inventory (Bedford, & Foulds, 1978), BDI (Prenatally, 3-4 days postpartum, 6 months, &5 years). **Child:** PPVT-R (5 years)	Depression severity was associated with vocabulary development score, $F(1,3704)=11.08$, $p<0.01$, with a beta of -0.05 and an R^2 of 0.003; as was chronicity, $F(1,3704)=8.06$, $p<.01$, with a beta of -.05 and an R^2 of 0.002; but not timing of depressive episodes.	Blind-to-hypothesis assessment of cognitive development. Controlled for gender, birth order of child, maternal age, education, family income, number of changes in marital status. Multiple assessments and large initial sample.	Based in Australia, limiting applicability to UK population. Limited generalizability of sample to general population. High attrition rate 30% Some significant differences between study completers and non-completers, in terms of risk factors, and maternal depression severity. Therefore, may be a conservative estimate of true association Not clear if depression was chronic, or reoccurring.

Figures:

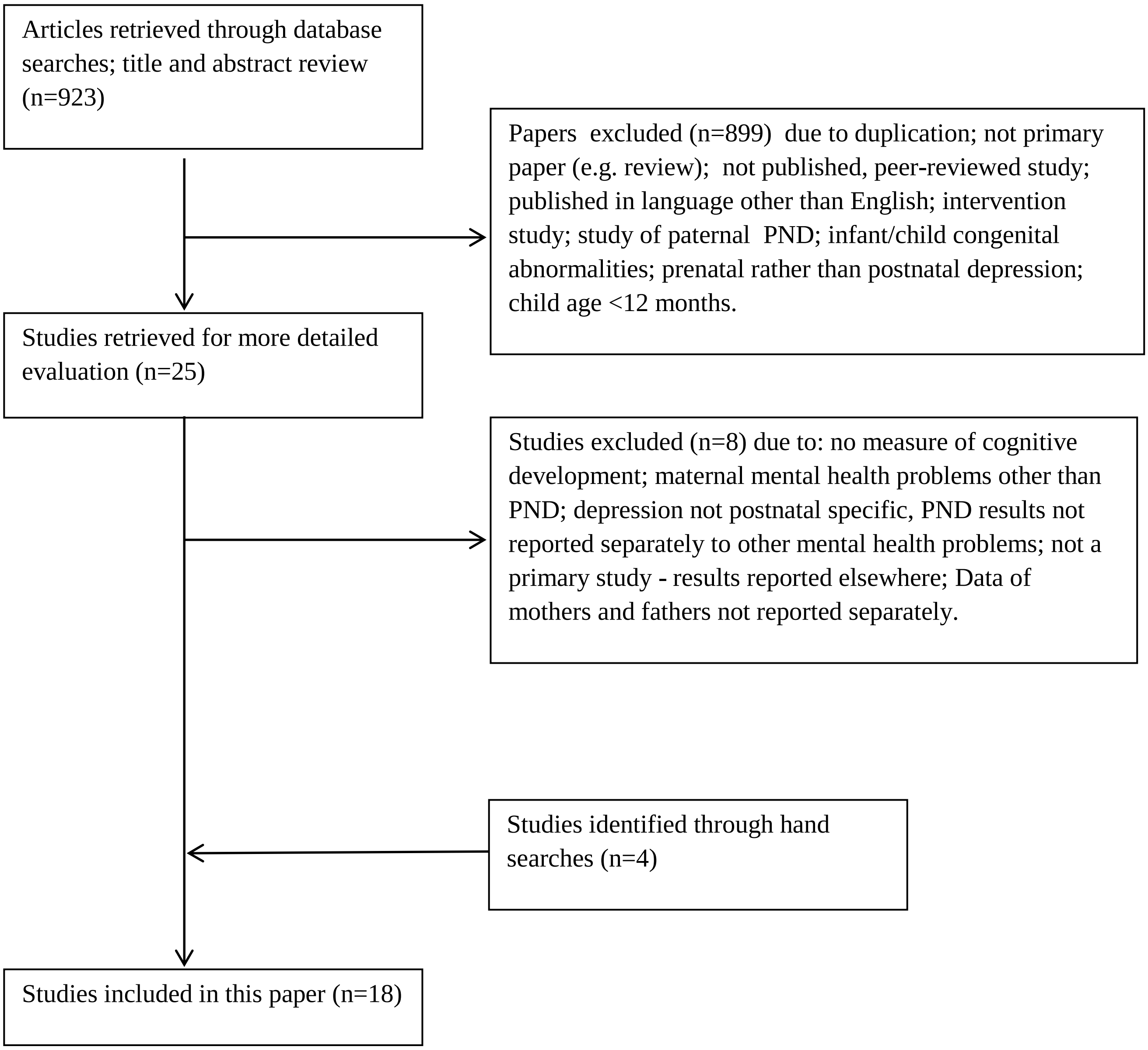

Figure 1. Flow diagram of search results and excluded studies.

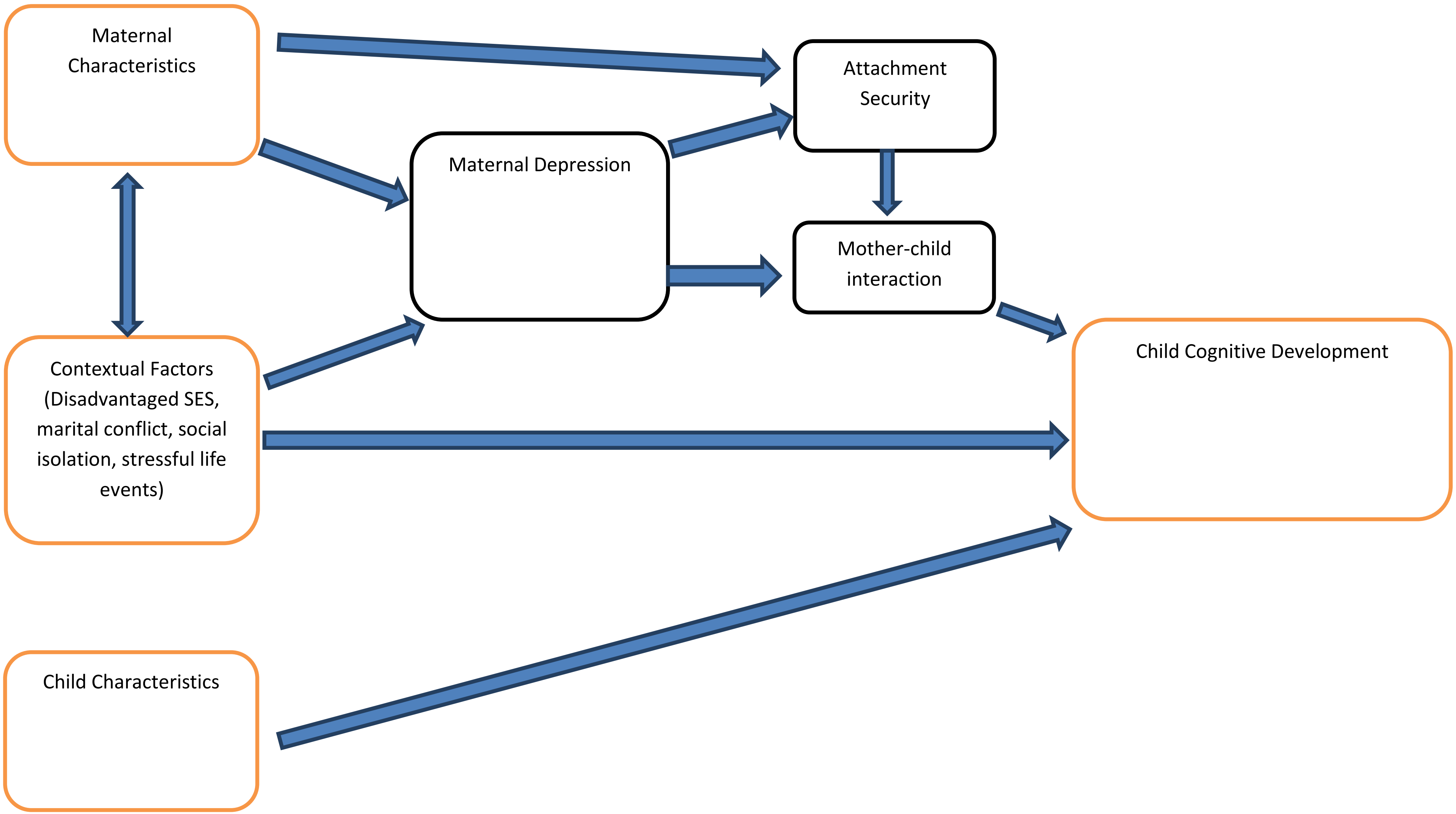

Figure 1. Model of how maternal depression impacts on child development.